

O. R. TAMBO DISTRICT MUNICIPALITY



Contract No: MIS 266 088 B

NTSONYINI NGQONGWENI REGIONAL WATER SUPPLY SCHEME PHASE 2A:

CONSTRUCTION OF NTSONYINI NGQONGWENI OFF-CHANNEL STORAGE DAM – CONTRACT 2

SEPTEMBER 2026

VOLUME 2

(NON-PRINTABLE AND NON-RETURNABLE VOLUME)

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BID AMOUNT:

CSD SUPPLIER NUMBER:

CLOSING DATE & TIME:

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CONTRACT No: MIS 266 088 B

NTSONYINI NGQONGWENI REGIONAL WATER SUPPLY SCHEME

PHASE 2A:

**CONSTRUCTION OF NTSONYINI NGQONGWENI OFF-CHANNEL STORAGE DAM –
CONTRACT 2**

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PORTION 1: TENDER

PART T1: TENDERING PROCEDURES

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PART T1.3: STANDARD CONDITION OF TENDER

The Standard Conditions of Tender that shall govern, shall be the Standard Conditions of Tender as contained in Annex C of the CIDB Standard for Uniformity as published in Government Gazette No 42622 of 8 August 2019 as amended and supplemented by the Tender Data in Part T1.2.

The complete extract entitled “Annex C” is bound hereafter into this volume.

Annex C

Standard Conditions of Tender

C.1 General

C.1.1 Actions

C.1.1.1 The employer and each tenderer submitting a tender offer shall comply with these conditions of tender. In their dealings with each other, they shall discharge their duties and obligations as set out in C.2 and C.3, timeously and with integrity, and behave equitably, honestly and transparently, comply with all legal obligations and not engage in anticompetitive practices.

C.1.1.2 The employer and the tenderer and all their agents and employees involved in the tender process shall avoid conflicts of interest and where a conflict of interest is perceived or known, declare any such conflict of interest, indicating the nature of such conflict. Tenderers shall declare any potential conflict of interest in their tender submissions. Employees, agents and advisors of the employer shall declare any conflict of interest to whoever is responsible for overseeing the procurement process at the start of any deliberations relating to the procurement process or as soon as they become aware of such conflict and abstain from any decisions where such conflict exists or recuse themselves from the procurement process, as appropriate.

Note: 1) A conflict of interest may arise due to a conflict of roles which might provide an incentive for improper acts in some circumstances. A conflict of interest can create an appearance of impropriety that can undermine confidence in the ability of that person to act properly in his or her position even if no improper acts result.

2) Conflicts of interest in respect of those engaged in the procurement process include direct, indirect or family interests in the tender or outcome of the procurement process and any personal bias, inclination, obligation, allegiance or loyalty which would in any way affect any decisions taken.

C.1.1.3 The employer shall not seek and a tenderer shall not submit a tender without having a firm intention and the capacity to proceed with the contract.

C.1.2 Tender Documents

The documents issued by the employer for the purpose of a tender offer are listed in the tender data.

C.1.3 Interpretation

C.1.3.1 The tender data and additional requirements contained in the tender schedules that are included in the returnable documents are deemed to be part of these conditions of tender.

C.1.3.2 These conditions of tender, the tender data and tender schedules which are required for tender evaluation purposes, shall form part of any contract arising from the invitation to tender.

C.1.3.3 For the purposes of these conditions of tender, the following definitions apply:

a) **conflict of interest** means any situation in which:

- i) someone in a position of trust has competing professional or personal interests which make it difficult to fulfill his or her duties impartially;
- ii) an individual or tenderer is in a position to exploit a professional or official capacity in some way for their personal or corporate benefit; or
- iii) incompatibility or contradictory interests exist between an employee and the tenderer who employs that employee.

b) **comparative offer** means the price after the factors of a non-firm price and all unconditional discounts it can be utilised to have been taken into consideration;

- c) **corrupt practice** means the offering, giving, receiving or soliciting of anything of value to influence the action of the employer or his staff or agents in the tender process;
- d) **fraudulent practice** means the misrepresentation of the facts in order to influence the tender process or the award of a contract arising from a tender offer to the detriment of the employer, including collusive practices intended to establish prices at artificial levels;

C.1.4 Communication and employer's agent

Each communication between the employer and a tenderer shall be to or from the employer's agent only, and in a form that can be readily read, copied and recorded. Communications shall be in the English language. The employer shall not take any responsibility for non-receipt of communications from or by a tenderer. The name and contact details of the employer's agent are stated in the tender data.

C.1.5 Cancellation and Re-Invitation of Tenders

C.1.5.1 An employer may, prior to the award of the tender, cancel a tender if-

- a) due to changed circumstances, there is no longer a need for the engineering and construction works specified in the invitation;
- b) funds are no longer available to cover the total envisaged expenditure; or
- c) no acceptable tenders are received.
- d) there is a material irregularity in the tender process.

C.1.5.2 The decision to cancel a tender invitation must be published in the same manner in which the original tender invitation was advertised

C.1.5.3 An employer may only with the prior approval of the relevant treasury cancel a tender invitation for the second time.

C.1.6 Procurement procedures

C.1.6.1 General

Unless otherwise stated in the tender data, a contract will, subject to C.3.13, be concluded with the tenderer who in terms of C.3.11 is the highest ranked or the tenderer scoring the highest number of tender evaluation points, as relevant, based on the tender submissions that are received at the closing time for tenders.

C.1.6.2 Competitive negotiation procedure

C.1.6.2.1 Where the tender data require that the competitive negotiation procedure is to be followed, tenderers shall submit tender offers in response to the proposed contract in the first round of submissions. Notwithstanding the requirements of C.3.4, the employer shall announce only the names of the tenderers who make a submission. The requirements of C.8 relating to the material deviations or qualifications which affect the competitive position of tenderers shall not apply.

C.1.6.2.2 All responsive tenderers or at least a minimum of not less than three responsive tenderers that are highest ranked in terms of the evaluation criteria stated in the tender data shall be invited to enter into competitive negotiations based on the principle of equal treatment, keeping confidential the proposed solutions and associated information.

Notwithstanding the provisions of C.2.17, the employer may request that tenders be clarified, specified and fine-tuned in order to improve a tenderer's competitive position provided that such clarification, specification, fine-tuning or additional information does not alter any fundamental aspects of the offers or impose substantial new requirements which restrict or distort competition or have a discriminatory effect.

C.1.6.2.3 At the conclusion of each round of negotiations, tenderers shall be invited by the employer to revise their tender offer based on the same evaluation criteria, with or without adjusted weightings. Tenderers shall be advised when they are to submit their best and final offer.

C.1.6.2.4 The contract shall be awarded in accordance with the provisions of C.3.11 and C.3.13 after tenderers have been requested to submit their best and final offer.

C.1.6.3 Proposal procedure using the two stage-system

C.1.6.3.1 Option 1

Tenderers shall in the first stage submit technical proposals and, if required, cost parameters around which a contract may be negotiated. The employer shall evaluate each responsive submission in terms of the method of evaluation stated in the tender data, and in the second stage negotiate a contract with the tenderer scoring the highest number of evaluation points and award the contract in terms of these conditions of tender.

C.1.6.3.2 Option 2

C.1.6.3.2.1 Tenderers shall submit in the first stage only technical proposals. The employer shall invite all responsive tenderers to submit tender offers in the second stage, following the issuing of procurement documents.

C.1.6.3.2.2 The employer shall evaluate tenders received during the second stage in terms of the method of evaluation stated in the tender data, and award the contract in terms of these conditions of tender.

C.2 Tenderer's obligations

C.2.1 Eligibility

C.2.1.1 Submit a tender offer only if the tenderer satisfies the criteria stated in the tender data and the tenderer, or any of his principals, is not under any restriction to do business with employer.

C.2.1.2 Notify the employer of any proposed material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used by the employer as the basis in a prior process to invite the tenderer to submit a tender offer and obtain the employer's written approval to do so prior to the closing time for tenders.

C.2.2 Cost of tendering

C.2.2.1 Accept that, unless otherwise stated in the tender data, the employer will not compensate the tenderer for any costs incurred in the preparation and submission of a tender offer, including the costs of any testing necessary to demonstrate that aspects of the offer complies with requirements.

C.2.2.2 The cost of the tender documents charged by the employer shall be limited to the actual cost incurred by the employer for printing the documents. Employers must attempt to make available the tender documents on its website so as not to incur any costs pertaining to the printing of the tender documents.

C.2.3 Check documents

Check the tender documents on receipt for completeness and notify the employer of any discrepancy or omission.

C.2.4 Confidentiality and copyright of documents

Treat as confidential all matters arising in connection with the tender. Use and copy the documents issued by the employer only for the purpose of preparing and submitting a tender offer in response to the invitation.

C.2.5 Reference documents

Obtain, as necessary for submitting a tender offer, copies of the latest versions of standards, specifications, conditions of contract and other publications, which are not attached but which are incorporated into the tender documents by reference.

C.2.6 Acknowledge addenda

Acknowledge receipt of addenda to the tender documents, which the employer may issue, and if necessary apply for an extension to the closing time stated in the tender data, in order to take the addenda into account.

C.2.7 Clarification meeting

Attend, where required, a clarification meeting at which tenderers may familiarize themselves with aspects of the proposed work, services or supply and raise questions. Details of the meeting(s) are stated in the tender data.

C.2.8 Seek clarification

Request clarification of the tender documents, if necessary, by notifying the employer at least five (5) working days before the closing time stated in the tender data.

C.2.9 Insurance

Be aware that the extent of insurance to be provided by the employer (if any) might not be for the full cover required in terms of the conditions of contract identified in the contract data. The tenderer is advised to seek qualified advice regarding insurance.

C.2.10 Pricing the tender offer

C.2.10.1 Include in the rates, prices, and the tendered total of the prices (if any) all duties, taxes except Value Added Tax (VAT), and other levies payable by the successful tenderer, such duties, taxes and levies being those applicable fourteen (14) days before the closing time stated in the tender data.

C.2.10.2 Show VAT payable by the employer separately as an addition to the tendered total of the prices.

C.2.10.3 Provide rates and prices that are fixed for the duration of the contract and not subject to adjustment except as provided for in the conditions of contract identified in the contract data.

C.2.10.4 State the rates and prices in Rand unless instructed otherwise in the tender data. The conditions of contract identified in the contract data may provide for part payment in other currencies.

C.2.11 Alterations to documents

Do not make any alterations or additions to the tender documents, except to comply with instructions issued by the employer, or necessary to correct errors made by the tenderer. All signatories to the tender offer shall initial all such alterations.

C.2.12 Alternative tender offers

C.2.12.1 Unless otherwise stated in the tender data, submit alternative tender offers only if a main tender offer, strictly in accordance with all the requirements of the tender documents, is also submitted as well as a schedule that compares the requirements of the tender documents with the alternative requirements that are proposed.

C.2.12.2 Accept that an alternative tender offer must be based only on the criteria stated in the tender data or criteria otherwise acceptable to the employer.

C.2.12.3 An alternative tender offer must only be considered if the main tender offer is the winning tender.

C.2.13 Submitting a tender offer

C.2.13.1 Submit one tender offer only, either as a single tendering entity or as a member in a joint venture to provide the whole of the works identified in the contract data and described in the scope of works, unless stated otherwise in the tender data.

C.2.13.2 Return all returnable documents to the employer after completing them in their entirety, either electronically (if they were issued in electronic format) or by writing legibly in non-erasable ink.

C.2.13.3 Submit the parts of the tender offer communicated on paper as an original plus the number of copies stated in the tender data, with an English translation of any documentation in a language other than English, and the parts communicated electronically in the same format as they were issued by the employer.

C.2.13.4 Sign the original and all copies of the tender offer where required in terms of the tender data. The employer will hold all authorized signatories liable on behalf of the tenderer. Signatories for tenderers proposing to contract as joint ventures shall state which of the signatories is the lead partner whom the employer shall hold liable for the purpose of the tender offer.

C.2.13.5 Seal the original and each copy of the tender offer as separate packages marking the packages as "ORIGINAL" and "COPY". Each package shall state on the outside the employer's address and identification details stated in the tender data, as well as the tenderer's name and contact address.

C.2.13.6 Where a two-envelope system is required in terms of the tender data, place and seal the returnable documents listed in the tender data in an envelope marked "financial proposal" and place the remaining returnable documents in an envelope marked "technical proposal". Each envelope shall state on the outside the employer's address and identification details stated in the tender data, as well as the tenderer's name and contact address.

C.2.13.7 Seal the original tender offer and copy packages together in an outer package that states on the outside only the employer's address and identification details as stated in the tender data.

C.2.13.8 Accept that the employer will not assume any responsibility for the misplacement or premature opening of the tender offer if the outer package is not sealed and marked as stated.

C.2.13.9 Accept that tender offers submitted by facsimile or e-mail will be rejected by the employer, unless stated otherwise in the tender data.

C.2.14 Information and data to be completed in all respects

Accept that tender offers, which do not provide all the data or information requested completely and in the form required, may be regarded by the employer as non-responsive.

C.2.15 Closing time

C.2.15.1 Ensure that the employer receives the tender offer at the address specified in the tender data not later than the closing time stated in the tender data. Accept that proof of posting shall not be accepted as proof of delivery.

C.2.15.2 Accept that, if the employer extends the closing time stated in the tender data for any reason, the requirements of these conditions of tender apply equally to the extended deadline.

C.2.16 Tender offer validity

C.2.16.1 Hold the tender offer(s) valid for acceptance by the employer at any time during the validity period stated in the tender data after the closing time stated in the tender data.

C.2.16.2 If requested by the employer, consider extending the validity period stated in the tender data for an agreed additional period with or without any conditions attached to such extension.

C.2.16.3 Accept that a tender submission that has been submitted to the employer may only be withdrawn or substituted by giving the employer's agent written notice before the closing time for tenders that a tender is to be withdrawn or substituted. If the validity period stated in C.2.16 lapses before the employer evaluating tender, the contractor reserves the right to review the price based on Consumer Price Index (CPI).

C.2.16.4 Where a tender submission is to be substituted, a tenderer must submit a substitute tender in accordance with the requirements of C.2.13 with the packages clearly marked as "SUBSTITUTE".

C.2.17 Clarification of tender offer after submission

Provide clarification of a tender offer in response to a request to do so from the employer during the evaluation of tender offers. This may include providing a breakdown of rates or prices and correction of arithmetical errors by the adjustment of certain rates or item prices (or both). No change in the competitive position of tenderers or substance of the tender offer is sought, offered, or permitted.

Note: *Sub-clause C.2.17 does not preclude the negotiation of the final terms of the contract with a preferred tenderer following a competitive selection process, should the Employer elect to do so.*

C.2.18 Provide other material

C.2.18.1 Provide, on request by the employer, any other material that has a bearing on the tender offer, the tenderer's commercial position (including notarized joint venture agreements), preferencing arrangements, or samples of materials, considered necessary by the employer for the purpose of a full and fair risk assessment.

Should the tenderer not provide the material, or a satisfactory reason as to why it cannot be provided, by the time for submission stated in the employer's request, the employer may regard the tender offer as non-responsive.

C.2.18.2 Dispose of samples of materials provided for evaluation by the employer, where required.

C.2.19 Inspections, tests and analysis

Provide access during working hours to premises for inspections, tests and analysis as provided for in the tender data.

C.2.20 Submit securities, bonds and policies

If requested, submit for the employer's acceptance before formation of the contract, all securities, bonds, guarantees, policies and certificates of insurance required in terms of the conditions of contract identified in the contract data.

C.2.21 Check final draft

Check the final draft of the contract provided by the employer within the time available for the employer to issue the contract.

C.2.22 Return of other tender documents

If so instructed by the employer, return all retained tender documents within twenty-eight (28) days after the expiry of the validity period stated in the tender data.

C.2.23 Certificates

Include in the tender submission or provide the employer with any certificates as stated in the tender data.

C.3 The employer's undertakings

C.3.1 Respond to requests from the tenderer

C.3.1.1 Unless otherwise stated in the tender Data, respond to a request for clarification received up to five (5) working days before the tender closing time stated in the Tender Data and notify all tenderers who collected tender documents.

C.3.1.2 Consider any request to make a material change in the capabilities or formation of the tendering entity (or both) or any other criteria which formed part of the qualifying requirements used to prequalify a tenderer to submit a tender offer in terms of a previous procurement process and deny any such request if as a consequence:

- a) an individual firm, or a joint venture as a whole, or any individual member of the joint venture fails to meet any of the collective or individual qualifying requirements;
- b) the new partners to a joint venture were not prequalified in the first instance, either as individual firms or as another joint venture; or
- c) in the opinion of the Employer, acceptance of the material change would compromise the outcome of the prequalification process.

C.3.2 Issue Addenda

If necessary, issue addenda that may amend or amplify the tender documents to each tenderer during the period from the date that tender documents are available until three (3) working days before the tender closing time stated in the Tender Data. If, as a result a tenderer applies for an extension to the closing time stated in the Tender Data, the Employer may grant such extension and, shall then notify all tenderers who collected tender documents.

C.3.3 Return late tender offers

Return tender offers received after the closing time stated in the Tender Data, unopened, (unless it is necessary to open a tender submission to obtain a forwarding address), to the tenderer concerned.

C.3.4 Opening of tender submissions

C.3.4.1 Unless the two-envelope system is to be followed, open valid tender submissions in the presence of tenderers' agents who choose to attend at the time and place stated in the tender data. Tender submissions for which acceptable reasons for withdrawal have been submitted will not be opened.

C.3.4.2 Announce at the meeting held immediately after the opening of tender submissions, at a venue indicated in the tender data, the name of each tenderer whose tender offer is opened and, where

applicable, the total of his prices, number of points claimed for its BBBEE status level and time for completion for the main tender offer only.

C.3.4.3 Make available the record outlined in C.3.4.2 to all interested persons upon request.

C.3.5 Two-envelope system

C.3.5.1 Where stated in the tender data that a two-envelope system is to be followed, open only the technical proposal of valid tenders in the presence of tenderers' agents who choose to attend at the time and place stated in the tender data and announce the name of each tenderer whose technical proposal is opened.

C.3.5.2 Evaluate functionality of the technical proposals offered by tenderers, then advise tenderers who remain in contention for the award of the contract of the time and place when the financial proposals will be opened. Open only the financial proposals of tenderers, who score in the functionality evaluation more than the minimum number of points for functionality stated in the tender data, and announce the score obtained for the technical proposals and the total price and any points claimed on BBBEE status level. Return unopened financial proposals to tenderers whose technical proposals failed to achieve the minimum number of points for functionality.

C.3.6 Non-disclosure

Not disclose to tenderers, or to any other person not officially concerned with such processes, information relating to the evaluation and comparison of tender offers, the final evaluation price and recommendations for the award of a contract, until after the award of the contract to the successful tenderer.

C.3.7 Grounds for rejection and disqualification

Determine whether there has been any effort by a tenderer to influence the processing of tender offers and instantly disqualify a tenderer (and his tender offer) if it is established that he engaged in corrupt or fraudulent practices.

C.3.8 Test for responsiveness

C.3.8.1 Determine, after opening and before detailed evaluation, whether each tender offer properly received:

- a) complies with the requirements of these Conditions of Tender,
- b) has been properly and fully completed and signed, and
- c) is responsive to the other requirements of the tender documents.

C.3.8.2 A responsive tender is one that conforms to all the terms, conditions, and specifications of the tender documents without material deviation or qualification. A material deviation or qualification is one which, in the Employer's opinion, would:

- a) detrimentally affect the scope, quality, or performance of the works, services or supply identified in the Scope of Work,
- b) significantly change the Employer's or the tenderer's risks and responsibilities under the contract, or
- c) affect the competitive position of other tenderers presenting responsive tenders, if it were to be rectified.

Reject a non-responsive tender offer, and not allow it to be subsequently made responsive by correction or withdrawal of the non-conforming deviation or reservation.

C.3.9 Arithmetical errors, omissions and discrepancies

C.3.9.1 Check responsive tenders for discrepancies between amounts in words and amounts in figures. Where there is a discrepancy between the amounts in figures and the amount in words, the amount in words shall govern.

C.3.9.2 Check the highest ranked tender or tenderer with the highest number of tender evaluation points after the evaluation of tender offers in accordance with C.3.11 for:

- a) the gross misplacement of the decimal point in any unit rate;
- b) omissions made in completing the pricing schedule or bills of quantities; or
- c) arithmetic errors in:
 - (i) line item totals resulting from the product of a unit rate and a quantity in bills of quantities or schedules of prices; or
 - (ii) the summation of the prices.

C.3.9.3 Notify the tenderer of all errors or omissions that are identified in the tender offer and either confirm the tender offer as tendered or accept the corrected total of prices.

C.3.9.4 Where the tenderer elects to confirm the tender offer as tendered, correct the errors as follows:

- a) If bills of quantities or pricing schedules apply and there is an error in the line item total resulting from the product of the unit rate and the quantity, the line item total shall govern and the rate shall be corrected. Where there is an obviously gross misplacement of the decimal point in the unit rate, the line item total as quoted shall govern, and the unit rate shall be corrected.
- b) Where there is an error in the total of the prices either as a result of other corrections required by this checking process or in the tenderer's addition of prices, the total of the prices shall govern and the tenderer will be asked to revise selected item prices (and their rates if bills of quantities apply) to achieve the tendered total of the prices.

C.3.10 Clarification of a tender offer

Obtain clarification from a tenderer on any matter that could give rise to ambiguity in a contract arising from the tender offer.

C.3.11 Evaluation of tender offers

The Standard Conditions of Tender standardize the procurement processes, methods and procedures from the time that tenders are invited to the time that a contract is awarded. They are generic in nature and are made project specific through choices that are made in developing the Tender Data associated with a specific project.

Conditions of tender are by definition the document that establishes a tenderer's obligations in submitting a tender and the employer's undertakings in soliciting and evaluating tender offers. Such conditions establish the rules from the time a tender is advertised to the time that a contract is awarded and require employers to conduct the process of offer and acceptance in terms of a set of standard procedures.

The CIDB Standard Conditions of Tender are based on a procurement system that satisfies the following system requirements:	
Requirement	Qualitative interpretation of goal
Fair	The process of offer and acceptance is conducted impartially without bias, providing simultaneous and timely access to participating parties to the same information.
Equitable	Terms and conditions for performing the work do not unfairly prejudice the interests of the parties.
Transparent	The only grounds for not awarding a contract to a tenderer who satisfies all requirements are restrictions from doing business with the employer, lack of capability or capacity, legal impediments and conflicts of interest.
Competitive	The system provides for appropriate levels of competition to ensure cost effective and best value outcomes.

Cost effective	The processes, procedures and methods are standardized with sufficient flexibility to attain best value outcomes in respect of quality, timing and price, and least resources to effectively manage and control procurement processes.
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The activities associated with evaluating tender offers are as follows:

- a) Open and record tender offers received
- b) Determine whether or not tender offers are complete
- c) Determine whether or not tender offers are responsive
- d) Evaluate tender offers
- e) Determine if there are any grounds for disqualification
- f) Determine acceptability of preferred tenderer
- g) Prepare a tender evaluation report
- h) Confirm the recommendation contained in the tender evaluation report

C.3.11.1 General

The employer must appoint an evaluation panel of not less than three persons conversant with the proposed scope of works to evaluate each responsive tender offer using the tender evaluation methods and associated evaluation criteria and weightings that are specified in the tender data.

C.3.12 Insurance provided by the employer

If requested by the proposed successful tenderer, submit for the tenderer's information the policies and / or certificates of insurance which the conditions of contract identified in the contract data, require the employer to provide.

C.3.13 Acceptance of tender offer

Accept the tender offer; if in the opinion of the employer, it does not present any risk and only if the tenderer:

- a) is not under restrictions, or has principals who are under restrictions, preventing participating in the employer's procurement;
- b) can, as necessary and in relation to the proposed contract, demonstrate that he or she possesses the professional and technical qualifications, professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience and reputation, expertise and the personnel, to perform the contract;
- c) has the legal capacity to enter into the contract;
- d) is not; insolvent, in receivership, under Business Rescue as provided for in chapter 6 of the Companies Act No. 2008, bankrupt or being wound up, has his/her affairs administered by a court or a judicial officer, has suspended his/her business activities or is subject to legal proceedings in respect of any of the foregoing;
- e) complies with the legal requirements, if any, stated in the tender data; and
- f) is able, in the opinion of the employer, to perform the contract free of conflicts of interest.

C.3.14 Prepare contract documents

C.3.14.1 If necessary, revise documents that shall form part of the contract and that were issued by the employer as part of the tender documents to take account of:

- a) addenda issued during the tender period,
- b) inclusion of some of the returnable documents and
- c) other revisions agreed between the employer and the successful tenderer.

C.3.14.2 Complete the schedule of deviations attached to the form of offer and acceptance, if any.

C.3.15 Complete adjudicator's contract

Unless alternative arrangements have been agreed or otherwise provided for in the contract, arrange for both parties to complete formalities for appointing the selected adjudicator at the same time as the main contract is signed.

C.3.16 Registration of the award

An employer must, within twenty-one (21) working days from the date on which a contractor's offer to perform a construction works contract is accepted in writing by the employer, register and publish the award on the cidb Register of Projects.

C.3.17 Provide copies of the contracts

Provide to the successful tenderer the number of copies stated in the Tender Data of the signed copy of the contract as soon as possible after completion and signing of the form of offer and acceptance.

C.3.18 Provide written reasons for actions taken

Provide upon request written reasons to tenderers for any action that is taken in applying these conditions of tender but withhold information which is not in the public interest to be divulged, which is considered to prejudice the legitimate commercial interests of tenderers or might prejudice fair competition between tenderers.

PART T1.4: PREFERENTIAL PROCUREMENT REGULATIONS

These Conditions of Tender are subject to the requirements of the Preferential Procurement Regulations, 2022 published in Government Gazette No 47452 dated 4 November 2022.

The complete extract is bound hereafter into this Volume.

GOVERNMENT NOTICES • GOEWERMENTSKENNISGEWINGS

NATIONAL TREASURY

NO. 2721

4 November 2022

**PREFERENTIAL PROCUREMENT POLICY FRAMEWORK ACT, 2000:
PREFERENTIAL PROCUREMENT REGULATIONS**

The Minister Finance has, in terms of section 5, read with section 2(1)(b)(i) and (ii) and 2(1)(c), of the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000), and with effect from 16 January 2023, made the regulations set out in the Schedule.

SCHEDULE**PREFERENTIAL PROCUREMENT REGULATIONS, 2022****Contents**

1. Definitions
2. Application
3. Identification of preference point system
4. 80/20 preference point system for acquisition of goods or services with Rand value equal to or below R50 million
5. 90/10 preference point system for acquisition of goods or services with Rand value above R50 million
6. 80/20 preference points system for tenders to generate income or to dispose of or lease assets with Rand value equal to or below R50 million
7. 90/10 preference point system for tenders to generate income or to dispose of or lease assets with Rand value above R50 million
8. Criteria for breaking deadlock in scoring
9. Remedies
10. Repeal of regulations
11. Short title and commencement

Definitions

1. In these Regulations, unless the context indicates otherwise, any word or expression to which a meaning has been assigned in the Act must bear the meaning so assigned—

“highest acceptable tender” means a tender that complies with all specifications and conditions of tender and that has the highest price compared to other tenders;

“lowest acceptable tender” means a tender that complies with all specifications and conditions of tender and that has lowest price compared to other tenders;

“price” means an amount of money tendered for goods or services, and includes all applicable taxes less all unconditional discounts;

“Rand value” means the total estimated value of a contract in Rand, calculated at the time of the tender invitation;

“specific goals” means specific goals as contemplated in section 2(1)(d) of the Act which may include contracting with persons, or categories of persons, historically disadvantaged by unfair discrimination on the basis of race, gender and disability including the implementation of programmes of the Reconstruction and Development Programme as published in *Government Gazette* No. 16085 dated 23 November 1994;

“tender” means a written offer in the form determined by an organ of state in response to an invitation to provide goods or services through price quotations, competitive tendering process or any other method envisaged in legislation;

“tender for income-generating contracts” means a written offer in the form determined by an organ of state in response to an invitation for the origination of income-generating contracts through any method envisaged in legislation that will result in a legal agreement between the organ of state and a third party that produces revenue for the organ of state, and includes, but is not limited to, leasing and disposal of assets and concession contracts, excluding direct sales and disposal of assets through public auctions; and

“the Act” means the Preferential Procurement Policy Framework Act, 2000 (Act No. 5 of 2000).

Application

2. These Regulations apply to organs of state as defined in section 1¹ of the Act.

Identification of preference point system

3.(1) An organ of state must, in the tender documents, stipulate—

- (a) the applicable preference point system as envisaged in regulations 4, 5, 6 or 7;
- (b) the specific goal in the invitation to submit the tender for which a point may be awarded, and the number of points that will be awarded to each goal, and proof of the claim for such goal.

(2) If it is unclear whether the 80/20 or 90/10 preference point system applies, an organ of state must, in the tender documents, stipulate in the case of—

- (a) an invitation for tender for income-generating contracts, that either the 80/20 or 90/10 preference point system will apply and that the highest acceptable tender will be used to determine the applicable preference point system; or
- (b) any other invitation for tender, that either the 80/20 or 90/10 preference point system will apply and that the lowest acceptable tender will be used to determine the applicable preference point system.

80/20 preference point system for acquisition of goods or services with Rand value equal to or below R50 million

4.(1) The following formula must be used to calculate the points out of 80 for price in respect of an invitation for a tender with a Rand value equal to or below R50 million, inclusive of all applicable taxes:

¹ Paragraph (f) of the definition of organ of state in section 1 of the Act includes any other institution or category of institutions included in the definition of “organ of state” in section 239 of the Constitution and recognised by the Minister by notice in the *Government Gazette* as an institution or category of institutions to which the Act applies. Government Notices—

(a) R. 501 of 8 June 2011 recognises, with effect from 7 December 2011, all public entities listed in Schedules 2 and 3 to the Public Finance Management Act, 1999; and

(b) R. 571 of 15 June 2017 recognises, with effect from 17 June 2017, national and provincial government components listed in Schedule 3 to the Public Service Act, 1994 and municipal entity as defined in section 1 of the Local Government: Municipal Systems Act, 2000, as institutions to which the Act applies.

Note should be taken of notices issued from time to time in terms of paragraph (f) of this definition. The application of these Regulations is also subject to applicable exemptions approved in terms of section 3 of the Act.

$$P_s = 80 \left(1 - \frac{P_t - P_{\min}}{P_{\min}} \right)$$

Where-

P_s = Points scored for price of tender under consideration;

P_t = Price of tender under consideration; and

$P_{\min}$ = Price of lowest acceptable tender.

(2) A maximum of 20 points may be awarded to a tenderer for the specific goal specified for the tender.

(3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.

(4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

90/10 preference point system for acquisition of goods or services with Rand value above R50 million

5.(1) The following formula must be used to calculate the points out 90 for price in respect of an invitation for tender with a Rand value above R50 million, inclusive of all applicable taxes:

$$P_s = 90 \left(1 - \frac{P_t - P_{\min}}{P_{\min}} \right)$$

Where-

P_s = Points scored for price of tender under consideration;

P_t = Price of tender under consideration; and

$P_{\min}$ = Price of lowest acceptable tender.

(2) A maximum of 10 points may be awarded to a tenderer for the specific goal specified for the tender.

(3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.

(4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

80/20 preference points system for tenders for income-generating contracts with Rand value equal to or below R50 million

6.(1) The following formula must be used to calculate the points for price in respect of an invitation for tender for income-generating contracts, with a Rand value equal to or below R50 million, inclusive of all applicable taxes:

$$Ps = 80 \left(1 + \frac{Pt - Pmax}{Pmax} \right)$$

Where-

Ps = Points scored for price of tender under consideration;

Pt = Price of tender under consideration; and

Pmax = Price of highest acceptable tender.

(2) A maximum of 20 points may be awarded to a tenderer for the specific goal specified for the tender.

(3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.

(4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

90/10 preference point system for tenders for income-generating contracts with Rand value above R50 million

7.(1) The following formula must be used to calculate the points for price in respect of a tender for income-generating contracts, with a Rand value above R50 million, inclusive of all applicable taxes:

$$Ps = 90 \left(1 + \frac{Pt - Pmax}{Pmax} \right)$$

Where-

Ps = Points scored for price of tender under consideration;

Pt = Price of tender under consideration; and

Pmax = Price of highest acceptable tender.

(2) A maximum of 10 points may be awarded to a tenderer for the specific goal specified for the tender.

(3) The points scored for the specific goal must be added to the points scored for price and the total must be rounded off to the nearest two decimal places.

(4) Subject to section 2(1)(f) of the Act, the contract must be awarded to the tenderer scoring the highest points.

Criteria for breaking deadlock in scoring

8.(1) If two or more tenderers score an equal total number of points, the contract must be awarded to the tenderer that scored the highest points for specific goals.

(2) If two or more tenderers score equal total points in all respects, the award must be decided by the drawing of lots.

Remedies

9.(1) If an organ of state is of the view that a tenderer submitted false information regarding a specific goal, it must—

- (a) inform the tenderer accordingly; and
- (b) give the tenderer an opportunity to make representations within 14 days as to why the tender may not be disqualified or, if the tender has already been awarded to the tenderer, the contract should not be terminated in whole or in part.

(2) After considering the representations referred to in subregulation (1)(b), the organ of state may, if it concludes that such information is false—

- (a) disqualify the tenderer or terminate the contract in whole or in part; and
- (b) if applicable, claim damages from the tenderer.

Repeal of regulations

10.(1) Subject to this regulation, the Preferential Procurement Regulations, 2017 published in Government No. 40553 of 20 January 2017, are hereby repealed with effect from the date referred to in regulation 11.

(2) Any tender advertised before the date referred to in regulation 11 must be dealt with in terms of the Preferential Procurement Regulations, 2017.

Short title and commencement

11. These Regulations are called the Preferential Procurement Regulations, 2022 and take effect on 16 January 2023.

PART T1.5: GUIDANCE DOCUMENTS FOR THE CALCULATION OF LOCAL CONTENT

These Conditions of Tender are subject to the requirements of the SATS 1286:2011, "Technical specification on the measurement and verification of local content"

The "Guidance Document for the calculation of Local Content" and various other guidance documents are bound hereafter into this Volume.

Guidance Document for the Calculation of Local Content

1. DEFINITIONS

Unless explicitly provided in this guideline, the definitions given in SATS 1286:2011 apply.

2. GENERAL

2.1. Introduction

This guideline provides tenderers with a detailed description of how to calculate local content of products (goods, services and works) by components/material/services and enables them to keep an updated record for verification requirements as per the SATS 1286:2011 Annexure A and B.

The guideline consists of two parts, namely:

- a written guideline; and
- three declarations that must be completed:
 - Declaration C: “Local Content Declaration – Summary Schedule” (see Annexure C);
 - Declaration D: “Imported Content Declaration – Supporting Schedule to Annex C” (see Annexure D); and
 - Declaration E: “Local Content Declaration – Supporting Schedule to Annex C” (see Annexure E).

The guidelines and declarations should be used by tenderers when preparing a tender. A tenderer must complete Declarations D and E, and consolidate the information on Declaration C.

Annexure C must be submitted with the tender by the closing date and time as determined by the Tender Authority. The Tender Authority reserves the right to request that Declarations D and E also be submitted.

If the tender is successful, the tenderer must continuously update Declarations C, D and E with actual values for the duration of the contract.

NOTE:

Annexure A is a note to the purchaser in SATS 1286:2011; and
Annexure B is the Local Content Declaration IN SATS 1286:2011.

2.2. What is local content?

According to SATS 1286:2011, the local content of a product is the tender price less the value of imported content, expressed as a percentage. It is, therefore, necessary to first compute the imported value of a product to determine the local content of a product.

2.3. Categories: Imported and Local Content

The tenderer must differentiate between imported content and local content.

Imported content of a product by components/material/services is separated into two categories, namely:

- products imported directly by the tenderer; and
- products imported by a third party and supplied to the tenderer.

2.3.1. Imported Content

Identify the imported content, if any, by value for products by component/material/services. In the case of components/materials/services sourced from a South African manufacturer, agent, supplier or subcontractor (i.e. third party), obtain that information and Declaration D from the third party.

Calculate the imported content of components/materials/services to be used in the manufacture of the total quantity of the products for which the tender is to be submitted.

As stated in clause 3.2.4 of SATS 1286:2011: "If information on the origin of components, parts or materials is not available, it will be deemed to be imported content."

2.3.1.1. Imported directly by the tenderer:

When the tenderer import products directly, the onus is on the tenderer to provide evidence of any components/materials/services that were procured from a non-domestic source. The evidence should be verifiable and pertain to the tender as a whole. Typical evidence will include commercial invoices, bills of entry, etc.

When the tenderer procures imported services such as project management, design, testing, marketing, etc and makes royalty and lease payments, such payments relating to the tender must be included when calculating imported content.

2.3.1.2. Imported by a third party and supplied to the tenderer:

When the tenderer supplies components/material/services that are imported by any third party (for example, a domestic manufacturer, agent, supplier or subcontractor in the supply chain), the onus is on the tenderer to obtain verifiable evidence from the third party.

The tenderer must obtain Declaration D from all third parties for the related tender. The third party must be requested by the tenderer to continuously update Declaration D. Typical evidence of imported content will include commercial invoices, bills of entry etc.

When a third party procures imported services such as project management, design, testing, marketing etc. and makes royalty and lease payments, such payments relating to the tender must be included when calculating imported content.

2.3.1.3. Exempt Imported Content:

Exemptions, if any, are granted by the Department of Trade and Industry (**the dti**). Evidence of the exemptions must be provided and included in Annexure D.

2.3.2. Local Content

Identify and calculate the local content, by value for products by components/materials/services to be used in the manufacture of the total quantity of the products.

3. ANNEXURE C

3.1. Guidelines for completing Annexure C: Local Content Declaration – Summary Schedule

Note: The paragraph numbers correspond to the numbers in Annexure C.

C1. Tender Number

Supply the tender number that is specified on the specific tender documentation.

C2. Tender description

Supply the tender description that is specified on the specific tender documentation.

C3. Designated products

Supply the details of the products that are designated in terms of this tender (i.e. buses).

C4. Tender Authority

Supply the name of the tender authority.

C5. Tendering Entity name

Provide the tendering entity name (for example, Unibody Bus Builders (Pty) Ltd).

C6. Tender Exchange Rate

Provide the exchange rate used for this tender, as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MBD) 6.2.

C7. Specified local content %

Provide the specified minimum local content requirement for the tender (i.e. 80%), as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MDB) 6.2.

C8. Tender item number

Provide the tender item number(s) of the products that have a local content requirement as per the tender specification.

C9. List of items

Provide a list of the item(s) corresponding with the tender item number.
This may be a short description or a brand name.

Calculation of local content

C10. Tender price

Provide the unit tender price of each item excluding VAT.

C11. Exempted imported content

Provide the ZAR value of the exempted imported content for each item, if applicable. These value(s) must correspond with the value(s) of column D16 on Annexure D.

C12. Tender value net of exempted imported content

Provide the net tender value of the item, if applicable, by deducting the exempted imported content (C11) from the tender price (C10).

C13. Imported value

Provide the ZAR value of the items' imported content.

C14. Local value

Provide the local value of the item by deducting the Imported value (C13) from the net tender value (C12).

C15. Local content percentage (per item)

Provide the local content percentage of the item(s) by dividing the local value (C14) by the net tender value (C12) as per the local content formula in SATS 1286.

Tender Summary

C16. Tender quantity

Provide the tender quantity for each item number as per the tender specification.

C17. Total tender value

Provide the total tender value by multiplying the tender quantity (C16) by the tender price (C10).

C18. Total exempted imported content

Provide the total exempted imported content by multiplying the tender quantity (C16) by the exempted imported content (C11). These values must correspond with the values of column D18 on Annexure D.

C19. Total imported content

Provide the total imported content of each item by multiplying the tender quantity (C16) by the imported value (C13).

C20. Total tender value

Total tender value is the sum of the values in column C17.

C21. Total exempted imported content

Total exempted imported content is the sum of the values in column C18. This value must correspond with the value of D19 on Annexure D.

C22. Total tender value net of exempted imported content

The total tender value net of exempt imported content is the total tender value (C20) less the total exempted imported content (C21).

C23. Total imported content

Total imported content is the sum of the values in column C19. This value must correspond with the value of D53 on Annexure D.

C24. Total local content

Total local content is the total tender value net of exempted imported content (C22) less the total imported content (C23). This value must correspond with the value of E13 on Annexure E.

C25. Average local content percentage of tender

The average local content percentage of tender is calculated by dividing total local content (C24) by the total tender value net of exempted imported content (C22).

4. ANNEXURE D

4.1. Guidelines for completing Annexure D: “Imported Content Declaration – Supporting Schedule to Annexure C”

Note: The paragraph numbers correspond to the numbers in Annexure D.

D1. Tender number

Supply the tender number that is specified on the specific tender documentation.

D2. Tender description

Supply the tender description that is specified on the specific tender documentation.

D3. Designated products

Supply the details of the products that are designated in terms of this tender (i.e. buses).

D4. Tender authority

Supply the name of the tender authority.

D5. Tendering entity name

Provide the tendering entity name (i.e. Unibody Bus Builders (Pty) Ltd).

D6. Tender exchange rate

Provide the exchange rate used for this tender, as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MBD) 6.2.

Table A. Exempted Imported Content

D7. Tender item number

Provide the tender item number(s) of the product(s) that have imported content.

D8. Description of imported content

Provide a list of the exempted imported product(s), if any, as specified in the tender.

D9. Local supplier

Provide the name of the local supplier(s) supplying the imported product(s).

D10. Overseas supplier

Provide the name(s) of the overseas supplier(s) supplying the exempted imported product(s).

D11. Imported value as per commercial invoice

Provide the foreign currency value of the exempted imported product(s) disclosed in the commercial invoice accepted by the South African Revenue Service (SARS).

D12. Tender exchange rate

Provide the exchange rate used for this tender as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MBD) 6.2.

D13. Local value of imports

Convert the value of the exempted imported content as per commercial invoice (D11) into the ZAR value by using the tender exchange rate (D12) disclosed in the tender documentation.

D14. Freight costs to port of entry

Provide the freight costs to the South African Port of the exempted imported item.

D15. All locally incurred landing costs and duties

Provide all landing costs including customs and excise duty for the exempted imported product(s) as stipulated in the SATS 1286:2011.

D16. Total landed costs excl VAT

Provide the total landed costs (excluding VAT) for each item imported by adding the corresponding item values in columns D13, D14 and D15. These values must be transferred to column C11 on Annexure C.

D17. Tender quantity

Provide the tender quantity of the exempted imported products as per the tender specification.

D18. Exempted imported value

Provide the imported value for each of the exempted imported product(s) by multiplying the total landed cost (excl. VAT) (D16) by the

tender quantity (D17). The values in column D18 must correspond with the values of column C18 of Annexure C.

D19. Total exempted imported value

The total exempted imported value is the sum of the values in column D18. This total must correspond with the value of C21 on Annexure C.

Table B. Imported Directly By Tenderer

D20. Tender item numbers

Provide the tender item number(s) of the product(s) that have imported content.

D21. Description of imported content:

Provide a list of the product(s) imported directly by tender as specified in the tender documentation.

D22. Unit of measure

Provide the unit of measure for the product(s) imported directly by the tenderer.

D23. Overseas supplier

Provide the name(s) of the overseas supplier(s) supplying the imported product(s).

D24. Imported value as per commercial Invoice

Provide the foreign currency value of the product(s) imported directly by tenderer disclosed in the commercial invoice accepted by the South African Revenue Service (SARS).

D25. Tender rate of exchange

Provide the exchange rate used for this tender as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MBD) 6.2.

D26. Local value of imports

Convert the value of the product(s) imported directly by the tenderer as per commercial invoice (D24) into the ZAR value by using the tender exchange rate (D25) disclosed in the tender documentation.

D27. Freight costs to port of entry

Provide the freight costs to the South African Port of the product(s) imported directly by the tenderer.

D28. All locally incurred landing costs and duties

Provide all landing costs including customs and excise duty for the product(s) imported directly by the tenderer as stipulated in the SATS 1286:2011.

D29. Total landed costs excl VAT

Provide the total landed costs (excluding VAT) for each item imported directly by the tenderer by adding the corresponding item values in columns D26, D27 and D28.

D30. Tender quantity

Provide the tender quantity of the product(s) imported directly by the tenderer as per the tender specification.

D31. Total imported value

Provide the total imported value for each of the product(s) imported directly by the tenderer by multiplying the total landed cost (excl. VAT) (D29) by the tender quantity (D30).

D32. Total imported value by tenderer

The total value of imports by the tenderer is the sum of the values in column D31.

Table C. Imported by Third Party and Supplied to the Tenderer

D33. Description of imported content

Provide a list of the product(s) imported by the third party and supplied to the tenderer as specified in the tender documentation.

D34. Unit of measure

Provide the unit of measure for the product(s) imported by the third party and supplied to tenderer as disclosed in the commercial invoice.

D35. Local supplier

Provide the name of the local supplier(s) supplying the imported product(s).

D36. Overseas supplier

Provide the name(s) of the overseas supplier(s) supplying the imported products.

D37. Imported value as per commercial invoice

Provide the foreign currency value of the product(s) imported by the third party and supplied to the tenderer disclosed in the commercial invoice accepted by SARS.

D38. Tender rate of exchange

Provide the exchange rate used for this tender as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MBD) 6.2.

D39. Local value of imports

Convert the value of the product(s) imported by the third party as per commercial invoice (D37) into the ZAR value by using the tender exchange rate (D38) disclosed in the tender documentation.

D40. Freight costs to port of entry

Provide the freight costs to the South African Port of the product(s) imported by third party and supplied to the tenderer.

D41. All locally incurred landing costs and duties

Provide all landing costs including customs and excise duty for the product(s) imported by third party and supplied to the tenderer as stipulated in the SATS 1286:2011.

D42. Total landed costs excluding VAT

Provide the total landed costs (excluding VAT) for each product imported by third party and supplied to the tenderer by adding the corresponding item values in columns D39, D40 and D41.

D43. Quantity imported

Provide the quantity of each product(s) imported by third party and supplied to the tenderer for the tender.

D44. Total imported value

Provide the total imported value of the product(s) imported by third party and supplied to the tenderer by multiplying the total landed cost (D42) by the quantity imported (D43).

D45. Total imported value by third party

The total imported value from the third party is the sum of the values in column D44.

Table D. Other Foreign Currency Payments

D46. Type of payment

Provide the type of foreign currency payment. (i.e. royalty payment for use of patent, annual licence fee, etc).

D47. Local supplier making the payment

Provide the name of the local supplier making the payment.

D48. Overseas beneficiary

Provide the name of the overseas beneficiary.

D49. Foreign currency value paid

Provide the value of the listed payment(s) in their foreign currency.

D50. Tender rate of exchange

Provide the exchange rate used for this tender as per the Standard Bidding Document (SBD) and Municipal Bidding Document (MBD) 6.2.

D51. Local value of payments

Provide the local value of each payment by multiplying the foreign currency value paid (D49) by the tender rate of exchange (D50).

D52. Total of foreign currency payments declared by tenderer and/or third party

The total of foreign currency payments declared by tenderer and/or a third party is the sum of the values in column D51.

D53. Total of imported content and foreign currency payment

The total imported content and foreign currency payment is the sum of the values in column D32, D45 and D52. This value must correspond with the value of C23 on Annexure C.

5. ANNEXURE E

5.1. Guidelines to completing Annexure E: “Local Content Declaration-Supporting Schedule to Annexure C”

The paragraph numbers correspond to the numbers in Annexure E

E1. Tender number

Supply the tender number that is specified on the specific tender documentation.

E2. Tender description

Supply the tender description that is specified on the specific tender documentation.

E3. Designated products

Supply the details of the products that are designated in terms of this tender (for example, buses/canned vegetables).

E4. Tender authority

Supply the name of the tender authority.

E5. Tendering entity name

Provide the tendering entity name (for example, Unibody Bus Builders (Pty) Ltd) Ltd).

Local Goods, Services and Works

E6. Description of items purchased

Provide a description of the items purchased locally in the space provided.

E7. Local supplier

Provide the name of the local supplier that corresponds to the item listed in column E6.

E8. Value

Provide the total value of the item purchased in column E6.

E9. Total local products (Goods, Services and Works)

Total local products (goods, services and works) is the sum of the values in E8.

E10. Manpower costs:

Provide the total of all the labour costs accruing only to the tenderer (i.e. not the suppliers to tenderer).

E11. Factory overheads:

Provide the total of all the factory overheads including rental, depreciation and amortisation for local and imported capital goods, utility costs and consumables. (Consumables are goods used by individuals and businesses that must be replaced regularly because they wear out or are used up. Consumables can also be defined as the components of an end product that are used up or permanently altered in the process of manufacturing, such as basic chemicals.)

E12. Administration overheads and mark-up:

Provide the total of all the administration overheads, including marketing, insurance, financing, interest and mark-up costs.

E13. Total local content:

The total local content is the sum of the values of E9, E10, E11 and E12. This total must correspond with C24 of Annexure C.

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SOUTH AFRICAN NATIONAL STANDARD

Local goods, services and works — Measurement and verification of local content

WARNING

**This document references other
documents normatively.**

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Edition 1

Table of changes

Change No.	Date	Scope

Foreword

This South African National Standard was prepared by National Committee SABS/TC 003, *Conformity assessment (CASCO)*, in accordance with procedures of the SABS, in compliance with annex 3 of the WTO/TBT agreement.

This document was approved for publication in April 2017.

Reference is made in 1.1, the note to 1.1 and 2.6 to the "relevant national legislation". In South Africa this means the Preferential Procurement Policy Framework Act (PPPFA), 2000 (Act No. 5 of 2000).

Reference is made in the note to 2.10 to a "national accreditation body". In South Africa this means the South African National Accreditation System (SANAS).

Reference is made in 5.1(a) to an "accredited verification body". In South Africa this means a body accredited by the South African National Accreditation System (SANAS).

Reference is made in 5.1(b) to an "independent, registered and qualified auditor". For the purposes of this document, this means a registered auditor approved by the Independent Regulatory Board for Auditors (IRBA) in terms of the Auditing Profession Act, 2005 (Act No. 26 of 2005), professional accounting practitioners registered with the South African Institute of Accounting, the South African Institute of Professional Accountants or the Association of Chartered Certified Accountants; and professional management accountants registered with the Chartered Institute of Management Accountants.

Reference is made in 5.1(c) to a "qualified technical industry specialist". In South Africa a qualified technical industry specialist may include qualified engineers, scientists or industry associations.

Annex A forms an integral part of this document.

Compliance with this document cannot confer immunity from legal obligations.

Introduction

Preferential procurement policies and their associated regulations, such as local content requirements, are mechanisms used by the government and organs of state in the adjudication of tenders, to give consideration to procuring locally manufactured products that comply with specified requirements. Governments may identify specific industries which are deemed to be of critical importance to the economic sustainability and industrial development of their country.

In order to calculate and verify local content, a standardized approach is essential, and this document specifies the approach used in South Africa. To achieve the goals of local content, a technical verification is required to substantiate the bill of materials of the designated product or service. The financial auditor then confirms the local content calculation as true to the manufacturing capabilities of the tenderer and his/her suppliers.

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Local goods, services and works — Measurement and verification of local content

1 Scope

1.1 This standard specifies requirements and procedures to define, measure, declare and verify the local content of goods, services and works when required for procurement and other purposes, in terms of the relevant national legislation (see foreword).

NOTE The product should contain no less than the level of local content as determined by the relevant national legislation (see foreword) and other procurement requirements.

1.2 This standard does not specify the required safety, quality or other properties of the product.

NOTE The responsibility to include the requirements rests with the procurement authority.

2 Definitions

For the purposes of this document, the following definitions apply.

2.1

component

elementary part (element or portion) of a product

2.2

imported content

that portion of the tender price represented by

- a) the cost of imported components, and
- b) the cost of parts or materials which have been or are still to be imported (whether by the suppliers or the suppliers' subcontractors or any other third party) the costs of which are inclusive of the costs abroad, plus freight and other direct importation costs, such as landing cost, dock duties, import duty, sales duty or other similar tax or duty at the South African port of entry excluding value added tax (VAT)

2.3

local content

that portion of the tender price that is not included in the imported content, provided that local manufacturing takes place and is calculated in accordance with the local content formula (see 3.1)

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2.4

manufacture

conversion process that uses materials, components and parts to make a product

NOTE This may include the process of assembly.

2.5

material

ingredient, raw material, component or part used in the manufacture of a product

2.6

products

produced goods, services or works, or manufactured goods as defined in the relevant national legislation (see foreword)

2.7

tender price

price offered by the tenderer, excluding value added tax (VAT)

2.8

tenderer

bidder

person or organization that submits a tender offer

2.9

verification

confirmation through the provision of objective evidence that the specified requirements have been fulfilled

2.10

verification body

body that provides assurance of the claims of local content made by the supplier

NOTE In order to provide assurance as to the competence of the verification body, the user may require that the verification body be accredited to perform these functions by a national accreditation body (see foreword).

3 Local content measurement

3.1 Calculation of local content

3.1.1 The local content percentage of the product shall be as specified in accordance with annex A. The local content, *LC*, expressed as a percentage of the tender price, shall be calculated as follows:

$$LC = (1 - x/y) \cdot 100$$

where

x is the imported content (see 2.2), in Rand (ZAR);

y is the tender price (see 2.7), in Rand (ZAR).

3.1.2 Prices referred to in the determination of *x* shall all be converted to Rand (ZAR) by using the exchange rate as specified in accordance with annex A.

3.2 Documentation required for the calculation of local content

3.2.1 Documentation used for the purposes of measuring local content shall include, but is not limited to, details of all imported components, parts or materials indicating origin, manufacturer, freight cost and other direct importation costs, such as landing cost, dock duties, and import duty and sales duty, i.e. landed cost.

3.2.2 Documentary proof used for calculating x in the measurement of local content and proof of the tender price y shall be kept accessible for a period of no less than five years.

3.2.3 The tenderer shall be responsible for the accuracy of the information, including the imported content in the supply chain.

3.2.4 If information on the origin of components, parts or materials is not available, the components, parts or materials will be deemed to be imported content.

3.3 Control of documents and records by the tenderer

3.3.1 Documents and records to provide evidence of compliance with the requirements of this technical specification shall be controlled.

3.3.2 A documented procedure to define the controls needed for the identification, storage, protection, retrieval, retention and disposition of records shall be established.

3.3.3 Records shall remain legible, readily identifiable and retrievable.

4 Declaration

The tenderer shall attach the local content declaration signed by the Chief Financial Officer or other legally responsible person nominated in writing by the Chief Executive Officer, or senior member/person with management responsibility (close corporation, partnership or individual) to the purchaser stating the local content percentage of the product, calculated in accordance with 3.1, and confirming the final tender price.

5 Verification

5.1 The procurement authority may require that the measurement of local content be verified. The verification shall be conducted by:

- a) an accredited verification body (see foreword); or
- b) an independent, registered and qualified auditor (see foreword); or
- c) a qualified technical industry specialist (see foreword).

5.2 Local content verification shall be conducted in two parts as follows:

- a) verification of the financial documentation to ensure local content is in accordance with the designated requirement; and
- b) factory shop floor technical verification of the local content as described in the documentation verified in 5.2(a).

5.3 Those conducting the verification shall have defined and documented procedures for the verification activities.

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Annex A
(normative)

Notes to purchasers

In addition to data clearly describing the product ordered, the following requirements shall be specified in tender invitations and in each order or contract:

- a) the local content percentage requirements (see 3.1.1), and
- b) the exchange rate requirements (see 3.1.2).

Bibliography

Standards

SANS 10845-1/ISO 10845-1, *Construction procurement – Part 1: Processes, methods and procedures*.

Other publications

Guidance document for the calculation of local content. Available from http://www.thedti.gov.za/industrial_development/ip.jsp.



national treasury

Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

Private Bag X115, Pretoria, 0001

TO: ACCOUNTING OFFICERS OF ALL NATIONAL DEPARTMENTS AND
CONSTITUTIONAL INSTITUTIONS

ACCOUNTING OFFICERS OF ALL MUNICIPALITIES AND MUNICIPAL ENTITIES

ACCOUNTING AUTHORITIES OF ALL SCHEDULE 2 AND 3 PUBLIC ENTITIES

HEAD OFFICIALS OF PROVINCIAL TREASURIES

NATIONAL TREASURY DESIGNATED SECTORS CIRCULAR NUMBER 3 OF 2019/2020:

INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM THRESHOLD FOR LOCAL PRODUCTION AND CONTENT FOR STEEL CONVEYANCE PIPES, PIPE FITTINGS AND SPECIALS

1. PURPOSE

1.1 The purpose of this Circular is to:

- 1.1.1. Introduce amendments to the Circular for large bore spiral submerged arc welded steel conveyance pipes dated 22 January 2018; and
- 1.1.2. Provide information to accounting officers (AOs) and accounting authorities (AAs) in terms of which they may procure the aforementioned products which have been designated as a sector for local production and content.

2. BACKGROUND

- 2.1 The Preferential Procurement Regulations, 2017 made in terms of section 5 of the Preferential Procurement Policy Framework Act, 2000 (Act No 5 of 2000), which came into effect on 01 April 2017, make provision for the Department of Trade and Industry (**the dti**) to designate sectors in line with national development and industrial policies for local production.
- 2.2 Regulation 8 (2) of the Preferential Procurement Regulations, 2017 prescribes that in the case of a designated sector, an organ of state must advertise an invitation to tender with a specific condition that only locally produced services or goods, or locally manufactured goods, with a stipulated minimum threshold for local production and content will be considered.
- 2.3 To this end, **the dti** has designated and determined the stipulated minimum threshold for the Steel Conveyance Pipes, Pipe Fittings and Specials for local production and content. The range of Steel Pipes considered for this round of designation is 500mm to

3500mm. Conversely, all sizes of Pipe Fittings and Specials are included in the designation.

- 2.4 The designation is applicable to all purchases regardless of the procurement method followed and there is no financial threshold.

3. SECTOR DESIGNATION

- 3.1 The Circular is applicable where an organ of state purchases directly or indirectly from a manufacturer and/or service provider; in a case of turnkey projects (design, build, operate and/ or transfer); and/or on purchases for maintenance and repairs where a contract is awarded or extended for a project in which the designated products are part of the bill of quantities or materials to be utilised in the entire project.
- 3.2 A large bore spiral submerged arc welded steel conveyance pipe is a building material made from hot rolled steel sheets in coils which are basically an alloy of iron and carbon and are slit to the required width to suit the diameter of the required pipe. These slits are then submerged arc, spirally welded together to form the pipe. These pipes are widely used in the construction industry, in a variety of manufacturing and industrial applications, to convey liquids and gasses from one point to another. In the case of water supply; they convey water from bulk water supply installations such as dams to reservoirs. From reservoirs, the smaller electric resistance welded (ERW) pipes are used to transfer the water as municipal supply to commercial and residential buildings.
- 3.3 Pipe fittings or pipe specials refers to tees, bends, tapers, collars, flange adapters, blank flanges, expansion joints, mechanical joints, ring girders and similar accessories that are used as connections in a pipeline or tubing system that conveys liquid and/or solid materials. The work involves selecting and preparing pipe or tubing, joining it together by various means and the location and repair of leaks. Pipe fittings and specials are manufactured from a wide variety of materials including carbon steel, stainless steel, brass, copper, bronze and cast iron.
- 3.4 Flanges connect pipes, valves, pumps and other equipment to form a piping system. A flange can add support to a pipeline, close or block an existing pipeline, or they can be used for creating joints and attaching additional pieces to the system. Flange joints are made by bolting together two flanges with a gasket between them to provide a seal.
- 3.5 There is a distinction between bare, galvanized and lined and coated large bore spiral submerged arc welded steel conveyance pipe. The distinction similarly applies to pipe fittings and specials, excluding forged components.
- 3.5.1 The bare large bore spiral submerged arc welded steel conveyance pipe as is implied by the name, has not been lined, coated or galvanized. It is thus more prone to corrosion (rusting) and abrasion (inside) of the pipe as well as cathodic erosion (outside) of the pipe by direct current (DC) underground;
- 3.5.2 Galvanized large bore spiral submerged arc welded steel conveyance pipe is where the bare pipe is dipped in a hot zinc bath and both inside and outside surfaces are coated with zinc to avoid corrosion;
- 3.5.3 Bare or galvanized pipes can be lined (inside) and coated (outside) steel pipes by applying protective coatings in the form of paints to protect them from corrosion. This pipe is typically used to convey water.

- 3.6 The specifications and stipulated minimum threshold percentages and requirements for local production and content in respect to steel conveyance pipes, pipe fittings and specials are as follows:
- 3.7 To ensure that local production and content is discharged on manufacturing activities, the following components which have been designated must be included in bid invitations:

Table 1: Steel Conveyance Pipes

Manufacturing Process of Steel Conveyance Pipe	Size	% Local Content	Physical Properties
Spiral submerged arc welding	500mm - 3500mm	100%	Bare
Spiral submerged arc welding	500mm - 3500mm	100%	Galvanized
Spiral submerged arc welding	500mm - 3500mm	80%	Lined and coated
Spiral submerged arc welding	500mm - 3500mm	80%	Galvanized, lined and coated
Pipes, Pipe Fittings and Specials made from Ductile Iron MUST NOT be considered for public procurement.			

Table 2: Steel Pipe Fittings and Specials

Steel Pipe Fittings and Specials	Percentage Local content
Bare	100%
Galvanized	100%
Galvanized and Coated	80%
Galvanized, Lined and Coated	80%
Forged fittings (Flanges)	100%

- 3.7.1 All primary steel products i.e. coils, sheets and plates used in the fabrication of steel conveyance pipes, pipe fittings and specials are included in this designation and must be manufactured and sourced locally. This is to support and sustain the existing local steelmaking capacity. Minimum threshold percentages for fabricated pipe fittings and specials that are Bare; Galvanized; Lined and Coated as well as Galvanized, Lined and Coated fittings are applicable. It is important to note that fabricated fittings refer to coil-based pipe fittings and specials. Accordingly, forged fittings are assigned a separate threshold.
- 3.7.2 In the designation, imported input raw materials (i.e. zinc ingots and additives for the galvanising processes as well as round bar for forged flanges) used in the fabrication of

the large bore spiral submerged arc welded steel conveyance pipe as well as pipe fittings and specials are deemed as locally manufactured input materials. These inputs should be imported in raw material form for further fabrication in South Africa.

- 3.7.3 The imported input raw materials, as specified in 3.7.2, used in the manufacture and fabrication of steel conveyance pipes, pipe fittings and specials will be deemed to have been sourced locally for the purposes of calculating local content.

4. INVITATION OF BIDS FOR STEEL CONVEYANCE PIPES, PIPE FITTINGS AND SPECIALS

- 4.1 Bids in respect of Steel Conveyance Pipes, Pipe Fittings and Specials must contain a specific bidding condition that only locally produced or locally manufactured Steel Conveyance Pipes, Pipe Fittings and Specials with a stipulated minimum threshold for local production and content will be considered.

- 4.1.1 If the quantity of materials and/or products required cannot be wholly sourced from South African based manufacturers and/or at the designated local content threshold at any particular time, bidders should obtain written approval from **the dti** to supply the remaining portion at a lower local content threshold. Such applications should be submitted and approval be obtained prior to the closure of the bid(s) concerned. **the dti**, in consultation with the procuring organ of state, will grant approvals on a case-by-case basis and will consider the following:

- a) required volumes in the particular bid;
- b) available collective South African industry manufacturing capacity at that time;
- c) delivery times;
- d) availability of input materials and components;
- e) technical considerations including operating conditions;
- f) materials of construction; and
- g) security of supply and emergencies.

- 4.1.2 Bidders must clearly indicate in their bids the quantities of material and products to be supplied and the level of local content for each product.

- 4.1.3 The turn-around time for processing of approval or authorisation requests is 5 working days from the date of receipt. Therefore, such applications should reach **the dti** at least five days before closing date and time of bid.

- 4.1.4 The approval process that **the dti** follows is that if there is a particular designated product and the minimum threshold for local content cannot be met for various reasons, bidders must apply for approval or authorisation (when the tender is still open, before closing date). After checking with the industry, **the dti** will then decide whether or not to grant an authorisation. This is per bid.

- 4.1.5 The tender information / relevant information must be provided on the tenderer's / supplier's letterhead when requesting an authorisation letter:

- a) Procuring entity/government department/state owned company,
- b) Tender/bid number,

- c) Closing date,
- d) Item(s) for which the approval is being requested,
- e) Detailed specifications issued by the procuring entity,
- f) Local content that can be met,
- g) Reason(s) for the request, and
- h) Supporting letters from local manufacturers/sub-suppliers.

4.1.6 Approval requests for Pipes, Pipe Fittings and Specials made from Ductile Iron material will not be considered for reasons that ductile iron pipes (pipe fittings & specials) and steel pipes (pipe fittings & specials) can be used interchangeably, and there is sufficient capacity to manufacture steel pipes, pipe fittings and specials in the country. The procurement of Pipes, Pipe Fittings and Specials made from Ductile Iron material is non-compliant with this instruction note.

4.1.7 Organs of state may contact **the dti** in instances where the stipulated minimum threshold for local content cannot be met in order for **the dti** to verify and in consultation with the AO/AA provide directives in this regard.

4.1.8 For further information, bidders and procuring state organs may contact the Metals Fabrication, Capital and Rail Transport Equipment unit within **the dti** at telephone 012 394 1356/3138/3522 or email localcontent@thedti.gov.za

4.1.9 Bid specifications for the steel conveyance pipes, pipe fittings and specials referred to above may be done in collaboration with **the dti**.

4.2 AOs/AAs must stipulate in bid invitations that:

4.2.1 The exchange rate to be used for the calculation of local production and content must be the exchange rate published by the South African Reserve Bank (SARB) on the date of the advertisement of the bid.

4.2.2 Only the South African Bureau of Standards (SABS) approved technical specification number SATS 1286:2011 must be used to calculate local content.

4.3 The local content (LC) expressed as a percentage of the bid price must be calculated in accordance with the following formula which must be disclosed in the bid documentation:

$$LC = (1 - x/y) * 100$$

Where

x is the imported content in Rand

y is the bid price in Rand excluding value added tax (VAT)

Prices referred to in the determination of x must be converted to Rand (ZAR) by using the exchange rate published by the SARB on the date of advertisement of the bid.

4.4 AOs/AAs must clearly stipulate in the bid documentation that the SABS approved technical specification number SATS 1286:2011 and the Guidance on the Calculation of Local Content together with the Local Content Declaration Templates [Annex C (Local Content Declaration: Summary Schedule), D (Imported Content Declaration: Supporting Schedule to Annex C) and E (Local Content Declaration: Supporting

Schedule to Annex C)] are accessible to all potential bidders on **the dti's** official website http://www.thedti.gov.za/industrial_development/ip.jsp at no cost.

- 4.5 For the purpose of paragraphs 4.1, 4.2 and 4.3 above, the Declaration Certificates for Local Production and Content (SBD/MBD 6.2) must form part of the bid documentation. The SBD 6.2 is for use by all national and provincial departments, constitutional institutions and public entities listed in schedules 2, 3A, 3B, 3C and 3D to the Public Finance Management Act whilst the MBD 6.2 is for use by all municipalities and municipal entities to which the Municipal Finance Management Act (MFMA) applies.
- 4.6 AOs/AAs must stipulate in the bid documentation:
 - 4.6.1 that the Declaration Certificate for Local Production and Content (SBD / MBD 6.2) together with the Annex C (Local Content Declaration: Summary Schedule) must be completed, duly signed and submitted by the bidder at the closing date and time of the bid;
 - 4.6.2 that the rates of exchange quoted by the bidder in paragraph 4.1 of the Declaration Certificate will be verified for accuracy; and
 - 4.6.3 all the information relevant to bidders provided in paragraphs 4.1.1 to 4.1.7

5. EVALUATION OF BIDS FOR STEEL CONVEYANCE PIPES

- 5.1 An evaluation process in line with Preferential Procurement Regulations, 2017 must be followed.

6. EVALUATION OF BIDS BASED ON FUNCTIONALITY

- 6.1 Whenever it is deemed necessary to evaluate bids on the basis of functionality, the prescripts contained in Preferential Procurement Regulations, 2017 and paragraph 6 and 11 of the Implementation Guide must be followed.

7. POST AWARD AND REPORTING REQUIREMENTS

- 7.1. Once bids are awarded, **the dti** must be:
 - (i) notified of all the successful bidders and the estimated value of the contracts; and
 - (ii) provided with copies of the contracts, the SBD/MBD 6.2 Certificates together with the Declaration C submitted by the successful bidders within 30 days of award.
- 7.2 The purpose of the requirements of paragraph 7.1 above is for **the dti** to, among others, conduct compliance audits with a view to monitor the implementation of the industrial development strategies.
- 7.3 Contractors may not be allowed to sub-contract in such a manner that the local production and content of the overall value of the contract is reduced to below the minimum threshold as stipulated in regulation 8 of the Preferential Procurement Regulations, 2017.

8. CONTACT INFORMATION

8.1 Any enquiries in respect of Local Production and Content and all documents to be submitted to the dti must be directed as follows:

The Department of Trade and Industry
Private Bag X84
Pretoria
0001

For Attention:

Chief Director: Industrial Procurement
Tel: (012) 394 1435
Fax: (012) 394 1535
EMAIL: localcontent@thedti.gov.za

9. APPLICABILITY

- 9.1 This Circular applies to all national and provincial departments, constitutional institutions, public entities listed in schedules 2 and 3 to the PFMA, and municipalities and municipal entities to which the MFMA applies.

10. DISSEMINATION OF INFORMATION CONTAINED IN THIS CIRCULAR

- 10.1 Heads of provincial treasuries are requested to bring the contents of this Circular to the attention of accounting officers and supply chain management officials of their respective provincial departments.
- 10.2 Accounting officers of national and provincial departments are requested to bring the contents of this Circular to the attention of accounting authorities and the supply chain management officials of their departments, Schedule 3A and 3C public entities reporting to their respective executive authorities.
- 10.3 Accounting officers of municipalities and municipal entities are requested to bring the contents of this Circular to the attention of the supply chain management officials of their municipalities and municipal entities.
- 10.4 Accounting authorities of Schedule 2, 3B and 3D public entities are requested to bring the contents of this Circular to the attention of the supply chain management officials of their public entities.

11. NOTIFICATION TO THE AUDITOR-GENERAL

- 11.1 A copy of this Circular will be forwarded to the Auditor-General for notification.

12. REPEAL OF CIRCULAR DATED 22 JANUARY 2018

This Circular repeals Circular on invitation and evaluation of bids based on stipulated minimum threshold for local production and content for steel conveyance pipes, pipe fittings and specials dated 22 January 2018 and effective 18 February 2018.

13. AUTHORITY FOR THIS CIRCULAR AND EFFECTIVE DATE

- 13.1 This Circular is issued in terms of regulation 8(3) of the Preferential Procurement Regulations, 2017 and takes effect on date of issuance.



MR WILLIE MATHEBULA

ACTING CHIEF PROCUREMENT OFFICER

DATE: 20.12.19



national treasury

Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

**TO: ACCOUNTING OFFICERS OF ALL NATIONAL DEPARTMENTS AND
CONSTITUTIONAL INSTITUTIONS**

**ACCOUNTING OFFICERS OF ALL MUNICIPALITIES AND MUNICIPAL
ENTITIES**

**ACCOUNTING AUTHORITIES OF ALL SCHEDULE 2 AND 3 PUBLIC
ENTITIES**

HEAD OFFICIALS OF PROVINCIAL TREASURIES

**NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 11 OF
2016/2017**

**INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM
THRESHOLD FOR LOCAL PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND
ACTUATORS**

1. PURPOSE

- 1.1 The purpose of this Instruction is to regulate the environment within which Accounting Officers (AOs) and Accounting Authorities (AAs) may procure valves products and actuators which have been designated as a sector for local production and content.

2. BACKGROUND

- 2.1 The Preferential Procurement Regulations, 2011("the Regulations") issued in terms of Section 5 of the Preferential Procurement Policy Framework Act, 2000 (Act No 5 of 2000) which came into effect on 7 December 2011, make a provision for the Department of Trade and Industry (**the dti**) to designate sectors in line with the national development and industrial policies for local production.
- 2.2 Regulation 9 (1) of the Regulations prescribes that, in the case of designated sectors, wherein the award of bids for local production and content is of critical importance, such bids must be advertised with a specific bidding condition that only locally produced goods, services or works or locally manufactured goods, with a stipulated minimum threshold for local production and content will be considered.
- 2.3 **The dti** has designated and determined the stipulated minimum threshold for valves products, manual actuators (gearbox) and pneumatic actuators for local production and content.

**NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 11 OF 2016/2017
INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM THRESHOLD FOR LOCAL
PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND ACTUATORS**

3. SECTOR DESIGNATION

- 3.1 The stipulated minimum threshold percentage for local production and content for the different types of valves products, manual actuators (gearbox) and pneumatic actuators is 70%.
- 3.2 To ensure that local production and content is discharged on manufacturing activities, the following valves products, manual actuators (gearbox) and pneumatic actuators which have been designated must be included in bid invitations:

Types of Valves	Pressure type	Size	Pressure Rating (or imperial equivalent)	% Local Content per unit
Check Valves (Non-Return valves, Reflux valves, Tilting Disk valves Double Door, Multi Door, Swing Check)	Low pressure	80mm-3500mm	PN6-PN25	70%
	High pressure	80mm-2500mm	Class 150 -1500 Metric PN25 - PN250	70%
Butterfly Valves (Rotating Disk valves, Rotary Control valve, Quarter Turn Gate valve)	Low pressure	80mm-3500mm	PN6-PN25	70%
	High pressure	80mm-3500mm	Class 150 -1500 Metric PN25 - PN250	70%
Ball Valves (Spherical valves, Rotary valves)	Low pressure	20-300mm	PN10-PN25	70%
	High pressure	20-600mm	Class 150 - 4500 Metric PN25 - PN450	70%
Gate Valves (RSVs, Wedge Gates, Sluice valves, Parallel Slides, Penstocks, Bonnet Gates, Scour valves)	Low pressure	15mm-1800mm	PN6 - PN25	70%
	High pressure	80mm-1800mm	Metric PN 25 - PN100	70%
Diaphragm Valves (Slurry valve or Saunders valve)	Low pressure	15mm-350mm	PN10, PN16 & PN 25	70%
Knife Gate Valves	Low pressure	40mm-1200mm	PN10 & PN16	70%
Safety or Relief Valves (Pressure valve or Vacuum valve)	Low pressure	15mm-32mm	PN16	70%
Taps, Cocks	Low pressure	Full range	N/A	70%
Pneumatic actuators - Double acting (Vein type, Linear Type, Scotch Yolk Type, Rotary Type, Double Crank Type, Rack & Pinion Type)	Low pressure	~392 000nm torque	N/A	70%

**NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 11 OF 2016/2017
INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM THRESHOLD FOR LOCAL
PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND ACTUATORS**

Types of Valves	Pressure type	Size	Pressure Rating (or imperial equivalent)	% Local Content per unit
Pneumatic actuators - spring return (Vein type, Linear Type, Scotch Yolk Type, Rotary Type, Double Crank Type, Rack & Pinion Type)	Low pressure	~215 000nm torque	N/A	70%
Manual actuators (Gearboxes)	Low pressure	~200 000nm torque	N/A	70%
Fire Hydrants (Underground) Fire Deluge valve	Low pressure	65mm inlet	PN16	70%
Pressure Reducing valve (PRV) (Self-Regulating valve)	Low pressure	Full range	Full range	70%
Plug Valves (excluding expanding plug valves) (Double Block & Bleed valve)	Low pressure	20-600mm	PN10-PN26	70%
	High pressure	20-600mm	PN25-PN100	
Control valve (Globe Control valve, Piston Type Control valve)	Low pressure	25-600mm	PN10-PN25	70%
	High pressure	25-600mm	Class 150 -4500 Metric PN25 - PN750	
Air valve (Vacuum release valve)	Low pressure	50-300mm	PN10-PN25	
	High pressure	50-300mm	PN25-PN40	
Pinch valve (slurry valve)	Low pressure	50 -800mm	PN10 -PN40	
Disc valve	Low pressure	50-600mm	PN10-PN16	
Sleeve valve (Fixed Cone valves, Discharge valves, Scour valves, Howell Bungler valves Energy Dissipating valve)	Low pressure	Full range	PN 10 - PN25	

3.3 The minimum of 70% local content in the case of each individual valve, manual actuator (gearbox) and pneumatic actuator designated, must be made up of the following:

- 3.3.1 a combination of the use of locally produced and certified castings, forgings and/or fabrications, and
- 3.3.2 verifiable manufacturing activities that shall include as a minimum, machining, drilling, coating, assembling and testing of the valves in question.

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INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM THRESHOLD FOR LOCAL
PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND ACTUATORS**

- 3.4 The averaging out of local content either across any number of valve and gearbox/actuator combinations, or locally made and imported valves/other items, is not allowable.
- 3.5 Each individual valve, manual actuator (gearbox) or pneumatic actuator is subject to the minimum of 70% Local Content threshold.
- 3.6 For further information, bidders and procuring State Organs may contact the Metals Fabrication, Capital and Rail Transport unit within **the dti** at telephone 012 394 1356 or email Thandi Phele at tphele@thedti.gov.za.
- 3.7 Bid specifications for the valves products and actuators referred to above may be done in collaboration with **the dti**.

4. INVITATION OF BIDS FOR VALVES PRODUCTS AND ACTUATORS

- 4.1 Bids in respect of valves products and actuators must be advertised with a specific bidding condition that:
 - 4.1.1. Only locally manufactured valves products, manual actuators (Gearboxes) and pneumatic actuators with a stipulated minimum threshold for local production and content will be considered.
 - 4.1.2. If the quantity; input materials; and/or components of valves products and actuators required cannot be wholly sourced from South African (SA) based manufacturers to achieve the designated local content threshold of 70% on a fully-built valve and/or manual actuator (gearbox) or pneumatic actuator at any particular time, bidders should request and obtain written exemption from **the dti**. Such exemption applications should be submitted and approvals should be obtained prior to the closure of the bid(s) concerned. **The dti**, in consultation with the procuring organ of state and the local industry, will consider the exemption applications on a case-by-case basis and will consider the following:
 - required volumes in the particular bid;
 - available collective SA industry manufacturing capacity at that time;
 - delivery times;
 - availability of input materials and components;
 - technical considerations including operating conditions; and
 - materials of construction
 - 4.1.3. Bidders must clearly indicate in their bids the quantities of designated valves, manual actuators (gearboxes) and pneumatic actuators to be supplied and the level of local content for each product
 - 4.1.4. Organs of state may contact **the dti** in instances where the stipulated minimum threshold for local content cannot be met in order for **the dti** to verify and in consultation with the AO/AA provide directives in this regard.
- 4.2 AOs/AAs must stipulate in bid invitations that:
 - 4.2.1. the exchange rate to be used for the calculation of local production and content must be the exchange rate published by the South African Reserve Bank (SARB) on the date of advertisement of the bid; and

**NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 11 OF 2016/2017
INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM THRESHOLD FOR LOCAL
PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND ACTUATORS**

- 4.2.2. only the South African Bureau of Standards (SABS) approved technical specification number SATS 1286:2011 must be used to calculate local content
- 4.3 The Local Content (LC) expressed as a percentage of the bid price must be calculated in accordance with the following formula which must be disclosed in the bid documentation:

$$LC = \left(1 - \frac{x}{y}\right) * 100$$

Where

x is the imported content in Rand

y is the bid price in Rand excluding value added tax (VAT)

- In the case of turnkey products/projects x and y will only refer to the designated valve products, manual actuators (gearboxes) and pneumatic actuators in the project – refer to Clause 3.1 above
 - Prices referred to in the determination of x must be converted to Rand (ZAR) by using the exchange rate published by the SARB on the date of advertisement of the bid.
- 4.4 AOs/AAs must clearly stipulate in the bid documentation that the SABS approved technical specification number SATS 1286:2011 and the Guidance on the Calculation of Local Content together with the Local Content Declaration Templates [**Annexure C** (Local Content Declaration: Summary Schedule), **D** (Imported Content Declaration: Supporting Schedule to **Annexure C**) and **E** (Local Content Declaration: Supporting Schedule to Annex C)] are accessible to all potential bidders on the dti's official website [http://www.thedti.gov.za/industrial development/ip.jsp](http://www.thedti.gov.za/industrial%20development/ip.jsp) at no cost.
- 4.5 For the purpose of paragraphs 4.1, 4.2 and 4.3 above, the attached Declaration Certificates for Local Production and Content (SBD/MBD 6.2) must form part of the bid documentation. The SBD 6.2 is for use by all national and provincial departments, constitutional institutions and public entities listed in Schedules 2, 3A, 3B, 3C and 3D to the Public Finance Management Act whilst the MBD 6.2 is for use by all municipalities and municipal entities to which the Municipal Finance Management Act (MFMA) apply.
- 4.6 AOs/AAs must stipulate in the bid documentation that:
- 4.6.1 the Declaration Certificate for Local Production and Content (SBD / MBD 6.2) together with the **Annexure C** (Local Content Declaration: Summary Schedule) must be completed, duly signed and submitted by the bidder at the closing date and time of the bid; and
- 4.6.2 the rates of exchange quoted by the bidder in paragraph 4.1 of the Declaration Certificate will be verified for accuracy.
- 5. EVALUATION OF BIDS FOR VALVES PRODUCTS AND ACTUATORS**
- 5.1 A two stage evaluation process may be followed to evaluate the bids received.
- 5.1.1 **First stage: Evaluation in terms of the stipulated minimum threshold for local production and content**

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PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND ACTUATORS**

- (a) Bids must be evaluated by line item (***no averaging allowed***) in terms of the minimum threshold stipulated in the bid documents.
- (b) The declaration made by the bidder in the Declaration Certificate for Local Content (SBD / MBD 6.2) and **Annexure C** (Local Content Declaration: Summary Schedule) must be used for this purpose. If the bid is for more than one product (i.e. more than one valve type, size or pressure rating or different model of manual actuator (gearbox) or pneumatic actuator, the local content percentages for each product contained in **Annexure C** must be used.
- (c) The amendment of the stipulated minimum threshold for local production and content is not allowed.
- (d) AOs / AAs must verify the accuracy of the rates of exchange quoted by the bidder in paragraph 4.1 of the Declaration Certificate for Local Content (SBD / MBD 6.2)

5.1.2 Second stage: Evaluation in terms of the 80/20 or 90/10 preference point systems

- (a) Only bids that achieve the minimum stipulated threshold for local production and content may be evaluated further. Unless otherwise exempted by the Minister of Finance, the evaluation must be done in accordance with the 80/20 or 90/10 preference point systems prescribed in Preferential Procurement Regulations, 2011.
- (b) AOs/AAs must ensure that contracts for valves products and actuators / components are awarded at prices that are market related taking into account, among others, the dti's pre-determined benchmark prices, value for money and economies of scale.
- (c) Where appropriate, prices may be negotiated with short listed or preferred bidders. Such negotiations must not prejudice any other bidders.

5.2 Benchmark / market related prices

- 5.2.1 AOs/AAs are required to ensure that reasonable or market related prices are secured for the valves, manual actuators (gearbox) and pneumatic actuators being procured taking into account factors such as benchmark prices, value for money and economies of scale.
- 5.2.2 For this purpose, AOs/AAs may approach **the dti** for assistance, where possible, with benchmark prices for the different classes and components of valves products and manual actuators (gearbox) and pneumatic actuators that have been designated for local production and content. **The dti** will be in a position to provide price references for the different products that have been designated for local production and content.

6. EVALUATION OF BIDS BASED ON FUNCTIONALITY

- 6.1 Whenever it is deemed necessary to evaluate bids on the basis of functionality, the prescripts contained in Regulation 4 of the Preferential Procurement Regulations, 2011 and paragraphs 6 and 11 of the Implementation Guide must be followed.

7. POST AWARD AND REPORTING REQUIREMENTS

- 7.1 Once bids are awarded, **the dti** must be:

**NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 11 OF 2016/2017
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PRODUCTION AND CONTENT FOR VALVES PRODUCTS AND ACTUATORS**

- 7.1.1 notified of all the successful bidders and the estimated value of the contracts; and
- 7.1.2 provided with copies of the contracts, the SBD/MBD 6.2 Certificates together with the Declaration C submitted by the successful bidders.
- 7.2 The purpose of the requirements of paragraph 7.1 above is for **the dti** to among others conduct compliance audits with a view to monitor the implementation of the industrial development strategies.
- 7.3 Contractors must not be allowed to sub-contract in such a manner that the local production and content of the individual products is reduced to below the stipulated minimum threshold.
- 7.4 Where, after the award of a bid, contractors experience challenges in meeting the stipulated minimum threshold for local content the dti must be informed accordingly in order for the dti to verify and in consultation with the AO/AA provide directives in this regard.

8. CONTACT INFORMATION

- 8.1 Any enquiries in respect of Local Production and Content and all documents to be submitted to the dti must be directed as follows:**

The Department of Trade and Industry
Private Bag X84
Pretoria
0001
For Attention:
Dr Tebogo Makube
Chief Director: Industrial Procurement
Tel: (012) 394 3927
Fax: (012) 394 4927
EMAIL: TMakube@thedti.gov.za

9. APPLICABILITY

- 9.1 This Instruction applies to all national and provincial departments, constitutional institutions; public entities listed in Schedules 2 and 3 to the PFMA, and, municipalities and municipal entities to which the MFMA apply.

10. DISSEMINATION OF INFORMATION CONTAINED IN THIS INSTRUCTION

- 10.1 Heads of provincial treasuries are requested to bring the contents of this Instruction to the attention of Accounting Officers and supply chain management officials of their respective provincial departments.
- 10.2 Accounting Officers of national and provincial departments are requested to bring the contents of this instruction to the attention of Accounting Authorities and the supply chain management officials of Schedule 3A and 3C public entities reporting to their respective executive authorities.

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- 10.3 Accounting Officers of municipalities and municipal entities are requested to bring the contents of this instruction to the attention of the supply chain management officials of their municipalities and municipal entities.
- 10.4 Accounting Authorities of Schedule 2, 3B and 3D public entities are requested to bring the contents of this instruction to the attention of the supply chain management officials of their public entities.

11. NOTIFICATION TO THE AUDITOR-GENERAL

- 11.1 A copy of this Instruction will be forwarded to the Auditor-General for notification.

12. REPEAL OF INSTRUCTION DATED 6 FEBRUARY 2014

This Instruction repeals Instructions on invitation and evaluation of bids based on a stipulated minimum threshold for local production and content for valves products and actuators dated 21 July 2015 and effective on the date of issue and the similar Instruction issued on 11 February 2016 effective on 18 February 2016.

13. AUTHORITY FOR THIS INSTRUCTION AND EFFECTIVE DATE

- 13.1 This Instruction is issued in terms of Regulation 9(2) of the Preferential Procurement Regulations, 2011 and takes effect from the date of issue.

PP *M. J. Shuterangano*
KENNETH BROWN
CHIEF PROCUREMENT OFFICER
DATE: 12/7/2016



national treasury

Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

**TO: ACCOUNTING OFFICERS OF ALL NATIONAL DEPARTMENTS AND
CONSTITUTIONAL INSTITUTIONS**

ACCOUNTING OFFICERS OF ALL MUNICIPALITIES AND MUNICIPAL ENTITIES

ACCOUNTING AUTHORITIES OF ALL SCHEDULE 2 AND 3 PUBLIC ENTITIES

HEAD OFFICIALS OF PROVINCIAL TREASURIES

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017.

**INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM THRESHOLD
OF CONVERSION PROCESSES FOR LOCAL PRODUCTION AND CONTENT FOR STEEL
PRODUCTS AND COMPONENTS FOR CONSTRUCTION.**

1. PURPOSE

- 1.1 The purpose of this instruction note is to regulate the environment within which accounting officers (AOs) and accounting authorities (AAs) may procure steel products and components for construction which have been designated as a sector for local production and content.

2. BACKGROUND

- 2.1 The Preferential Procurement Regulations, 2011 ("the regulations") issued in terms of section 5 of the Preferential Procurement Policy Framework Act, 2000 (Act No 5 of 2000) which came into effect on the 7 December 2011, make provision for the Department of Trade and Industry (**the dti**) to designate sectors in line with the national development and industrial policies for local production.
- 2.2 Regulation 9 (1) of the Regulations prescribes that, in the case of designated sectors, wherein the award of bids for local production and content is of critical importance, such bids must be advertised with the specific bidding condition that only locally produced goods, services or works or locally manufactured goods, with a stipulated minimum threshold for local production and content will be considered.
- 2.3 **the dti** has designated and determined the stipulated minimum threshold for steel products and components for construction for the state procurement for local production and content.

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

3. PRODUCT DESIGNATION

- 3.1 In this instruction note, steel products and components for construction have been recommended for designation
- 3.2 Steel products and components for construction refer to:
- 3.2.1 **Fabricated structural steel** which includes a wide range of free standing shapes, cross sections and sizes of steel metal pieces produced through a variety of operations according to a specific design, certain standards of chemical composition and mechanical properties. The fabricated components are produced from various primary and downstream steel products, including: channels (parallel and taper flanges); I-beams and H-beams; angles (equal and unequal); bars (flat; square and round); reinforcing bar and fasteners. The fabrication comprises of detailing (cutting, rolling, drilling, bending, grinding and machining), fitting, welding and/or, fastening, surface preparation (cleaning) and surface protection (coating) of steel components for application in an assortment structures.
- 3.2.2 In addition to the processes in 3.2.1; **joining components** such as gussets, cleats, stiffeners, splices, plates, cranks, kinks, doglegs, holes, girders, spacers, tabs, brackets, fasteners (bolts, nuts, rivets and nails) are used for connection and assembly of structures.
- 3.2.3 **Frames** refer to all rigid structures that surround doors, windows, patio, showers and built-in-cupboards made of steel.
- 3.2.4 **Roof Cladding** refers to a layer of covering applied to a roof in order to provide both weather protection and aesthetic appeal which consist of large sheets of material, or many small, overlapping units made of steel.
- 3.2.4.1 **Vertical cladding** refers to the protective or insulating layer fixed to the outside of a building or another structure for aesthetic appeal made of steel.
- 3.2.5 **Wire Products** refers to all downstream wire products manufactured from hot-rolled ferrous wire rod coils, including drawn wire – carbon/alloy steel (galvanised or plain), articles of wire – forged, wire rope/strand, fabric reinforcing, all fencing wire (barbed, welded mesh, hexagonal wire netting, diamond mesh), welding electrodes nails/tacks, chains, gabions, springs and screws.
- 3.2.6 **Fasteners** refer to hardware products that mechanically join or affix two or more steel components.
- 3.2.7 **Ducting and Structural Pipework** refers to non-conveyance tubing fabricated from steel sheeting and plate with structural supports.
- 3.2.8 **Gutters, downpipes & launders** refers to drainage systems made from sheeting associated with roofing
- 3.2.9 **Primary steel products** which includes flat and long products which are converted into value-added steel products in 3.2.1 to 3.2.8 as well as for reinforcement of buildings and structures.

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

- 3.3 Table 1 provides the stipulated minimum threshold for local content and production for steel products and components for construction (as described in 3.2)

Table 1a: Minimum local content for Steel Value-added Products

Steel Construction Materials	Components	Local Content Threshold
Fabricated Structural Steel	Latticed steelwork, reinforcement steel, columns, beams, plate girders, rafters, bracing, cladding supports, stair stringers & treads, ladders, steel flooring, floor grating, handrailing and balustrading, scaffolding, ducting, gutters, launders, downpipes and trusses	100%
Joining/Connecting Components	Gussets, cleats, stiffeners, splices, cranks, kinks, doglegs, spacers, tabs, brackets	100%
Frames	Doors and Windows	100%
Roof and Cladding	Bare steel cladding, galvanised steel cladding, colour coated cladding	100%
Fasteners	Bolts, nuts, rivets and nails	100%
Wire Products	All fencing products: all barbed wire and mesh fencing, fabric/mesh reinforcing, gabions, wire rope/strand and chains, welding electrodes, nails/tacks, springs and screws	100%
Ducting and Structural Pipework	Non-conveyance tubing fabricated from steel sheeting and plate with structural supports	100%
Gutters, downpipes & launders	Fabricated materials made from sheeting associated with roof drainage systems	100%

Table 1b: Minimum local content for Primary Steel Products

Steel Construction Materials	Local Content Threshold
Plates (>4.5mm thick and supplied in flat pieces)	100%
Sheets (<4.5mm thick and supplied in coils)	100%
Galvanised and Colour Coated Coils	100%
Wire Rod and Drawn Wire	100%
Sections (Channels; Angles, I-Beams and H-Beams)	100%
Reinforcing bars	100%

- 3.4 In the designation, imported inputs raw materials (i.e. zinc and additives in the surface preparation and protection processes (cleaning and coating/galvanising)) used in the production of steel products and components for construction are deemed as locally manufactured input materials.
- 3.5 The imported input raw materials, as specified in 3.4, used in the manufacture and production of steel products and components for construction will be deemed to have been sourced locally for the purposes of calculating local content.

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

The application of this instruction note is applicable where an organ of state purchases directly from the manufacturer, in a case of turnkey projects (design, build, operate and/or transfer) and/or on purchases for maintenance and repairs where a contract is awarded for a project which the designated products are part of the bill of quantities or materials to be utilised in the entire project.

- 3.6 Organs of state may contact **the dti** in instances where the stipulated minimum threshold for local content cannot be met in order for **the dti** to verify and in consultation with the AO/AA provide directives in this regard.
- 3.7 For further information, bidders and procuring state organs may contact the following units with **the dti**: Metals Fabrication, Capital and Rail Transport Equipment at telephone 012 394 1356 or email Thandi Phele at TPhele@thedti.gov.za and Primary Minerals processing & Construction at telephone 012 394 5157 or email Tapiwa Samanga at TSamanga@thedti.gov.za.
- 3.8 Bid specifications for the designated products in this instruction note may be done in collaboration with **the dti**.

4. INVITATION OF BIDS FOR STEEL PRODUCTS AND COMPONENTS

- 4.1 Bids in respect of steel products and components for construction must contain a specific bidding condition which states that:
- 4.1.1. Only locally produced or locally manufactured steel products and components for construction with a stipulated minimum threshold for local production and content will be considered.
- 4.1.2. If the quantity of steel products and components for construction required cannot be wholly sourced from South African (SA) based manufacturers and/or at the designated local content threshold stipulated in paragraph 3.3 at any particular time, bidders and the procuring entities should obtain written exemption from **the dti**. **the dti**, in consultation with the procuring organ of state and the local industry, will consider the exemption applications on a case-by-case basis and will consider the following:
- required volumes in the particular bid;
 - available collective SA industry manufacturing capacity at that time;
 - delivery times;
 - availability of input materials and components;
 - technical considerations including operating conditions;
 - materials of construction; and
 - security of supply
- 4.1.3. Bidders must clearly indicate in their bids the quantities to be supplied and the level of local content for each product.
- 4.2 AOs/AAs must stipulate in bid invitations that:

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

- 4.2.1. the exchange rate to be used for the calculation of local production and content must be the exchange rate published by the South African Reserve Bank (SARB) at 12:00 on the date of advertisement of the bid; and
- 4.2.2. only the South African Bureau of Standards (SABS) approved technical specification number SATS 1286:2011 must be used to calculate local content

- 4.3 The local content (LC) expressed as a percentage of the bid price must be calculated in accordance with the following formula which must be disclosed in the bid documentation:

$$LC = [1 - x/y] * 100$$

Where

x is the imported content in Rand

y is the bid price in Rand excluding value added tax (VAT)

(in the case of turnkey products/projects x and y will only refer to the value of steel products and components in the project)

Prices referred to in the determination of x must be converted to Rand (ZAR) by using the exchange rate published by the SARB at 12:00 on the date of advertisement of the bid.

- 4.4 **AOs/AAs must clearly stipulate in the bid documentation that the SABS approved technical specification number SATS 1286:2011 and the Guidance on the Calculation of Local Content together with the Local Content Declaration Templates [Annex C (Local Content Declaration: Summary Schedule), D (Imported Content Declaration: Supporting Schedule to Annex C) and E (Local Content Declaration: Supporting Schedule to Annex C)] are accessible to all potential bidders on the dti's official website <http://www.thedti.gov.za/industrialdevelopment/ip.jsp> at no cost.**
- 4.5 For the purpose of paragraphs 4.1, 4.2 and 4.3 above, the attached Declaration Certificates for Local Production and Content (SBD/MBD 6.2) must form part of the bid documentation. The SBD 6.2 is for use by all national and provincial departments, constitutional institutions and public entities listed in schedules 2, 3A, 3B, 3C and 3D to the Public Finance Management Act whilst the MBD 6.2 is for use by all municipalities and municipal entities to which the Municipal Finance Management Act (MFMA) apply.
- 4.6 AOs/AAs must stipulate in the bid documentation that:
- (a) the Declaration Certificate for Local Production and Content (SBD / MBD 6.2) together with the Annex C (Local Content Declaration: Summary Schedule) must be completed, duly signed and submitted by the bidder at the closing date and time of the bid;
 - (b) bidders must submit a certificate from a registered auditor confirming that the Local Content Declaration Templates have been audited and certified as correct. (See paragraph 5 of the Declaration Certificate); and
 - (c) the rates of exchange quoted by the bidder in paragraph 4.1 of the Declaration Certificate will be verified for accuracy.

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

4.7 Benchmark / market related prices

4.7.1. AOs/AAs are required to ensure that reasonable or market related prices are secured for steel products and components for construction being procured taking into account factors such as benchmark prices, value for money and economies of scale.

4.7.2. For this purpose, AOs/AAs may approach **the dti** for assistance, where possible, with benchmark prices for steel products and components for construction that have been designated for local production and content. **The dti** will be in a position to provide price references for the different products that have been designated for local production and content.

4.8 Bid specifications for the sub-sectors referred to in paragraph 3 above and the price benchmarking referred to in paragraph 4.7 above must be done in collaboration with the dti. Contact information in this regard is provided in paragraph 8 below.

5. EVALUATION OF BIDS FOR STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

5.1 A two stage evaluation process may be followed to evaluate the bids received.

5.1.1. First stage: Evaluation in terms of the stipulated minimum threshold for local production and content

5.1.1.1 Bids must be evaluated in terms of the minimum threshold stipulated in the bid documents.

5.1.1.2 The declaration made by the bidder in the Declaration Certificate for Local Content (SBD / MBD 6.2) and Annex C (Local Content Declaration: Summary Schedule) must be used for this purpose. If the bid is for more than one product, the local content percentages for each product contained in Declaration C must be used.

5.1.1.3 The amendment of the stipulated minimum threshold for local production and content is not allowed.

5.1.1.4 A bid may be disqualified if:

- The bidder fails to achieve the stipulated minimum threshold for local production and content unless written exemption has been granted to the bidder by **the dti** to bid at a lower local content level; and
- The Declaration Certificate for Local Content (SBD / MBD 6.2), the Annex C (Local Content Declaration: Summary Schedule) and the registered auditors' certificate referred to in paragraphs 4.6 (a) and (b) are not submitted as part of the bid documentation.

5.1.1.5 AOs / AAs must verify the accuracy of the rates of exchange quoted by the bidder in paragraph 4.1 of the Declaration Certificate for Local Content (SBD / MBD 6.2)

5.1.2 Second stage: Evaluation in terms of the 80/20 or 90/10 preference point systems

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

5.1.2.1 Only bids that achieve the minimum stipulated threshold for local production and content may be evaluated further. Unless otherwise exempted by the Minister of Finance, the evaluation must be done in accordance with the 80/20 or 90/10 preference point systems prescribed in Preferential Procurement Regulations, 2011.

5.1.2.2 AOs/AAs must ensure that contracts for steel products and components are awarded at prices that are market related taking into account, among others, the dti's pre-determined benchmark prices, value for money and economies of scale.

5.1.2.3 Where appropriate, prices may be negotiated with short listed or preferred bidders. Such negotiations must not prejudice any other bidders.

6. EVALUATION OF BIDS BASED ON FUNCTIONALITY

6.1 Whenever it is deemed necessary to evaluate bids on the basis of functionality, the prescripts contained in regulation 4 of the Preferential Procurement Regulations, 2011 and paragraphs 6 and 11 of the Implementation Guide must be followed.

7. POST AWARD AND REPORTING REQUIREMENTS

7.1 Once bids are awarded, **the dti** must be:

- (i) notified of all the successful bidders and the estimated value of the contracts; and
- (ii) provided with copies of the contracts, the SBD/MBD 6.2 Certificates together with the Declaration C submitted by the successful bidders.

7.2 The purpose of the requirements of paragraph 7.1 above is for **the dti** to among others conduct compliance audits with a view to monitor the implementation of the industrial development strategies.

7.3 Contractors may not be allowed to sub-contract in such a manner that the local production and content of the overall value of the contract is reduced to below the minimum threshold as stipulated in regulation 9 of the Preferential Procurement Regulations, 2011.

8. CONTACT INFORMATION

8.1 **Any enquiries in respect of Local Production and Content and all documents to be submitted to the dti must be directed as follows:**

The Department of Trade and Industry
Private Bag X84
Pretoria
0001

For Attention:

Dr Tebogo Makube
Chief Director: Industrial Procurement
Tel: (012) 394 3927

NATIONAL TREASURY DESIGNATED SECTORS INSTRUCTION NUMBER 15 OF 2016/2017: STEEL PRODUCTS AND COMPONENTS FOR CONSTRUCTION

Fax: (012) 394 4927

EMAIL: TMakube@thedti.gov.za

9. APPLICABILITY

- 9.1 This instruction applies to all National and Provincial Departments, Constitutional Institutions; Public Entities listed in schedules 2 and 3 to the PFMA, and, Municipalities and Municipal Entities to which the MFMA apply.

10. DISSEMINATION OF INFORMATION CONTAINED IN THIS INSTRUCTION NOTE

- 10.1 Heads of Provincial Treasuries are requested to bring the contents of this Instruction to the attention of accounting officers and supply chain management officials of their respective provincial departments.
- 10.2 Accounting Officers of National and Provincial Departments are requested to bring the contents of this Instruction to the attention of Accounting Authorities and the supply chain management officials of Schedule 3A and 3C Public Entities reporting to their respective Executive Authorities.
- 10.3 Accounting Officers of Municipalities and Municipal Entities are requested to bring the contents of this Instruction to the attention of the supply chain management officials of their Municipalities and Municipal entities.
- 10.4 Accounting Authorities of Schedule 2, 3B and 3D Public Entities are requested to bring the contents of this Instruction to the attention of the supply chain management officials of their Public Entities.

11. NOTIFICATION TO THE AUDITOR-GENERAL

- 11.1 A copy of this Instruction Note will be forwarded to the Auditor-General for notification.

12. AUTHORITY FOR THIS INSTRUCTION NOTE AND EFFECTIVE DATE

- 12.1 This Instruction is issued in terms of Regulation 9(2) of the Preferential Procurement Regulations, 2011 and takes effect on the date of issuance.
- 12.2 This Instruction takes effect on 1 February 2017.



SCHALK HUMAN
ACTING CHIEF PROCUREMENT OFFICER
DATE: 13.01.2017



national treasury

Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

Private Bag X115, Pretoria, 0001

TO: ACCOUNTING OFFICERS OF ALL NATIONAL DEPARTMENTS AND
CONSTITUTIONAL INSTITUTIONS
ACCOUNTING OFFICERS OF ALL MUNICIPALITIES AND MUNICIPAL ENTITIES
ACCOUNTING AUTHORITIES OF ALL SCHEDULE 2 AND 3 PUBLIC ENTITIES
HEAD OFFICIALS OF PROVINCIAL TREASURIES

NATIONAL TREASURY DESIGNATED SECTORS CIRCULAR NUMBER 1 OF 2019/2020:

**INVITATION AND EVALUATION OF BIDS BASED ON A STIPULATED MINIMUM
THRESHOLD FOR LOCAL PRODUCTION AND CONTENT FOR PLASTIC PIPES**

1. PURPOSE

- 1.1 The purpose of this circular is to provide information to accounting officers (AOs) and accounting authorities (AAs) in terms of which they may procure the Plastic Pipes which have been designated for local production and content.

2. BACKGROUND

- 2.1 The Preferential Procurement Regulations, 2017 ('the regulations') made in terms of section 5 of the Preferential Procurement Policy Framework Act, 2000 (Act No 5 of 2000) which came into effect on 01 April 2017 make provision for The Department of Trade and Industry (**the dti**) to designate sectors in line with national development and industrial policies for local production.
- 2.2 Regulation 8 (2) of the regulations prescribes that in the case of a designated sector, an organ of state must advertise the invitation to tender with a specific condition that only locally produced services or goods or locally manufactured goods with a stipulated minimum threshold for local production and content, will be considered.
- 2.3 To this end, the dti has designated and determined the stipulated minimum threshold for the Plastic Pipes for local production and content.

3. SECTOR DESIGNATION

3.1 Plastic Conveyance Pipes Definition:

Pipes are hollow cylinders or tubes used to convey water, gas, oil, or other fluid-like substances. Pipes are made in many materials including ceramic, fiberglass, many metals, concrete and plastic. Plastic pipes have a variety of characteristics such as

flexibility, lightweight, endurance, corrosion-proof, etc. that allow plastic pipe systems to fulfil a wide variety of service requirements. They are therefore used in infrastructure applications, such as drinking water supply and distribution, gas transmission and distribution, land and underground drainage, sewerage disposal and underground cable protection, all of which may be divided as pressure and non-pressure pipelines. Plastic piping networks form an integral, expensive, long term and extremely important part of the infrastructure of this country.

3.2 Pipe types and diameters:

There are four (4) classes of pipes with varying diameters that are used in water and sanitation infrastructure. Depending on the raw material used, plastic pipes are classified under the following types:

- Polyvinyl chloride (PVC) pipes;
- High density polyethylene (HDPE) pipes;
- Polypropylene (PP) pipes and
- Glass reinforced plastic (GRP) pipes.

These are further divided into different diameter sizes ranging from **10 mm to 3700 mm**.

3.3 The stipulated minimum threshold percentages for local production and content for the Plastic Pipes is **100%**.

3.4 To ensure that local production and content is discharged on manufacturing activities, the following components must be included in bid invitations:

Product Types	Stipulated minimum threshold local content
Polyvinyl chloride (PVC) pipes	100%
High density polyethylene (HDPE) pipes;	100%
Polypropylene (PP) pipes	100%
Glass reinforced plastic (GRP) pipes	100%

4. INVITATION OF BIDS FOR PLASTIC PIPES

4.1 Bids in respect of Plastic Pipes must contain a specific bidding condition that only locally produced or locally manufactured Plastic Pipes with a stipulated minimum threshold for local production and content will be considered.

4.1.1 If the quantity of materials and/or products required cannot be wholly sourced from South African based manufacturers and/or at the designated local content threshold at any particular time, bidders should obtain written approval from **the dti** to supply the remaining portion at a lower local content threshold. Such approval applications should be submitted and approval be

obtained prior to the closure of the bid(s) concerned. **the dti**, in consultation with the procuring organ of state, will grant approval on a case-by-case basis and will consider the following:

- required volumes in the particular bid;
- available collective South African industry manufacturing capacity at that time;
- delivery times;
- availability of input materials and components;
- technical considerations including operating conditions;
- materials of construction; and
- security of supply and emergencies.

4.1.2 Bidders must clearly indicate in their bids the quantities of material and products to be supplied and the level of local content for each product.

4.1.3 Organs of state may contact **the dti** in instances where the stipulated minimum threshold for local content cannot be met in order for **the dti** to verify and in consultation with the AO/AA provide directives in this regard.

4.1.4 For further information, bidders and procuring state organs may contact the Plastics Unit within **the dti** at telephone 012 394 1406 or email **Thokozani Masilela**: TMasilela@thedti.gov.za

4.1.5 Bid specifications for Plastic Pipes referred to above may be done in collaboration with **the dti**.

4.2 AOs/AAs must stipulate in bid invitations that:

4.2.1 The exchange rate to be used for the calculation of local production and content must be the exchange rate published by the South African Reserve Bank (SARB) on the date of the advertisement of the bid.

4.2.2 Only the South African Bureau of Standards (SABS) approved technical specification number SATS 1286:2011 must be used to calculate local content.

4.3 The local content (LC) expressed as a percentage of the bid price must be calculated in accordance with the following formula which must be disclosed in the bid documentation:

$$LC = (1 - x/y) * 100$$

Where

x is the imported content in Rand

y is the bid price in Rand excluding value added tax (VAT)

Prices referred to in the determination of x must be converted to Rand (ZAR) by using the exchange rate published by the SARB on the date of advertisement of the bid.

- 4.4 AOs/AAs must clearly stipulate in the bid documentation that the SABS approved technical specification number SATS 1286:2011 and the Guidance on the Calculation of Local Content together with the Local Content Declaration Templates [Annex C (Local Content Declaration: Summary Schedule), D (Imported Content Declaration: Supporting Schedule to Annex C) and E (Local Content Declaration: Supporting Schedule to Annex C)] are accessible to all potential bidders on **the dti's** official website http://www.thedti.gov.za/industrial_development/ip.jsp at no cost.
- 4.5 For the purpose of paragraphs 4.1, 4.2 and 4.3 above, the Declaration Certificates for Local Production and Content (SBD/MBD 6.2) must form part of the bid documentation. The SBD 6.2 is for use by all national and provincial departments, constitutional institutions and public entities listed in schedules 2, 3A, 3B, 3C and 3D to the Public Finance Management Act, whilst the MBD 6.2 is for use by all municipalities and municipal entities to which the Municipal Finance Management Act (MFMA) applies.
- 4.6 AOs/AAs must stipulate in the bid documentation that:
- 4.6.1 the Declaration Certificate for Local Production and Content (SBD / MBD 6.2) together with the Annex C (Local Content Declaration: Summary Schedule) must be completed, duly signed and submitted by the bidder at the closing date and time of the bid; and
- 4.6.2 the rates of exchange quoted by the bidder in paragraph 4.1 of the Declaration Certificate will be verified for accuracy.

5. EVALUATION OF BIDS FOR PLASTIC PIPES

- 5.1 An evaluation process in line with Preferential Procurement Regulations, 2017 must be followed.

6. EVALUATION OF BIDS BASED ON FUNCTIONALITY

- 6.1 Whenever it is deemed necessary to evaluate bids on the basis of functionality, the prescripts contained in PPR 2017 and the Implementation Guide must be followed.

7. POST AWARD AND REPORTING REQUIREMENTS

- 7.1 Once bids are awarded, **the dti** must be:
- (i) notified of all the successful bidders and the estimated value of the contracts; and
 - (ii) provided with copies of the contracts, the SBD/MBD 6.2 Certificates together with the Declaration C submitted by the successful bidders.
- 7.2 The purpose of the requirements of paragraph 7.1 above is for **the dti** to, among others, conduct compliance audits with a view to monitor the implementation of the industrial development strategies.

- 7.3 Contractors may not be allowed to sub-contract in such a manner that the local production and content of the overall value of the contract is reduced to below the minimum threshold as stipulated in regulation 12 (2) of the Preferential Procurement Regulations, 2017.

8. CONTACT INFORMATION

- 8.1 **Any enquiries in respect of Local Production and Content and all documents to be submitted to the dti must be directed as follows:**

The Department of Trade and Industry
Private Bag X84
Pretoria
0001

For Attention:

Dr Tebogo Makube
Chief Director: Industrial Procurement
Tel: (012) 394 3927
Fax: (012) 394 4927
EMAIL: TMakube@thedti.gov.za

9. APPLICABILITY

- 9.1 This Circular applies to all national and provincial departments, constitutional institutions, public entities listed in schedules 2 and 3 to the PFMA, and municipalities and municipal entities to which the MFMA applies.

10. DISSEMINATION OF INFORMATION CONTAINED IN THIS CIRCULAR

- 10.1 Heads of provincial treasuries are requested to bring the contents of this Circular to the attention of accounting officers and supply chain management officials of their respective provincial departments.
- 10.2 Accounting officers of national and provincial departments are requested to bring the contents of this Circular to the attention of accounting authorities and the supply chain management officials of Schedule 3A and 3C public entities reporting to their respective executive authorities.
- 10.3 Accounting officers of municipalities and municipal entities are requested to bring the contents of this Circular to the attention of the supply chain management officials of their municipalities and municipal entities.
- 10.4 Accounting authorities of Schedule 2, 3B and 3D public entities are requested to bring the contents of this Circular to the attention of the supply chain management officials of their public entities.

11. NOTIFICATION TO THE AUDITOR-GENERAL

11.1 A copy of this Circular will be forwarded to the Auditor-General for notification.

12. AUTHORITY FOR THIS CIRCULAR AND EFFECTIVE DATE

12.1 This Circular is issued in terms of regulation 8(3) of the Preferential Procurement Regulations, 2017 and takes effect on **16 September 2019**.



WILLIE MATHEBULA

ACTING CHIEF PROCUREMENT OFFICER

DATE: 16. 08. 19

Annex C

Local Content Declaration - Summary Schedule

(C1) Tender No.			
(C2) Tender description:			
(C3) Designated product(s)			
(C4) Tender Authority:			
(C5) Tendering Entity name:			
(C6) Tender Exchange Rate:	Pula		EU
(C7) Specified local content %			

Note: VAT to be excluded from all calculations

GBP

Calculation of local content							
Tender item no's	List of items	Tender price - each (excl VAT)	Exempted imported value	Tender value net of exempted imported content	Imported value	Local value	Local content % (per item)
(C8)	(C9)	(C10)	(C11)	(C12)	(C13)	(C14)	(C15)

Tender summary			
Tender Qty	Total tender value	Total exempted imported content	Total Imported content
(C16)	(C17)	(C18)	(C19)

Signature of tenderer from Annex B

Date:

(C20) Total tender value

(C21) Total Exempt imported content

(C22) Total Tender value net of exempt imported content

(C23) Total Imported content

(C24) Total local content

(C25) Average local content % of tender

Annex D

Imported Content Declaration - Supporting Schedule to Annex C

[illegible]

A. Exempted imported content

A. Exempted imported content				Calculation of imported content						Summary	
Tender item no's	Description of imported content	Local supplier	Overseas Supplier	Foreign currency value as per Commercial Invoice	Tender Exchange Rate	Local value of imports	Freight costs to port of entry	All locally incurred landing costs & duties	Total landed cost excl VAT	Tender Qty	Exempted imported value
(D7)	(D8)	(D9)	(D10)	(D11)	(D12)	(D13)	(D14)	(D15)	(D16)	(D17)	(D18)
(D19) Total exempt imported value											

(D19) Total exempt imported value

This total must correspond with
Annex C- C21

B. Imported directly by the Tenderer

[illegible]

(D32) Total imported value by tenderer

C. Imported by a 3rd party and supplied to the Tenderer

[illegible]

(D45) Total imported value by 3rd party

D. Other foreign currency payments

D. Other foreign currency payments			Calculation of foreign currency payments		Summary of payments
Type of payment	Local supplier making the payment	Overseas beneficiary	Foreign currency value paid	Tender Rate of Exchange	Local value of payments
(D46)	(D47)	(D48)	(D49)	(D50)	(D51)

(D52) Total of foreign currency payments declared by tenderer and/or 3rd party

(D53) Total of imported content & foreign currency payments - (D32), (D45) & (D52) above

**This total must correspond with
Annex C - C23**

Signature of tenderer from Annex B

Date:

Annex E

Local Content Declaration - Supporting Schedule to Annex C

(E1)	Tender No.	
(E2)	Tender description:	
(E3)	Designated products:	
(E4)	Tender Authority:	
(E5)	Tendering Entity name:	

Note: VAT to be excluded from all calculations

Local Products (Goods, Services and Works)	Description of items purchased	Local suppliers	Value
	(E6)	(E7)	(E8)
(E9) Total local products (Goods, Services and Works)			

(E10) **Manpower costs** (Tenderer's manpower cost)

(E11) **Factory overheads** (Rental, depreciation & amortisation, utility costs, consumables etc.)

(E12) **Administration overheads and mark-up** (Marketing, insurance, financing, interest etc.)

(E13) **Total local content**

This total must correspond with Annex C - C24

Signature of tenderer from Annex B

Date: _____

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PORTION 2: THE CONTRACT

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PART C1.7: HEALTH AND SAFETY SPECIFICATIONS BY EMPLOYER

The Health and Safety Specifications by the Employer will be issued electronically to all tenderer's who attend the compulsory site briefing and provide their details accordingly.

PART C1.8: ENVIRONMENTAL MANAGEMENT PLAN BY EMPLOYER

The Environmental Management Plan by the Employer will be issued electronically to all tenderer's who attend the compulsory site briefing and provide their details accordingly.

PORTION 2: THE CONTRACT

PART C3: SCOPE OF WORKS

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PART C3.3: STANDARD SPECIFICATIONS

The standard specifications on which this contract is based are the SANS 1200 Standardized Specifications for Civil Engineering Construction.

Although not bound in, nor issued with this Document, the following Sections of the SANS 1200 Standardized Specifications shall form part of this Contract:

SANS 1200 STANDARDISED SPECIFICATIONS (formally SABS 1200)

A	1986	-	GENERAL
AB	1986	-	ENGINEER'S OFFICE
C	1982	-	SITE CLEARANCE
D	1990	-	EARTHWORKS
DB	1989	-	EARTHWORKS (PIPE TRENCHES)
DE	1989	-	EARTHWORKS (SMALL EARTH DAMS)
DK	1984	-	GABIONS AND PITCHING
G	1982	-	CONCRETE STRUCTURAL
H	1990	-	STRUCTURAL STEELWORK
L	1983	-	MEDIUM PRESSURE PIPELINES
LB	1983	-	BEDDING (PIPES)
LD	1982	-	SEWERS
MK	1981	-	KERBING AND CHANNELING

Note: In the above specifications, all reference to SABS must be replaced with SANS

SANS SPECIFICATIONS

SANS 1921: Construction Management Requirements for Works Contracts
Part 1: (Ed 1.1): General Engineering and Construction Works (2017)
Part 2: Accommodation of traffic on public roads occupied by the contractor (2004)
Part 3: (Ed. 1.1) Structural steelwork (2018)
Part 4: (Ed. 1.1) Third-party management support in works contracts (2018)
Part 5: Earthworks activities which are to be performed by hand (2004)
Part 4: HIV/AIDS awareness (2004)

STANDARD DEPARTMENT OF WATER AFFAIRS AND FORESTRY SPECIFICATIONS

DWS 2510/01	General Valve Specification.	June 2000
DWS 2510/03	Gate Valves	June 2000
DWS 2510/03	Butterfly Valves	June 2000
DWS 2510/03	Non-return Valves	June 2000
DWS 9900/C3	Corrosion Protection of Valves, Flow Meters and Outlet Pipes	September 2002

COTO STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE WORKS

Chapter 12: Geotechnical Applications

Note: The word "Schedule" of Quantities as used in the Standardised Specifications shall mean the "Bill" of Quantities referred to in the General Conditions of Contract (GCC).

The word "Engineer" as used in the Standardised Specifications shall mean the "Employer's Representative" referred to in the General Conditions of Contract (GCC).

AMENDMENTS TO THE STANDARD AND PARTICULAR SPECIFICATIONS

In certain clauses the Standard, Standardized and Particular Specifications allow a choice to be specified in the Project Specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in this part of the Project Specifications. It also contains additional specifications required for this particular contract.

Any reference to old SABS specifications shall be amended to reflect the latest replacement in the SANS specifications.

The number of each clause and each payment item in this part of the project specifications consists of the prefix PS (for SANS 1200 and COTO) followed by a number corresponding to the number of the relevant clause or payment item in the standard specifications and the amendments shall be read together with the standardized specifications. The number of a new clause or payment item, which does not form part of a clause or a payment item in the Standard Specifications and which is included here, is also prefixed by PS (for SANS 1200 and COTO) but followed by a new number which follows on the last clause or item number used in the relevant section of the Standard Specifications.

Where pay items are not included in the Schedule, it will be deemed that these amendments have deleted them. All reference to the "Machinery and Occupational Safety Act (Act 6 of 1983)" should be amended to reflect the "Occupational Health and Safety Act (Act 85 of 1993)".

AMENDMENTS TO THE STANDARD AND PARTICULAR SPECIFICATIONS

PSA:	GENERAL	C3.3-3
PSC:	SITE CLEARANCE	C3.3-9
PSD:	EARTHWORKS	C3.3-10
PSDB:	EARTHWORKS (PIPE TRENCHES)	C3.3-19
PSDE:	EARTHWORKS (SMALL EARTH DAMS)	C3.3-24
PSDK:	GABIONS AND PITCHING	C3.3-26
PSG:	CONCRETE (STRUCTURAL)	C3.3-28
PSH:	STRUCTURAL STEELWORK	C3.3-57
PSL:	MEDIUM PRESSURE PIPELINE	C3.3-58
PSLB:	BEDDING (PIPES)	C3.3-66
PSLD:	SEWERS	C3.3-68



PSA GENERAL

PSA-3 MATERIALS

PSA-3.1 Quality

Where there is a standardization mark programme for any material, all such material supplied shall bear the official standardization mark.

Alternative materials or equipment proposed by the Contractor shall be tested. The test, as well as the materials or equipment, shall be approved by the Engineer prior to any such materials or equipment being built into the works and all costs involved in testing shall be deemed to be included in the rates tendered.

PSA-4. PLANT

PSA-4.2 Contractor's Office, Stores and Services

It is not a requirement of this contract for the Contractor to provide an approved field laboratory on site, although he may elect to do so. If no laboratory is provided, the Contractor shall nevertheless arrange to have the required quality control tests (e.g. densities, concrete strengths, etc) performed by an approved commercial laboratory. The Tenderer's tendered rates shall include full compensation for such tests.

The Contractor's camp shall be kept neat and clean at all times and all surplus or rejected material shall be removed from the site.

PSA-5 CONSTRUCTION

PSA-5.1 Survey

PSA-5.1.1 Setting out of the Works

Reference points are indicated on the drawings or will be made available on the site of the works. Additional lines and levels required for setting out the works shall be established by the Contractor and must be checked and approved by the Engineer before commencement of construction.

PSA 5.4 Protection of Overhead and Underground Services

Add the following to the existing Clause:

"There is limited information regarding the existing services in the areas of the Works. Enquiries shall be made with the relevant authorities/departments to confirm details of services indicated on the drawings and to obtain supplementary information.

Where indicated on the Drawings or where directed, services shall be exposed to enable the design of the work to be checked/revised/confirmed.

The existence of, or the position or depth of, any underground services which may be affected by the Work shall be ascertained by exploratory excavations using hand tools. Such exploratory excavations shall be carried out, refilled and reinstated in an approved manner as expeditiously as possible. Hand excavation rates are included in the schedules



for this purpose.

Timeous written notice shall be submitted (including that to the authority/department concerned) stating when it is intended to commence work across or near any existing works or services. Such work shall not be commenced until the necessary permission (including any conditions relating thereto) has been received. Work across or near any existing works or services shall be carried out in compliance with the requirements of the relevant authority/department.

Manhole covers, valve boxes, hydrants, etc. shall not be covered over and shall be accessible at all times.

The Contractor shall be held responsible for any damage to overhead or underground services, and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval of the authority concerned. In the event of a service being damaged the Contractor shall immediately notify the authority concerned as well as the Engineer. The Contractor shall not repair any such service unless instructed to do so, but the rectification cost shall be for his account, when wilfully damaged.

Payment for accommodation of services will not be made where no physical accommodation is provided or required, such as in temporary exposure of services during exploratory excavation."

Add the following new Clause:

"PSA 5.4.1 Protection during construction

The Contractor shall take all reasonable precautions and arrange its operations in such a manner as to prevent damage occurring to all known services during the period which the Contractor has occupation and /or possession of the Site.

Services left exposed shall be suitable protected from damage and in such a manner as will eliminate any danger arising there from to the public and/or workmen, all in accordance with the requirements of the prevailing legislation and related regulations.

Unless otherwise instructed by the Engineer, no services shall be left exposed after its exact position has been determined and all excavations carried out for the purpose of exposing underground services shall be promptly backfilled and compacted. In roadways, the requirements of Sub-clause 5.9 of SANS 1200 DB should be observed. In other areas compaction is to be to 90% modified AASHTO density."

Add the following new Clause:

"PSA 5.4.2 Alterations and repairs to existing services

Unless the contrary is clearly specified in the Contract or ordered by the Engineer, the Contractor shall not carry out alterations to existing services. When any such alterations become necessary, the Contractor shall promptly inform the Engineer, who will make arrangements for such work, to be executed by the owner of such services.

Should damage occur to any existing service, the Contractor shall immediately inform the Engineer, or when this is not possible, the relevant authority, and obtain instructions as to



who should carry out repairs. In urgent cases, the Contractor shall take appropriate steps to minimise damage to and interruption of the services. No repairs to telecommunication cables or electric power line and cable shall be attempted by the Contractor without the authorisation of the relevant authority."

PSA-5.5 Dealing with water on Works

Add the following to Clause 5.5:

"Dealing with both surface and sub-surface water for the duration of the Contract shall be covered by the provisions of these clauses and payment items under project specification PSA-8.8.6 only.

It will be necessary to deal with water on the works in three forms:

- a) Surface runoff in streams, channels, rivers and floodplains;
- b) Sub-surface groundwater flow, inclusive of leakage water; and
- c) Sub-surface water encountered due to excavations below the natural water table.

Dealing with all water to allow the proper execution of the construction works in an adequately dry environment shall be the responsibility of the Contractor. He shall devise and implement adequate measures and controls to ensure that water does not impede his progress, damage the works, or compromise construction in any way. The Contractor shall be responsible for all consequences related to his water control measures; such as erosion caused by re-routed streamflow, floods generated by failure of a coffer dam, mudslides, etc. No monetary or time extension claims consequential to water damage, or inadequate control measures, or the failure of control measures, for all water, shall be entertained.

Except for the cost of installation of a small coffer and 900 mm diameter diversion pipe, no additional payment for dealing with water on the Works will be made other than that stated under Clause PSA-8.8.6."

PSA-5.8 Ground and access to works

Add the following:

"On completion of operations the Contractor shall restore the ground surface, wherever it may have been disturbed, to its original condition by filling in all ruts with material similar to the material within the rut and levelling the ground and, where necessary, planting grass and shrubs as may be required. Any boundary fences which have been removed or damaged by his operations and activities shall be repaired and/or reinstated at the Contractor's expense."

PSA-8. MEASUREMENT AND PAYMENT

PSA-8.2 Payment

Add the following sub-clause:

"PSA-8.2.5 Establishment of Facilities on the Site

Should the combined total tendered for pay items 8.3 (Fixed Charge and Value Related Items) and 8.4 (Time Related Items) exceed 10% and 15% of the tender sum (excluding CPA, contingencies and VAT) respectively, the tenderer shall state his reasons in writing for tendering in this manner. The tenderer's attention is drawn to **Tender Form Y: Contractor's Establishment on Site**, (bound in Volume 1), to be completed by the tenderer.



If the tenderer should require additional compensation for these preliminary and general obligations by including such additional compensation in the tendered rates and/or lump sum of items in the Bill of Quantities, these items and the value of such additional compensation shall also be indicated in writing in a letter attached to **Tender Form Y**. The tendered rate shall apply in the same manner as pay items 8.3 and 8.4.

PSA-8.3 Scheduled fixed-charge and value-related items

PSA-8.3.2 Establishment of Facilities on the Site

PSA-8.3.2.1 Facilities for the Engineer

Add the following additional sub-item:

"The tendered rate shall cover all costs as specified in Sub-clauses 8.3.2.3 of SANS 1200 A to provide the facilities as specified in Clause PS-8."

PSA-8.3.2.2 Facilities for Contractor

For this Contract the sub-items of sub-clause 8.3.2.2 are consolidated into one item and the facilities for the Contractor will not be measured and paid for separately as itemised in sub-clause 8.3.2.2. Payment under item PSA-8.3.2.2 shall therefore be deemed to cover sub-items (a) to (j).

PSA-8.4 Scheduled time-related items

PSA-8.4.2 Operation and maintenance of Facilities on Site

PSA-8.4.2.1 Facilities for Engineer

Add the following additional sub-items:

"The tendered rates shall cover all costs as specified in Subclause 8.4.2.3 of SANS 1200 A to operate and maintain these facilities as specified in Clause PS-8."

PSA-8.4.2.2 Facilities for Contractor

Consolidate sub-items (a) to (j) of Clause 8.4.2.2 into one item as in PSA-8.3.2.2. Payment under PSA-8.4.2.2 shall be deemed to cover sub-items (a) to (j).

PSA 8.8 TEMPORARY WORKS

PSA-8.8.1 Main Access Road to Works (Maintain) Unit: Sum

The sum tendered shall cover all costs related to the maintenance of the main access road to the works as well as roads in and around the works which are used by the Contractor as described under the project specification.

Payment of the items of PSA-8.8.1 will be made as follows:

- 40% when the main access road to the works has been upgraded to a quality adequate (in the opinion of the engineer) to carry the traffic utilising the route to the site.
- 20% when the roads in and around the Works have been constructed to a quality adequate (in the opinion of the engineer) to carry the traffic utilising the roads.
- The remainder to be spread evenly over the remaining extent of the project as a Time Related obligation.



PSA-8.8.2 Dealing with Traffic

The tendered rates shall cover the costs of all aspects described under PSA 5.10.

PSA 8.8.4 Existing services

Add the following to the payment Clause

“The rates for Item (c) shall cover the cost of excavating by means of hand tools within authorised dimensions, for all precautionary measures to protect the services from damage during excavation and backfilling, and for subsequent backfilling and compacting. Compaction of material in all areas except in roadways shall be to 90% of the modified AASHTO density.

The rate for excavation in roadways shall include compensation for compacting excavated or selected backfill material to 93% of modified AASHTO density. Reinstating layerworks and surfacing shall be measured and paid for under SANS 1200 DB.

The tendered rate shall also include for keeping excavations, safe, for dealing with surface and subsurface water, for removing surplus excavated material from the Site, for transporting all material within the free-haul distance, and for supplying adequate supervision during both excavation and backfilling operations. No Overhaul will be measured and paid.”

PSA-8.8.6 Special Water Control in Terms of the Project Specification

Replace this item with the following:

PSA-8.8.6.1 Dealing with Surface runoff in streams, channels, rivers, and floodplains..... Unit: Sum

The sum tendered shall cover all costs related to dealing with surface runoff water on the full area of the site under the control of the Contractor, maintenance of measures implemented, rehabilitation of any consequential damage and rehabilitation of control measures on completion of construction.

PSA-8.8.6.2 Dealing with Sub-surface groundwater flow Unit: Sum

The sum tendered shall cover all costs related to dealing with sub-surface groundwater flow over the full area of the site under the control of the Contractor, maintenance of measures implemented, rehabilitation of any consequential damage and rehabilitation of control measures on completion of construction.

PSA-8.8.6.3 Dealing with Sub-surface water table Unit: Sum

The sum tendered shall cover all costs related to dealing with Sub-surface water encountered due to excavations below the natural water table over the full area of the site under the control of the Contractor, maintenance of measures implemented, rehabilitation of any consequential damage and rehabilitation of control measures on Completion of construction.

Payment of the items of PSA-8.8.6.1 will be made as follows:

- 20% when all facilities as proposed by the Contractor and approved by the Engineer have been implemented.
- The remainder to be spread evenly over the remaining extent of the project as a Time Related obligation.



Payment of the items of PSA-8.8.6.2 to PSA-8.8.6.4 will be made as a Time Related obligation over the full duration of the contract.

Add new pay item:

PSA- 8.8.7 River Diversion Unit: Lump Sum

Sheet A of the Bill of Quantities provides an estimate of quantities for the proposed river diversion strategy as per the Engineer's design as described in the PS-14.1. While this is provided as an aid to the Contractor to price the temporary works, the Contractor will take full responsibility for the final design and construction, and maintenance of the diversion works. As such, payment for the construction of these works will only be made through the lump sum item of PSA-8.8.7 and Sheet A of the Bill of Quantities will not be re-measurable.

The Contractor shall critically evaluate the measures envisaged and the risks associated with the proposed strategy and price the item accordingly. The rate submitted shall cover all risk, labour, equipment, materials, etc. necessary to construct, maintain and potentially reconstruct the diversion works in the event of a flood in excess of the capacity of the system and the consequential risk to the ongoing works which may be affected by such flooding. The rate shall further include for the complete removal and disposal of all temporary diversion works located outside the dam footprint upon completion of their intended function, and for the reinstatement of all affected areas to the satisfaction of the Engineer.

Notwithstanding the configurations proposed, the Contractor shall take full responsibility and risk for the final implementation to manage flood risks in the river for the full duration of the project.

Payment of this item will be made in three amounts as follows:

- 60 % of the Tendered Sum when the construction of the coffer dam and pipe is complete;
- 20% of the Tendered Sum halfway through the diversion process; and
- 20% of the Tendered Sum when the diversion facilities are removed.



PSC SITE CLEARANCE

PSC 5 CONSTRUCTION

PSC 5.1 Areas to be cleared and grubbed

Add the following to the existing Clause:

“Small diameter pipeline routes shall be cleared to a distance of 1.0 m on both sides of the pipeline centre line and large diameter pipeline routes shall be cleared to a distance 2.0 m on both sides of the pipeline centre line. Route pegs or markers shall not be destroyed or damaged during clearing operations.”

PSC 8.2.7 Dismantle and remove pipelines, electricity transmission line, cables, etc

The payment item will be used for the dismantling for re-use of various miscellaneous elements.

Modify the unit to include the following;

Sum	The lump sum to dismantled and removed the item described
Number (No):	The number of complete items to be dismantled and removed.
Ton (T)	The metric ton of steelwork to be dismantled and removed
Square metre (m2)	The square metre of the item to be dismantled and removed

The tendered rate shall also cover all the costs for the careful removal to maintain the integrity of the item, cleaning, transporting, loading, off-loading and storage of the existing items at the designated stockpile site or storage area for the duration of the project.

PSC 8.2.8 Demolish and remove structures/buildings and dismantle steelwork, etc

Modify the unit to include the following;

Number (No)	The number of complete items to be demolished and removed.
Ton (T)	The metric ton of steelwork to be demolished and removed
Metre	The linear metre of the item to be demolished and removed

The tendered rate shall also cover all the costs for the demolition, transporting, loading, off-loading of the item at the designated spoil site and the compaction thereof to limit settlement of the site, as applicable.



PSD EARTHWORKS

PSD 2 INTERPRETATIONS

PSD 2.3 Definitions

Replace the definition of Restricted Excavation with the following:

Restricted excavation shall be excavation in areas where access, geometry, slope conditions, adjacent structures, services, or other physical constraints prevent the efficient use of conventional bulk earthmoving equipment and methods.

Restricted excavation shall specifically include:

- Excavation on steep slopes, batters, embankments, or other locations where bulldozers or other conventional bulk earthmoving equipment cannot safely or practically operate;
- Thin or narrow strips, slivers, wedges, isolated pockets, or irregular remnants of material remaining after completion of previous bulk excavation, where such material cannot be economically removed using normal bulk excavation methods;
- Excavation requiring specialised equipment, reduced production rates, multiple handling, trimming operations, or manual assistance due to restricted access or working space.

The classification of excavation as restricted excavation shall be determined by the Engineer, taking into account accessibility, safety requirements, working space constraints, and the practicality of excavation by normal bulk earthworks methods. The lines and annotations shown on the Drawings distinguishing restricted excavation from bulk excavation shall be used as guidance in making this evaluation.

PSD 3 MATERIALS

PSD 3.1 Classification for excavation purposes

PSD 3.1.2 Classes of excavation

Add the following:

"Only two classes of excavation will be measured for earthworks for this Contract, viz. hard rock excavation and soft excavation. Hard rock excavation shall be as specified in Clause 3.1.2 (c) of SANS 1200D. All other excavation will be considered as soft excavation for this Contract (i.e. all excavation as specified in Clauses 3.1.2(a), 3.1.2(b), 3.1.2(d) and 3.1.2(e) will be "soft" excavation).

PSD 3.2 Classification for Placing Purposes

PSD 3.2.2 Material Suitable for Replacing Overbreak in Excavations for Foundations

Where overbreak occurs under foundations or other elements placed on the ground it shall be replaced with mass concrete class 15 MPa/19 mm or with soilcrete as specified under Prescribed Mix Concrete in the modifications to the standardised concrete specifications, PSG 5.5.1.6.

PSD 3.3 Selection

Add the following new Clause:

"PSD 3.3.3 Selection in Borrow Pits and Excavations

"Approval of a borrow area for a certain purpose does not necessarily mean that all the



material in that area is suitable for the specified purpose. What it does mean is that the borrow area contains some suitable material. The onus shall rest on the Contractor to ensure that only material that is indeed suitable is removed and used for the specified purpose.

When the Contractor has to select excavated material for a specific purpose, the above provisions relating to borrow areas shall apply *mutatis mutandis* to excavations.

The Contractor shall not waste or contaminate material that has been selected for specific purpose."

PSD 5 CONSTRUCTION

PSD 5.1 Precautions

PSD 5.1.1 Safety

PSD 5.1.1.1 Barricading and Lighting

Replace reference to "Machinery and Occupational Safety Act, 1983 (Act 6 of 1983)" with "Occupational Health and Safety Act, 1993 (Act 85 of 1993)."

Replace sub-paragraph (a) and (b) with the following:

- "(a) adequately protected by a barrier or fence (with 2 wire strands for support) comprising fluorescent orange plastic netting of height at least 1 000 mm and as close to the excavation as practicable;
- (b) provided with notice boards marked "CLOSED" at each end of closed or partially closed roads; and
- (c) provided with flashing orange lights, placed as per traffic ordinance along the barricading at night."

Add the following to the existing Sub-clause:

"Should the Contractor fail to provide adequate lighting, signing and barricading, access to properties, or leave the Site in a dangerous condition, the Engineer shall be entitled to suspend all work under the Contractor until in the Engineer's opinion the Contractor's obligation in these respects have been fulfilled and/or arrange for any emergency work to be carried out by some other agency and to deduct the cost of this work from any monies due to the Contractor. All safety instructions must be adhered to immediately."

PSD 5.1.1.2 Safeguarding of excavations

Replace the reference in Sub-clause (a) to "The Machinery and Occupational Safety Act" with "the Occupational Health and Safety Act, 1993 (Act 85 of 1993)."

Add the following new Sub-clauses:

- "g) Loose ground, materials, tools and appliances shall be kept clear of the edge of the excavations and a pathway at least 0.30 m shall be left clear around such edge.
- h) The Contractor shall be solely and entirely responsible for maintaining excavations in a safe condition and his responsibility shall in no way be diminished by any instruction by the Engineer to take additional or improved protection or precautionary



measures. The Contractor will be required to provide the Engineer with his method statement for the excavation and shoring of excavations deeper than 2 m before commencing with the excavation.

He shall be responsible for the design and installation of all shoring to comply with the safety regulations of the Occupational Health and Safety Act and, in addition, to provide sufficient lateral support to avoid damage to adjacent structures, services or road surfaces. Shoring for the excavations shall be installed progressively as the excavations proceed.

No separate or additional payment shall be made for timbering and shoring, and allowance must be made for this work in the Bill of Quantities for excavation.

Timbering, shoring, etc., directed to be left in the excavations will be paid for at the scheduled rates."

PSD 5.1.1.3 Explosives

Omit the existing Clause and insert the following:

"The Contractor may be permitted to use explosives for breaking up hard material during excavations, for demolishing existing structures, and for other purposes where explosives are normally required, subject to the following conditions:

- (a) The Engineer may prohibit the use of explosives in cases where, in his opinion, the risk of injury to persons or damage to property of adjoining structures is too high. Such action by the Engineer does not entitle the Contractor to additional payment for having to resort to less economical methods of construction. The requirements of Particular Specification PPS-6 shall be adhered to.
- (b) When there is a possibility of damage to power and telephone lines or any other services or property, the Contractor shall adapt his method of blasting and the size of the charges and shall use adequate protective measures (e.g. cover-blasting) to reduce the risk of damage.
- (c) All accidents, injury to persons and animals and damage to property shall be reported to the Engineer in detail and in writing as soon as is practicable.
- (d) The Contractor will be required to set up a system to monitor his own blasting independently of monitoring by other parties. Special care shall be taken to ensure the works are not damaged in any way.
- (e) Any blasting within the work area must be organised in consultation with the ESKOM with regard the overhead power lines, and the Contractor shall accept all responsibility for any consequential damage occurring as a result of blasting and make-good any such damage at his own expense.
- (f) Adequate and appropriate warning shall be given to all affected parties surrounding the dam prior to blasting. These measures shall be approved by the Engineer.
- (g) Screening and protective measures shall be established around the work area as necessary to ensure acceptable environmental and safety conditions.
- (h) The blasts will be monitored separately by the Contractor and an independent specialist, as directed by the Engineer. The Contractor shall provide all assistance the specialist may require in undertaking the monitoring and he shall ensure the



equipment installed is not damaged in any way. Payment for the specialist shall be effected through SANS1200A Pay Item 8.5.

Notwithstanding the Contractor's compliance with the above provisions, the Contractor shall remain liable for any injury to persons and animals and loss of or damage to property occurring as a result of blasting operations."

PSD 5.1.2.2 Detection, location and exposure of existing services

Delete existing Clause and replace with the following:

- "(a) The Contractor shall be responsible for establishing the position of all underground services. Where any underground services are shown on the drawings the Contractor shall detect and locate such services and if so ordered, he shall excavate by hand to expose the services in areas and in a manner and at a time agreed with the Engineer. The Client takes no responsibility for the accuracy of the information shown on the drawings in respect of underground services, or for any omission (Refer also to PSA 5.4).
- (b) Where necessary, the Contractor shall employ the use of specialist equipment to locate underground services. If instructed to do so by the Engineer, he shall be paid for it from the Provisional Sum allowed for in the Bill of Quantities. The Contractor is required to provide daywork rates for the use of cable locators, pipe locators and sub-surface interfacing Radar.
- (c) At least 14 (fourteen) days before commencing with excavations to locate existing services under any Provincial/National road/Municipal main road (road with metropolitan route number)/Transnet track/service of municipal department/other authority, the Contractor shall:
 - (i) Arrange a site meeting with the authorities concerned and the Engineer to ascertain required precautionary measures.
 - (ii) Give written notice to the department/authority concerned and the Engineer of his intention to excavate.

The limits of the specified trench width shall be marked on the surfaced roadway and a clean vertical face shall be cut through the asphalt surface/asphalt foundation prior to machine excavation.

Payment for cutting through the asphalt surface/asphalt foundation shall be made as per Clause PSC 8.2.13."

PSD 5.1.2.3 Protection and alteration of existing services

Omit existing Clause and insert the following:

"The Contractor shall advise the Engineer at least 2 days in advance of the actual date on which he proposes to excavate near any existing service.

If practical, the Contractor shall first locate the service using specialist location equipment. He shall not excavate with mechanical equipment closer than 1 m to the estimated position of any such service and shall, if ordered, expose the service by means of hand excavation carried out under proper supervision. The Contractor shall backfill excavations at services with approved material to the compaction density ordered."

PSD 5.1.2.4 Negligence



Add the following to the existing Clause:

"When a service is damaged due to negligence on the part of the Contractor, he shall be liable for the cost of making good the damage and the Engineer shall deduct such cost from monies due to the Contractor."

PSD 5.2 METHODS AND PROCEDURES

PSD 5.2.2 Excavation

PSD 5.2.2.1 Excavation for general earthworks and for structures

Add the following to paragraph (b):

"All structures founded on rock shall be cast against the rock without the creation of additional working space.

When the nature of the material precludes the above procedure, additional excavations shall be carried out to provide working space for the erection of formwork. The rate tendered for item 8.3.5 will be deemed to include the cost of a working width of 600 mm, but the Contractor may excavate a greater working width at no additional cost to the Employer."

Unless otherwise instructed, the provision for working space in Sub-clause (c) shall be as follows:

- (i) Where back shuttering of concrete is to be used : 300 mm
- (ii) For brickwork : 150 mm
- (iii) For precast concrete chambers : 150 mm

Replace the contents of paragraph (e) with the following:

"Where excavations have been carried below the authorised levels by more than 250 mm, the Contractor shall fill such excavations to the correct level with approved mass concrete doweled to the parent rock to the satisfaction of the Engineer.

Where excavations for structures have been carried out in hard material, the Engineer may direct the over-excavation to be backfilled with mass concrete if there is a danger of settlement of differential settlement of the foundations.

Where the sides of excavation against which concrete is to be cast have been over-excavated or have collapsed partially, the Contractor shall re-trim the excavations if necessary and, unless other remedial measures are agreed to by the Engineer, shall cast the concrete for the structure, including the additional concrete that may be required as a result of the over-excavation or partial collapse. The cost of the additional concrete or remedial measures shall be for the Contractors account."

Add the following to new paragraph (f):

Hard rock excavations for the manufacture of aggregate for Hardfill shall be undertaken utilising blasting techniques. The design of the blasting operations, as well as the removal, haulage and processing of the blasted material shall be conducted by a qualified blast engineer and detailed method statements to describe the proposed actions must be submitted to the Engineer prior to any action on site. This shall include the requirements



of PSD 5.1.1.3

All blasting activities shall be complete before any foundation grouting or concrete works may commence. The Contractor shall plan his construction sequences accordingly.

PSD 5.2.2.3 Disposal

Add the following to Clause 5.2.2.3:

"All materials, excavated or other, surplus to that required for the Works shall be loaded, transported, tipped and spread inside the dam basin to the satisfaction of the Engineer."

Add the following New Clause:

"PSD 5.2.2.4 Selection and stockpiling

Approval or designation of the material in a particular borrow pit or excavation for a particular purpose does not imply that all the material in the borrow pit or excavation is suitable for the particular purpose to which the said approval or designation relates, nor that all material in the borrow pit or source should be used for the particular purpose. The Contractor shall select suitable material from that borrow pit or source, discard unsuitable material and reserve material for other purposes as necessary.

The Contractor shall organise and carry out his operations in such a manner as will prevent the contamination of suitable embankment and backfill material with unsuitable materials. Any excavated material which becomes, in the Engineer's opinion, unsuitable for use in embankments or backfill as a result of contamination, shall be disposed of in a manner acceptable to the Engineer and shall be replaced by the Contractor with materials acceptable to the Engineer, all at the Contractor's cost."

Temporary stockpiling of excavated materials may be required, depending on the construction sequences and methods chosen by the Contractor.

PSD 5.2.5 Transport for Earthworks

Replace the clause with the following:

"Transportation of all materials used under this Contract shall be regarded as freehaul."

PSD 6 TOLERANCES

Add the following New Clause:

PSD 6.3 Permissible deviations for the excavations for the dam foundation:

Permissible deviations for the excavations for the dam foundation: shall be as for Excavations for structural foundations to Degree of accuracy III. Failure to achieve these tolerances will require rectification to be determined by the Engineer for the account of the Contractor.

PSD 6.4 Preparation of Foundations on Rock to Receive Concrete

Rock surfaces to receive concrete shall be free of all dust, mud, loose or fractured material and other debris. Fissures shall be cleaned out and treated to the extent instructed by the Engineer. The surfaces shall be washed completely clean using air or water jets immediately prior to placing concrete, cement mortar or sprayed concrete. If instructed by the Engineer, the Contractor shall clean part of the foundation in advance of the



remainder for the purpose of inspection.

Where rock surfaces reach high temperatures under the influence of the sun, washing shall be carried out at night or in the early morning to avoid fracturing due to thermal shock.

PSD 6.5 Treatment of Foundations in Rock

PSD 6.5.1 General

The Engineer will instruct the Contractor on remedial measures required to deal with Geological features which are exposed after excavation and cleaning of the rock below the footprint of the dam. In principle, the following treatments shall be applied.

PSD 6.5.1.1 Treatment of Joints, Cracks and Fissures

Joints, cracks and fissures shall be cleaned out to a minimum depth of twice their width or to a depth instructed by the *Engineer*. The joints shall be flushed clean with water and cleaned with air before filling by one of the following procedures, or other methods as instructed by the *Engineer*.

- a) Cement Mortar: A mortar in the proportion 2:1:1 sand:cement:water shall be worked into the joint, crack or fissure to seal it completely.
- b) Cement Grout: A cement grout in the proportion 1:1 cement:water shall be pumped through a pipe set at the bottom of the joint, crack or fissure until it is completely filled. Grout shall then be brushed across the top of the joint, crack or fissure to ensure a good contact with the sealing element.

Where cracks are small and narrow, the *Engineer* may instruct that grout be brushed into such cracks to seal them.

PSD 6.5.1.2 Treatment of Faults, Dykes, Shear Zones and Zones of Poor Rock

Gougeable or weak material shall be excavated to a depth of three times its width or a minimum depth of 0.5 m or such other depth instructed by the *Engineer*. The excavation shall be filled with class 30/19 G50 concrete or dental concrete as specified in Clause 5.5.2.4(a) or other filling as instructed by the *Engineer*.

PSD 6.5.1.3 Local Treatment of Irregularities in the Dam Foundation

Irregularities such as holes, overhangs, steps, etc., shall be filled by one of the following means or other means as instructed by the *Engineer*.

- a) Dental Concrete: Concrete Class 15/38 G50 shall be used where instructed by the *Engineer* to fill voids and depressions in the foundation surface or to round off sharp changes in the profile of the foundation.

To ensure a good bond, the rock surface against which dental concrete is to be placed shall be thoroughly cleaned and moist at the time concrete is placed.

Dental concrete shall be prepared, placed and cured in accordance with the requirements of SANS 1200G. Where necessary it shall be compacted by ramming and vibration. Unless otherwise approved by the *Engineer*, it shall be cured for a minimum period of three days before being covered by fill material.

- b) Sprayed concrete: Sprayed concrete shall be placed where instructed by the

Engineer. The surfaces on which the sprayed concrete is to be placed shall be thoroughly cleaned and moist at the time of placing with no free water retained in depressions.

PSD 8 MEASUREMENT AND PAYMENT

PSD 8.1 Basic Principles

PSD 8.1.1 Amend the clause to reflect that the basic principle of measurement and payment for materials excavated and re-used in the Works shall be measured once in cut under this specification and separately in fill under SANS 1200DE. Payment for haulage shall be deemed included in the cut operation and no haulage shall be paid separately.

Measurement for all other excavation activities shall be as per the standardised specifications, as amended.

All excavation rates shall include for temporary stockpiling to suite the Contractors programme.

PSD 8.3.3 *Include the following:*

The rate tendered for restricted excavation shall be deemed to include for reduced productivity, specialised plant, additional handling, trimming, benching, access limitations, and all other costs associated with carrying out excavation under restricted conditions.

Add the following new Payment Item:

<u>"Item</u>	<u>Unit</u>
PSD 8.3.14 Foundation Preparation	Unit: m²
The tendered rate shall include full compensation for compaction, removal of dust, mud, loose or fractured material and other debris, and cleaning and moistening the surface. It shall include for all measures required to reinstate over-excavation. In the case of impoundment structures, the rate shall also allow for delays associated with the inspection and approval of the surface and the mapping of the surface by geologists and topographical survey. Payment for final preparation of the foundation surface shall be measured once only, irrespective of additional excavation. Should additional excavations in the foundation be required, the cleaned up for mapping and review and preparation of the surfaces so affected shall not be measured separately. Measurement shall be the net plan area of foundation preparation undertaken prior to the placing of concrete calculated from the dimensions and levels given on the drawings and specified and agreed foundation excavation surfaces.	
PSD 8.3.15 Treatment of joints, etc.....	Unit: m² or m³
The treatment of joints, cracks, fissures, fault and shear zones and zones of weak material and local treatment of irregularities shall be measured, as applicable, by the net volume or net area of material placed. Should measurement be by area, the average thickness of the treatment will be specified. The rate tendered shall include full compensation for all plant, labour and materials required to treat the foundation, as specified, including excavation and cleaning of the joint, crack fissure, fault and shear zone or zone of weak material, removal and	



disposal of excavated material and supply, placing and compaction of material within the area treated.

Separate items will be provided for:-

- (a) Cement Mortar;
- (b) Cement Grout;
- (c) Dental Concrete; and
- (d) Sprayed Concrete.



PSDB EARTHWORKS (PIPE TRENCHES)

PSDB 3 MATERIALS

PSDB 3.1 Classes of excavation

Replace this clause with the following:

"Only two classes of excavation will be measured for the pipe trenches of this Contract, viz. hard rock excavation and soft excavation. Hard rock excavation shall be as specified in Clause 3.1.2 (c) of SANS 1200D. All other excavation will be considered as soft excavation for this Contract (i.e. all excavation as specified in SANS 1200 D Clauses 3.1.2(a), 3.1.2(b), 3.1.2(d) and 3.1.2(e)) will be "soft" excavation.

The Tenderer's attention is called to the definition of hard rock. As trench excavation is considered to be restricted excavation, only Clause 3.1.2(c) (2) is applicable. The Engineer shall be the sole judge of what is considered "efficiently removed" in terms of this clause."

Add the following to the existing Sub-clauses:

PSDB 3.6 Material for reinstatement of paved roads and paved areas

"The Contractor shall obtain a direction from the Engineer with regard to the handling of the existing paving material.

Reinstatement of the paved areas will be done by the Contractor."

PSDB 3.7 Selection

"The Contractor shall use selective methods of excavating for the purpose of providing bedding materials for the pipelines."

PSDB 4 PLANT

PSDB 4.1 Excavation Equipment

Amend "50%" to read "20%".

PSDB 5 CONSTRUCTION

PSDB 5.1.4 Existing services that intersect or adjoin trenches

Add the following to the existing Clause:

"Where it is necessary for a rising main to pass under existing services, the Contractor shall carefully excavate and refill around them. During the course of the work, the services shall be adequately supported to the satisfaction of the Engineer. Any damage shall be reported without delay. Depending on the nature of the service damaged, the Engineer will rule whether the damage shall be made good by the Contractor or whether the owner of the service will be called upon to repair it on the Contractor's behalf. In any event, the cost of the repair work shall be for the Contractor's account."

PSDB-5.2 Minimum trench base width



Delete "minimum" and "not less than" throughout this Clause and add the following:

"The specified trench width shall be strictly observed. Should the excavated trench width exceed the specified width adjacent to and for 500 mm above the barrel of the pipe, remedial measures shall be directed and shall be provided at the Contractor's cost unless it can be shown that such excess width is due to factors beyond the Contractor's control."

Amend the table to reflect that all pipes of external diameter of the pipe barrel less than 300 mm shall have a side allowance of 250 mm.

Pipes have been designed with the minimum base width as per Clause 5.2, as amended, in mind and all trenched shall be excavated vertically to this width to at least 0.5 m above the crown of the pipe.

PSDB-5.4 Excavation, trench bottoms and backfilling of pipe trenches (Applicable to Clauses 5.4, 5.5 and 5.6)

The Tenderer shall give careful consideration as to how the trenches should be excavated and backfilled to ensure stability during construction and a structurally adequate system. The attention of the Tenderer is drawn to the auger and percussion hole logs included in the Drawings. The Tenderer is deemed to have comprehensively familiarised himself with ground conditions on the site, to the extent that he is confident that his proposed trench excavation and backfilling methods, as costed in his appropriate tendered unit rates, will be successful in practice.

Add the following to the existing Clause:

"Pipe trenches shall be excavated in lengths not exceeding 300 m, unless otherwise approved by the Engineer. Also refer to SANS 1200D Clause 5.1.4."

PSDB-5.5 Trench Bottom

Add the following:

Where required and so ordered in writing by the Engineer the bottom of the trench shall be stabilised using dump rock of the following specification:

- Max size < 300 mm
- % passing the 0.075 mm sieve < 5%

The dump rock shall be tipped into the trench bottom and compacted into the underlying soil until a stable base for the laying of bedding has been created.

The volume of material shall be determined by means of tally loads. Only one type of truck shall be used for all transportation of dump rock and the Contractor shall prove to the satisfaction of the Engineer the volume and consistency of each load of material supplied to the Works.

PSDB 5.6 Backfilling

PSDB 5.6.1 General

Insert the following after the first paragraph :

"Trenches affecting traffic shall be backfilled level with adjacent surfaces immediately after completion of pipe laying and successful testing. Should pipe laying not be completed before work is due to cease for the day, the Engineer shall be entitled to instruct the Contractor to backfill the trench and re-excavate it the following day in order to complete



pipe laying. The cost of the above activity shall be included in the Contractor's rates for excavation.

Buttresses left in soft ground to support the sides of trenches or headings for access shall be broken down during backfilling and compaction.

PSDB 5.6.3 &

PSDB 5.6.4 Disposal of surplus or unsuitable excavated material

Delete the existing Clauses 5.6.3 and 5.6.4, and replace with the following:

"Excavated material from the trench that is unsuitable or has become surplus because of bulking, displacement by the pipe and importation shall be disposed of in accordance with Clause SANS 1200C 3.1. The Contractor's attention is drawn to SANS 1200 D 5.2.2.3 in this regard.

The prior approval of the Engineer must be obtained before surplus material may be deposited, spread and levelled at agreed sites within the area of the works."

PSDB-5.6.8 Transport for Earthworks for Trenches

Replace the clause with the following:

"All material obtained from the trenches and from other necessary excavations on site, for use as backfill or bedding, will be considered to be transported within the freehaul distances, irrespective of the distance hauled, as well as any spoil of hard material to an approved spoil site.

No limited overhaul or long haul for trenches will be paid under this Contract."

PSDB 7 TESTING

PSDB 7.2 Taking and testing of samples (Additional clause after sub-clause 7.1)

"In terms of sub-clause 7.2 of SANS 1200 D, the Contractor shall carry out sufficient tests to satisfy himself about the consistency of materials placed around and over pipes. He shall make provision for this in his Quality Assurance Programme. Should it be found that insufficient tests are being taken to prove the above, due to for example inconsistencies, the Engineer may instruct additional tests to be taken at the Contractor's expense. These tests shall be deemed to be separate from the tests instructed under Clause 7.1."

Add the following new Clause:

"PSDB 7.3 Inspection at intermediate stages of construction

The Contractor shall call for an inspection of the works at the following intermediate stages of construction.

- (a) After completion of the trench excavation and preparation of the trench bottom; and before any pipe is laid or placed in the trench preparatory to laying.
- b) After the selected backfill material has been placed around the pipe; and before the remainder of the trench is backfilled.
- (c) After the top layer of the backfill material has been excavated/trimmed preparatory to final reinstatement with premix, before the premix is placed.



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

Failure to comply with the provision of this Clause may result in the suspension of work for a period as determined by the Engineer."

PSDB 8 MEASUREMENT AND PAYMENT

PSDB 8.1 Basic Principles

Add the following to sub-clause 8.1.2:

"For the purposes of clarity, the ground surface for trench excavation quantity measurement, shall be taken as the **existing** ground surface after topsoil or paving, as applicable, has been stripped. Trench depths for the embankment toe drains will be measured from the natural groundline as described above, and not the final embankment level."

PSDB 8.2 Computation of Quantities

Add the following to sub-clause 8.2.3:

"Volumes for the toe drain trenches will be measured neat as shown on the drawings. i.e. 700 mm base width with side slopes extending to natural ground level. Depths will be measured as above."

PSDB 8.3 Scheduled Items

PSDB 8.3.2 Excavate in all materials for trenches, backfill, compact and dispose of surplus material (Clause 8.3.2(a))

Add the following clauses:

"The attention of the Tenderer is drawn to clauses 5.2, 8.1 and 8.2 of SANS 1200DB in relation to the basic principles of quantity calculation and measurement and payment for excavation, backfilling and compaction in the pipe trenches.

The unit of measurement shall be the volume (m³) of material excavated, backfilled and compacted (inclusive of surplus disposal), measured on the neat lines of the drawings, as specified in SANS 1200DB clauses 5.2, 8.1 and 8.2.

The rate for this item shall include all costs for lateral support. Lateral support will not be measured and paid separately for this Contract. The Tendered rate shall make allowances for any deviation in the total volume of excavated and compacted material resulting from the trench profile produced using the Tenderer's proposed method of construction, as compared to that illustrated on the drawings."

PSDB 8.3.4 Particular Items

PSDB 8.3.4.a Shore trench opposite structure or service

Add the following:

"It will be the Contractor's responsibility to ensure the safety and stability of the trenches.

Payment for shoring of any pipeline trenches, should it be necessary, shall be deemed to be included in the rates tendered for trench excavation."



PSDB 8.3.5 Existing services that Intersect or Adjoin a Pipe Trench

Add the following:

“No payment will be made for crossing of services identified as abandoned at the time of crossing, or for services designated to be deviated and paid for as such.”

Add the following new Payment Item:

"Item

Unit

PSDB 8.3.8 Dump Rock Stabilisation of Trench Bottom..... Unit: m³

The unit of measurement shall be the cubic metre of dump-rock placed according to specification with the written permission of the Engineer. The volume shall be determined by means of tally loads.

The tendered rates shall cover the costs of acquiring, regardless of the distance, of delivering it to the trench, of placing and compacting the dump rock and any and all plant and labour required in the process.



SANS 1200 DE SMALL EARTH DAMS

PSDE 8.1 BASIC PRINCIPLES

PSDE 8.1.2 Add the following:

“Payment for haulage shall be deemed included in the cut operation and no haulage shall be paid separately.

All excavation rates shall include for temporary stockpiling to suit the Contractors programme where applicable.”

PSDE 3 MATERIALS

PSDE 3.1 Classification for excavation purposes

PSDE 3.1.2 Classes of excavation

Add the following:

“Only two classes of excavation will be measured for earthworks for this Contract, viz. hard rock excavation and soft excavation. Hard rock excavation shall be as specified in Clause 3.1.2 (c) of SANS 1200D. All other excavation will be considered as soft excavation for this Contract (i.e. all excavation as specified in Clauses 3.1.2(a), 3.1.2(b), 3.1.2(d) and 3.1.2(e) will be "soft" excavation).

PSDE 3.2 Classification for Placing Purposes

Add the following:

Grading curves and material specifications are described on the Drawings.

PSDE 3.2.3 Rockfill (and Rip-Rap)

All stone for the Rip-Rap Materials shall be of rock of a granitic type approved by the *Engineer* and shall be selected from Quarry A. The material shall be excavation run processed only to remove excess fines or to remove or degrade oversize particles and shall meet the following requirements:

- a) Be hard, dense, durable quarried rock that is free from weathering, cracks, seams and other defects that will cause rapid or excessive deterioration or degradation during service.
- b) Conform to the grading envelopes indicated on the Drawings
- c) Contain no more than 5% by mass in total of impurities (undesirable material) such as individual pieces of riprap which do not meet the quality requirements as specified and which can be visually differentiated from satisfactory pieces, plus dirt, sand, clay, rock fines and material of low density.
- d) The specific gravity of the individual particles shall be greater than 2,55.
- e) The dry 10% FACT value determined in accordance with SANS 5842 shall be not less than 110kN.
- f) The wet 10% FACT value determined in accordance with SANS 5842 shall be not less than 75% of the determined dry value.
- g) The loss after 5 cycles measured by the modified sodium sulphate soundness test as below shall not be greater than 10%.
 - i) Initially the sample shall be broken into an approximately uniform grading and shall be screened. The portion passing the 19,0 mm sieve but retained on the 13,2 mm sieve shall be used in the test.
 - ii) The test sample shall weigh 1 000 grams +/-2% and shall be washed as described in SANS 5839.



- iii) The procedure specified in Section 3 of SANS 5839 shall be followed for 5 cycles.
- iv) The sample shall then be sieved using a 11,2 mm size as defined in Table 3 of SANS 5839.
- v) The percentage loss shall be determined from the mass of the material retained on the sieve and mass of the original sample.

PSDE 8 MEASUREMENT AND PAYMENT

PSDE 8.1 Basic Principles

PSDE 8.1.2 Add the following:

"Payment for haulage shall be deemed included in the cut operation and no haulage shall be paid separately.

All excavation rates shall include for temporary stockpiling to suit the Contractors programme where applicable."

PSDE 8.3 Scheduled Items

PSDE 8.3.4 Preparation of Exposed Surface

Add the following:

"The rate tendered shall cover also for the requirements of particular specification PPS10 Hardfill."

Add the following new Payment Item:

<u>"Item</u>	<u>Unit</u>
--------------	-------------

PSDE 8.3.5 Selected semi-pervious material	Unit: m ³
--	----------------------

PSDE 8.3.8 Overhaul

Delete this item.



SANS 1200 DK GABIONS AND PITCHING

PSDK 3 MATERIALS

PSDK 3.1.4 Geotextile

Replace with the following:

"The synthetic-fibre filter fabric shall be manufactured from a synthetic polymer processed into a permeable, homogeneous sheet. The sheet shall be either of a woven, non-woven or knitted construction.

The synthetic-fibre filter fabric is classified according to the mechanical properties thereof, viz its penetration load, puncture resistance and the minimum water-percolation rate as measured in the permeability test, etc. Table PSDK/1 shall be used for determining the grade of a synthetic-fibre filter fabric.

TABLE PSDK/1

GRADE CLASSIFICATIONS OF GEOTEXTILES

PROPERTY	GRADE									TEST METHOD	
	NON-WOVEN							Woven			
	NW1	NW2	NW3	NW4	NW5	NW6	NW7	W1	W2		W3
Grab Strength, N	450	480	665	850	1045	1395	2100	650	870	1250	ASTM D4632-86
Trapezoidal Tear, N	205	245	330	375	480	645	1050	400	750	900	ASTM D4533-85
Puncture Resistance, kN	1.5	1.7	2.1	2.5	3.6	4.5	6.5				SABS 0221-88
Burst Strength, kN	1.3	1.5	2.1	2.5	3	4.2	6.3				ASTM D3786
Pore size O95W, micron	240	225	205	190	165	145	100	230	425	275	Franzius Institute
Pore size O95H, micron	195	185	170	155	125	100	70	380	700	425	Franzius Institute
Normal Permeability, x 10 ⁻³ m/s	3.9	4.3	4.5	4.9	5.4	5.9	4.8	0.26	0.61	0.75	SABS 0221-88
Transv. Permeability, l/hr	26	32	37	40	50	59	80				SABS 0221-88
Porosity, %	93	93	93	93	93	92	90				GTS
Min POA, %								10	5	10	Visual assess.

Notes: - The standard atmosphere for testing and the preconditioning atmosphere for all synthetic-fibre filter fabric tests (SANS tests and other) shall have a relative humidity falling within the range of 0 to 80 per cent and a temperature within the range of 15°C to 35°C. The resistance of a synthetic-fibre filter fabric to puncture is the average diameter of the hole formed when a 45° cone with a mass of 1 kg is dropped through 500 mm onto the synthetic-fibre filter fabric fixed in the holding device.

The synthetic-fibre filter fabric shall withstand the level of aggressiveness of the soil and ground water given below without significant loss of its strength and hydraulic properties during its design life of 25 years:



-
- Soil and ground water with a pH in the range of 4 to 12 (pH to be determined by Method A20, TMH1, 1986).
 - Soil (as paste) and ground water containing salts with a conductance of up to 1.0 S/m (conductivity to be determined by Method A21T, TMH1, 1986)

The synthetic-fibre filter fabric shall maintain at least 80% of its original strength after direct exposure to sunlight of 1 500 hours. The synthetic-fibre filter fabric shall be entirely rot-proof and shall not support the growth of algae.

The Contractor shall, at least 28 days before the installation of the synthetic-fibre filter fabric, submit to the Engineer samples of the synthetic-fibre filter fabric he proposes to use, so that the Engineer may confirm that the synthetic-fibre filter fabric meets the specified requirements."



PSG CONCRETE (STRUCTURAL)

PSG 1 SCOPE

PSG 1.1 Alter 1st sentence to read: “ For civil engineering, building, dam construction and filling of pipes.”

PSG 2.3 DEFINITIONS

PSG 2.3 a) General

Between “Cool Weather” and “Fixture” add the following definition for :-“Dam Concrete. Dam Concrete shall have the strength, water-tightness, durability and other qualities to achieve the structural safety and water storage capability of a dam and fulfil the purpose and performance requirements appropriate to the location in the dam structure. The mix proportions of Dam Concrete shall be determined for the different performance requirements and shall have the stiffness and consistency within limits of workability appropriate to:-

i) External concrete – in addition to the performance requirements for internal concrete, water-tightness and resistance to abrasion action and excellent surface appearance (Degree of Accuracy 1) is required)

ii) Internal concrete – low heat of hydration and good placing performance for large volume casting is required as is the capacity to resist water pressure and other loads by self weight.

iii) Structural concrete – the strength, bond to reinforcement and workability shall satisfy the requirement for placement in narrow spaces between reinforcement and formwork and shall meet the quality requirement for external concrete.

iv) Rock contact concrete – shall satisfy the requirements of internal concrete.”

PSG 2.3 b) Quality

Add the following sentence at the end of :- Strength Concrete. for strength “and shall satisfy the purpose and performance requirements of Dam Concrete.”

PSG 2.4 Explanation of Terms

PSG 2.4.3 Joints.

Add the following sentence after the 3rd sentence of the paragraph :-

“A designated joint normal to the axis of the dam crest is referred to as a transverse joint. A designated joint parallel with the axis of the crest is referred to as a longitudinal joint. A designated construction joint is the joint between consecutive lifts of the dam structure.”

Add the following new terms:

“PSG 2.4.4. Lift Schedule

A schedule prepared by the contractor and approved by the engineer for placing Dam Concrete in each predetermined block/labyrinth/section in order to complete a lift bounded by longitudinal joints and construction joints.”



PSG 2.4.5 Lift

A lift of concrete is the thickness of Dam Concrete placed continuously in a predetermined block/labyrinth/section of the dam.

PSG 2.4.6 Shear Key

A shear key is a shaped protrusion provided on a construction joint to transfer shearing forces along the joint.

PSG 2.4.7 Passive Anchor

A passive anchor shall mean reinforcement, galvanized or plain as may be specified, that is grouted into an existing concrete structure or into bedrock, which is designed to be cast into Dam Concrete to form a monolithic structure in order to mobilise the mass of the whole. "

PSG 2.4.8 Hydraulic Structure

A hydraulic structure means a reinforced or mass concrete element that is subject to hydraulic forces and the flow of water over one or more surfaces of such element. A hydraulic structure shall be designed and constructed to have the strength, water-tightness and durability and other qualities to achieve structural safety, and water storage capability of a dam."

PSG 3 MATERIALS

PSG 3.2.1 Applicable Specifications

Sections of the specifications listed in the Standard Specification have been superseded by new specifications. The pertinent changes are indicated in the table below. For the superseded sections of the listed specifications the new specifications will apply:

Description	Superseded Code	New Code
Cement: OPC, RHC	SABS 471	SANS 50197-1
Cement: PBFC	SABS 626	SANS 50197-1
Cement: PC15	SABS 831	SANS 50197-1
Cement: GBFS	SABS 1491 Part 1	SANS 50197-1
Aggregate	SABS 1083	SANS 1083
Drying shrinkage of concrete	SABS method 836	SANS 5836
Drying shrinkage of concrete	SABS method 1085	SANS 6085
Aggregate size	SABS 1083	SANS 1083
Sulphate content: Aggregates	SABS 850	SANS 5850-1
Drilling cores	SABS 865	SANS5865
Evaluate cores	SABS 0100 Part ii	SANS10100 Part 2

PSG 3.1 Approval of materials

Add the following to the existing Clause:

"The type or brand of cement stated in the Tender Certificate shall not be changed unless the Engineer's prior written approval to do so has been given."

PSG 3.2 Cement

Add the following :



"Cement and cement extenders shall be free flowing and free of lumps and shall be supplied in the manufacturer's sealed unbroken bags or in bulk. Material which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the Site, without delay."

Cement delivered to site shall have a Certificate stating the alkali content and date of manufacture which the Contractor shall maintain records of.

All cement and cement extenders used in the Works shall be tested by the manufacturer or the Contractor in a laboratory acceptable to the Engineer. Copies of all test results so obtained shall be delivered to the Engineer before the cement and cement extenders are incorporated in concrete.

All cements and factory produced cement blends shall comply with SANS ENV 197-1 and 2 ; and SANS 413-1 and -2 for masonry Cement; and shall carry the SANS mark.

All cement extenders used shall comply with SANS 1491 Parts 2 or 3 as appropriate for Fly Ash (FA) or Condensed Silica Fume (CSF) respectively and shall carry the SANS mark."

PSG 3.2.2 Alternative Types of Cement

Append sub-clause 3.2.2 with the following:

"The blending of fillers (slag and fuel ash) on site shall not be permitted unless written approval is obtained from the engineer. "

PSG 3.2.3 Storage of cement

Add the following to the existing Clause:

"Cement shall not be kept in storage for longer than three months without the Engineer's permission.

Cement shall not be supplied from any different source without the prior approval of the Engineer."

PSG 3.3 Water

Replace the clause with:

"Water shall be clean and free from detrimental concentrations of acids, alkalis, salts, sugar and other organic or chemical substances that could impair the durability and strength of the concrete or the embedded steel. The Contractor shall prove the suitability of the water by way of tests conducted by an approved laboratory. The water used for concrete shall comply with the requirements in Table 3.3 unless otherwise approved by the Engineer. For reinforced and prestressed concrete the chloride content of the mixing water shall not exceed 500 mg/l when tested in accordance with SABS method 202."

Table 3.3 Criteria for Inorganic Impurities in Water Used to Manufacture Concrete

Characteristic	Criteria	Test method
Ph	4.5 – 8.5	SABS method 113
Sulphates	Reinforced concrete and prestressed concrete : 400 ppm Mass concrete : 1 000 ppm	SABS method 212
Chlorides	500 ppm	SABS method 202
Conductivity @ 15°C	330 mS/m	SABS method 213
Total dissolved solids (TDS) @	Mass concrete : 3 000 ppm	SABS method 841



180 °C	Reinforced concrete : 1 500 ppm	
Alkali: Carbonates and bicarbonates	1 000 ppm	SABS method 837
Sugar	Negative	
Organic impurities	300 ppm (applicable if pH < 5)	Chemical oxidation demand

PSG 3.4 Aggregates

Add the following:

“The maximum chloride ion content of fine aggregate shall be 0,2% by mass of aggregate as measured by SANS Method 830.

The Contractor shall ensure that aggregates will not have a detrimental effect on the concrete produced. Aggregates prone to alkali silica reaction shall not be permitted, and the contractor shall supply certification to prove this to the engineer's satisfaction.”

PSG 3.5 ADMIXTURES

PSG 3.5.1 Approval of admixtures required

Admixtures may only be used with the prior written approval of the Engineer. All admixtures shall comply with ASTM C494-05 and shall be used strictly in accordance with the manufacturer's specifications.

Also refer to clause PSG-5.5.11.

PSG 3.9 Water Stops (New clause)

Add the following new clause:

“Water stops shall be either rubber or PVC manufactured to BS257, with or without centre bulb, all as scheduled. Samples of water bars are to be submitted to the Engineer for approval.

Dimensional tolerances of all types of PVC water stops shall be width ± 3 mm and web thickness $+1.5$ mm or -1 mm.”

PSG 3.10 Water Stops (New clause)

Add the following new clause:

“Grout shall consist of a cementitious mix complying with the requirements of the project specifications and shall be designed to:

- Be pumpable over the full length of the pipe
- Exhibit minimal bleed and segregation;
- Achieve the specified compressive strength after curing;
- Completely fill the pipe without leaving significant voids;

The grout mix shall be submitted to the Engineer for approval before commencement of the work”



PSG 4.5 FORMWORK

PSG 4.5.1 Design

Insert paragraph before the 1st sentence.

“Design of formwork for hydraulic structures shall take into account the Lift Schedule to satisfy the performance requirements of Dam Concrete/Hardfill. The formwork and support falsework shall be structurally designed and tightly installed in the designated position so that there is sufficient strength and stiffness to maintain accurate shape and size of the structure to achieve Degree of Accuracy 1 (see clause PSG 6.2.3). Where anchors are required to support the next lift, the construction plan shall take account of the time required for development of adequate strength of concrete”

Add the following:

“Formwork shall include all shuttering, casing, anchors, centring or any material required for the laying and forming of concrete floors, slabs, beams, lintels, walls, steps, columns, piers, etc. or any concrete requiring moulds or forms.

Forms shall be so constructed that they may be removed without damaging the concrete. All lumber shall be free from knot-holes, loose knots, cracks, splits, warps and other defects which may alternatively affect the strength of the formwork or the appearance of the finished structure.

All forms shall be free from bulges or warp and shall, before re-use, be re-conditioned and the concrete contact surfaces thoroughly cleaned.

Forms and surfaces shall be made of plywood, hard pressed fibreboard, sized and dressed, tongue and grooved lumber board, metal in which all bolts and rivet holes are countersunk or other approved material so that a plain smooth surface of the desired contour is obtained. The use of rough lumber wood as a concrete contact surface shall only be used with the approval of the Engineer and shall be limited to surfaces which are not exposed to view.”

PSG 4.5.2 Finish

The finish required on all concrete which is against forms and which will be visible after completion of the Works, shall be “smooth” as defined in sub-clause 5.2.1. (b)

The formwork panels shall be such that the surface of the concrete is free from irregularities, fins, bulges, etc. and joints between panels shall be sealed to prevent local honeycombing. No ferrules or spacers may be used through the walls of the water retaining [portions of the structure to position formwork

The layout of panels and joints in all formwork shall be subject to prior approval by the engineer, and the Contractor shall afford the Engineer a minimum of 1 week to approve the formwork design prior to its manufacture and/or erection.

All visible corners shall have a 20mm chamfer, unless otherwise specified on the drawings.

PSG 4.5.3 Ties

Insert paragraph after the 1st sentence.



"The use of proprietary metal tie rods or similar devices embedded in the concrete for holding forms shall be permitted provided that the ends of the tie rods are subsequently removed to a depth of not less than 50 mm and that in hydraulic structures the rods do not protrude through the full thickness of the concrete. Holes left by removal of tie rods shall be reamed with a suitable rotary toothed bit to provide a clean, rough surface that shall immediately be plugged with patching"

PSG 5 CONSTRUCTION

PSG 5.1 Reinforcement

PSG 5.1.3 Cover

In Subclause 5.1.3(a) amend the words "..." or stirrup" to read: "bar, secondary reinforcement, tie stirrup, tying-wire knots or wire ends."

Add the following to the sub-clause

"The minimum concrete cover to reinforcement shall be 40 mm unless otherwise indicated on the drawings. For Hydraulic Structures the cover requirements in Table 1 do not apply and shall be specified on the drawings.

Tying wire shall not encroach on the specified minimum cover by more than a single strand thickness."

Cover blocks shall be manufactured from concrete of grade, durability, density and impermeability at least equal to that specified for the respective elements except that 12 mm stone instead of 19 mm stone shall be used. The size of the cover blocks shall be 40 mm x 40 mm, with a thickness equal to the specified cover. Wires shall be cast into the blocks to enable them to be fixed to the reinforcement. The wires shall be fully galvanized Class A as per SANS 675 – 1993. The wires shall be carefully held in position while the concrete is setting to ensure that all the wires are inserted to a uniform and consistent depth of 50 % of the thickness of the cover block for all the cover blocks. The concrete shall be thoroughly compacted by means of a vibrator or vibratory table and the blocks shall be protected against early drying and shrinkage due to sun and wind, by being kept continually wet while still in the mould. After the blocks have been removed from the mould they shall be kept in water continuously until being used, and in any case for a period of not less than 14 days.

A comprehensive mix design for concrete in cover blocks shall be submitted to the Engineer for approval."

PSG 5.1.4 Splicing

Splice lengths shall be 50 diameters for straight bars unless otherwise specified on the drawings.

PSG 5.1.6 Spillway Facing Tie Rods (New clause)

Add the following new clause:



High tensile threaded rods (Dewydag or Giwi or similar), with diameter of 16 mm and tensile strength of 600 MPa, together with 150 mm diameter coil washers Grade 350W steel, shall be used to anchor the downstream facing of the stepped spillway into the Hardfill dam body. Where integrated into the support of the formwork for the surfacing concrete, the near surface portions (downstream of the coil washer) shall be removed and plugged using an approved commercial non-shrink cementitious grout designed for this purpose. Details of an integrated system are shown on the Drawings, but only the portions between the coil washers are to remain as part of the Permanent Works.

PSG 5.2 FORMWORK

PSG 5.2.1 Classification of finishes

a) Rough

Amend the degree of accuracy to level II for rough formwork

c) Special

Replace 1st sentence with :-

“Special finishes shall apply to the exterior surfaces of all Hydraulic Structures in contact with flowing water including the spillway, energy dissipation basin and training walls to satisfy permissible deviation Degree of Accuracy I (see clause 6.2.3 b), c) and d)).”

PSG 5.2.5 Removal of Formwork.

PSG 5.2.5.5 Add after 1st sentence. “ All forms shall be entirely removed from a lift to permit inspection before the forms for the next lift are set. No bagging or patchwork may be done prior to inspection of concrete by engineer”

PSG 5.2.6 Sliding formwork (New Clause)

Add the following new clauses:

PSG 5.2.6.1 Plant and equipment

Unless otherwise specified in the project specifications, hoisting equipment for sliding formwork, which operates stepwise with upward movements of between 10 mm and 100 mm will be acceptable. However, the use of linked hydraulic or pneumatic jacks is preferable, which are reversible and driven by an electrically operated pump, and which can hoist at a steady rate. The jacks shall have independent controls for regulating vertically and levelness. The jacking system shall ensure that the sliding-formwork assembly can be hoisted evenly.

The use of hoisting systems which operate without jack rods shall be subject to the approval of the Engineer.

All equipment shall be thoroughly tested and inspected before installation and shall be maintained in a good working order throughout the entire sliding operation.

The Contractor shall keep adequate back-up plant, equipment and quantities of materials on the site to ensure that the slide casting can proceed without interruption.



PSG 5.2.6.2 Instrumentation and monitoring

The Contractor shall supply and install suitable instrumentation on the sliding platform and foundations and against the sides of the structure for monitoring the height, verticality, levelness and twisting at regular distances. The equipment used, its utilization and the frequency of recording any readings shall be approved by the Engineer.

The Contractor shall be responsible for all monitoring work and shall ensure that records of all readings and measurements taken are filed systematically and are at all times available to the Engineer and the person in control of the sliding operation.

Unless otherwise specified, the verticality of the structure shall be controlled with laser alignment apparatus or optical plummets and the levelness of the sliding forms with a water-level system with reference control points placed at strategic locations.

Height and verticality shall be monitored at intervals not exceeding 4 hours. The readings shall be plotted immediately on graphs. When the structure is more than 10 mm out of vertical, the Engineer shall be notified immediately.

PSG 5.2.6.3 Supervision

During the entire period of the sliding operation, a competent person who is fully acquainted with the sliding technique and the Contractor's methods of construction shall be in attendance on the sliding platform and in control of the sliding operations.

PSG 5.2.6.4 Construction

The jacking frame shall be constructed with adequate clearance between the underside of the cross members and top of the formwork to allow the horizontal reinforcement and embedded items to be correctly installed. A control procedure shall be agreed on by the Contractor and the Engineer to ensure that all the reinforcement is placed. At all times there shall be horizontal reinforcement above the level of the top of the formwork panel.

Guides shall be provided to ensure that the vertical reinforcement can be correctly placed and the specified concrete cover over the reinforcement maintained.

Where the jack rods are to be recovered, adequate precautions shall be taken in respect of their removal without damage being caused to the concrete.

Where jack rods occur at openings or wall chases, adequate lateral support shall be provided to prevent their buckling.

Equipment and material shall be so distributed on the working platforms that the load will be evenly distributed over the jacks.

Guard plates shall be provided at the tops of the forms to the outside walls to prevent the concrete from falling down the outside.

The framework, forms and platforms shall be regularly cleared and the accumulation thereon of redundant concrete prevented.

The Contractor shall take all precautions to prevent contamination of the concrete by leaking oil or other causes.



PSG 5.2.6.5 The sliding process

The Contractor shall give the Engineer 24 hours' notice of his intention to commence with slide casting. Permission to commence with the sliding shall not be given by the Engineer before the sliding-formwork assembly is fully operative and the complete stock of all materials required for the slide casting as well as back-up plant and equipment are on the site.

The Contractor shall ensure that the rate of sliding is such that the concrete at the bottom of the formwork has obtained sufficient strength to support itself and all loads which may be placed on the concrete at the time, and that the concrete does not adhere to the sides of the forms.

The slide-casting operation shall be continuous, without any interruptions, until the full height of the structure has been reached, and shall be geared and organized so as to maintain an average rate of sliding of 350 mm per hour.

PSG 5.5 CONCRETE

PSG 5.5.1 Quality

PSG 5.5.1.1 General

Add the following:

"In addition to the foregoing, the quality of concrete shall satisfy the performance requirements of Dam Concrete for which all the ingredients have been selected and proved by laboratory testing to satisfy the requirements for workability and consistency during placement with low heat evolution during hardening and shall satisfy strength, durability and low permeability in the hardened state.

"The concrete required for the different parts are as follows :

All structural concrete.....30MPa/19mm.

Blinding and mass concrete 20MPa/19mm

Benching and Screeds 25MPa/13mm"

PSG 5.5.1.2 Consistency

Add the following to Table 3 – Slump Limits (mm)

1	2	3	4	5
Type of construction	Hand-placed		Vibrated	
	Max	Min	Max	Min
Dam Concrete.....	-	-	50	20

PSG 5.5.1.4 Chloride content

The maximum chloride content shall be as specified in column 5 of Table 4 for reinforced concrete exposed to a marine environment



PSG 5.5.1.5 Durability

Add the following:

The type of cement to be used in any concrete element shall take into account the environmental conditions and durability requirements at the location of the site of the Works.

The condition of exposure applicable to all concrete in terms of clause 5.5.1.5 of SANS 1200G is severe. The maximum water/cement ratio shall be 0,48 for all concrete.

Additional durability criteria shall be applied as specified under clauses of PSG 7.

All mixes shall be designed with a view to ensuring maximum durability.

PSG 5.5.1.6 Prescribed mix concrete

a) Soilcrete

Should the Contractor intend to use soilcrete, he will require the written approval of the Engineer and must propose an appropriately designed and tested mix for consideration.

Soilcrete shall contain at least 10% (PC) cement per volume mixed with approved selected material from excavations that is free from vegetable matter (Roots, grass, etc), rubble, etc. The selected material shall be evenly graded with a maximum aggregate size of 50mm. It shall be mixed with water to obtain a mortar-like consistency with a slump of not more than 100mm and placed, compacted and cured as specified for concrete.

b) No-Fines Concrete

No-fines concrete shall consist of 0.3 m³ 19 mm nominal size aggregate per 50 kg of cement and shall have a minimum average strength of a set of three cubes after 28 days of at least 5.5 MPa.

No-fines concrete shall be placed in accordance with the procedure approved by the engineer. It shall be placed in its final position within 15 minutes of having been mixed. Cement shall be measured by mass or in full pockets of 50 kg each and aggregate shall be measured by volume in approved measuring boxes or barrows.

The aggregate shall be moist or wetted before the cement is added. Where drum mixers are used, about 20% of the water shall be poured into the drum before the aggregate and cement are loaded. The mixing time in the drum shall be about 45 to 50 seconds.

The quantity of water added shall be just sufficient to form a smooth grout which will adhere to and completely coat each and every particle of aggregate, and which is just wet enough to ensure that, at points of contact of aggregate, the grout will run together to form a small fillet to bond the - aggregate together. The mix shall contain no more than 20 litres of water for every 50 kg of cement.

Mixing shall be done in an approved batch-type mechanical mixer.

The no-fines concrete shall be worked sufficiently to ensure that it will completely fill the space to be concreted and that adjacent aggregate particles are in contact with one another. Excessive tamping shall be avoided, and the concrete shall not in any circumstances be vibrated.



All no-fines concrete shall be protected from the elements and loss of moisture. Protection against loss of moisture shall be accomplished by one or more of the following methods:

- i) Retaining formwork in place.
- ii) Covering exposed surfaces with sacking or other approved material kept continuously wet.
- iii) Covering exposed surfaces with plastic sheeting,

No-fines concrete placed during cold weather shall be adequately protected against frost for at least 3 days.

c) Mortar for No-Fines capping

Mortar for No-fines capping shall consist of a 1 + 5 mix of sand and cement. The cement shall be a CEM II B-V and the sand shall be an approved fine sand conforming to SANS 1083. Mortar capping shall not be less than 15 mm, nor more than 25 mm thick.

Unless otherwise specified, all mortar capping shall be finished with a steel trowel. Mortar shall be protected as for No-fines Concrete for at least 48 hours.

PSG 5.5.1.7 Quality : Strength concrete

(a) Due to the nature of the mass concrete dam wall to be constructed, every effort shall be made to ensure that post-placement shrinkage shall be limited as far as possible.

(c) All concrete shall be based on designed mixes. Trial mixes shall be made by an approved laboratory with suitable experience.

PSG 5.5.1.8 Bleeding (Additional Clause after 5.5.1.7)

The concrete shall be proportioned with suitable materials so that total bleeding does not exceed 0,3mm/cm² as measured by ASTM C232-04."

PSG 5.5.2 Batching

PSG 5.5.2.3 Aggregates

Preference will be afforded to concrete mix designs including local aggregates of a high specific gravity. Where economy precludes the option, the placed concrete unit density to be realized using the proposed aggregates shall be made available to the Engineer as early as possible and it may be necessary to offset low densities by the incorporation of an increased proportion of stone plums. The inclusion of aggregates with a history of alkali reactivity in any of the mix designs in any of the mix designs shall be specifically brought to the attention of Engineer. The transportation of grade aggregates shall be undertaken in such a manner as to ensure that the grading uniformity is preserved and contamination is avoided. In the case of stockpiled aggregates of the same sizing but different moisture contents, specific gravity, shape or surface characteristics, the first source shall be completely exhausted before use is made of material from the second. At batching all aggregates shall be of stable moisture content and no visible surface water shall be permitted. In no circumstances shall the free moisture content of the fine aggregate exceed 8% of its dry mass at batching.



PSG 5.5.3 Mixing

PSG 5.5.3.2 Ready-mixed concrete

The use of ready-mixed concrete for this contract will be permitted provided that it complies with the requirements of this specification. Test results obtained by such a production facility shall not be regarded as part of the quality control system, and the Contractor shall take his own samples of concrete on site and have them tested in accordance with Clause 7 of SANS 1200 G and Clause PSG-7.2.

Should the Contractor propose the use of ready-mixed concrete, a motivation detailing with the reliability of supply and travel time of delivery trucks from the supplier's yard to the Site, shall be submitted for approval by the Engineer. Cognisance of the distance to any ready-mix concrete installation shall be taken into account in the mix design and quality assurance system to be implemented. Concrete obtained from an approved supplier of ready-mixed concrete shall be delivered to the site in a plastic state, requiring no further treatment and having the slump and compressive strength specified.

The temperature of the concrete at the point of delivery shall not be less than 5°C nor more than 30°C. Concrete shall not be delivered if the ambient temperature at site is less than 5°C. Concrete shall be placed within 1.0 hour from the time it is discharged from the mixer at the ready-mix plant.

PSG 5.5.5 Placing

In addition to sub-clauses 5.5.5.1 to 5.5.5.9 the following shall apply:

The Contractor shall give the Engineer at least 24 hours' notice of his intention to cast concrete.

Concrete shall be cast in one continuous operation where possible. Care must be taken to eliminate segregation when placing concrete.

In hot weather when plastic shrinkage is expected to occur or when the surface dries too rapidly, fog sprays or wet Hessian shall be applied during finishing operations. No concrete for the dam wall shall be placed at ambient temperatures in excess of 28°C.

Layer thickness shall be an even fraction of the lift height to be cast. The layers shall be carried forward in stair-step fashion in the pour block by means of successive discharges so that there is a setback of about 1.5m between the forward edge of successive layers. The stepped front shall progress from the one end of the pour block to the other until the form is filled and the pour completed. The lift thickness shall be appropriate to the ability of the vibrator to properly consolidate the concrete. Shallower lifts give better assurance of satisfactory consolidation into corners and against form faces.

Height of lifts and time interval between lifts shall be planned in the Lift Schedule such that placement in each pour block is regular and completed in the shortest time, with the least practical height difference between adjacent pour blocks in order that the hardened concrete differential within the pour block and relative to adjacent pour blocks is minimized

No standing or running water will be permitted where concrete is to be placed and under no circumstances will water displacement using concrete be tolerated.



The horizontal lifts of a previous lift of concrete shall be free from protruding rock, deep footprints and vibrator holes and other surface irregularities. As late as is feasible but prior to placement of the next lift, the inferior surface film and any contamination shall be removed to expose a clean mortar and aggregate surface without excessive undercutting and deep exposure of the aggregate. Sand blasting or high-pressure water jet equipment is appropriate for this purpose. When concrete is placed on the foundation, the rock surface shall be clean, rough and damp. The surfaces of rock or concrete shall be swept clean and kept continuously wet for at least 24 hours before it is covered with an evenly spread, 10 mm thick layer of mortar composed of cement and sand mixed in the same ratio as the cement and sand in the concrete mixture. This mortar shall be freshly mixed and placed immediately before the new concrete is placed. When placing on rock foundations, care shall be taken to ensure complete contact between the foundation rock and the concrete above; the mortar shall be brushed deeply into any crevices and rock joints.

Should placement of concrete occasionally be interrupted as a consequence of unforeseen circumstances, the exposed surface of the deposited concrete shall be protected fully from the sun by means of damp Hessian. On resumption of placement, all surface laitance shall be removed, and the freshly mixed concrete shall be thoroughly united with the old concrete. Should the period of interruption exceed 30 minutes, the concrete surface shall be treated in accordance with the above lift preparation requirements

Scheduled concrete payment items will be deemed to include for all the above.

PSG 5.5.6 Compaction

Add the following sub-clause:

“PSG 5.5.6.5 Vibration.

Vibration shall be systematic and shall thoroughly cover and penetrate the lower layer to between 50 – 100mm with particular attention to ensure full vibration when the perimeters of two discharges join, since the outer edge of the first batch shall not be vibrated until the next batch is placed against it. During compaction the vibrators shall remain at each penetration point until large air bubbles cease to rise and escape from the concrete. The top of the uppermost layer shall be levelled off and made even by means of vibration and holes from previous vibrator insertions closed. Boards shall then be placed on the surface in sufficient number to prevent footprints on the surface during working the surface off to the specified finish.”

PSG 5.5.7 Construction Joints

PSG 5.5.7.1 Add the following to sub-clause 5.5.7.1:

“Before construction work commences the Contractor shall indicate on the drawings his proposal for positioning construction joints and submit these to the Engineer for his comment and approval.”

PSG 5.5.7.1 Replace items b) of sub-clause 5.5.7.1 with the following:

“Construction joints shall coincide with contraction joints. The contractor shall provide a method statement prior to casting critical elements that includes the following information:

- Casting sequences



- Times between major pours.
- Volumes of concrete to be poured.
- Curing equipment and methodology to be used.
- Supply of materials.
- Means of ensuring that joints are water proof"

PSG 5.5.7.3 Replace sub-clause 5.5.7.3 with the following:

"The method adopted for forming joints not covered by 5.5.7.1, unforeseen joints and specifically all vertical or inclined construction joints shall be as follows:

Feather edges of concrete at joints shall be avoided and any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached. The intersections of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by the use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.

Construction joints consisting of free surfaces shall not exceed a slope of 15° from the horizontal unless otherwise agreed by the Engineer.

Surfaces shall be green cut when the concrete has set and while it is still green. The surface film and all loose material shall be removed, without disturbing the aggregate, by means of high-pressure water and air jets assisted by light brushing to expose the coarse aggregate over the entire area and to leave a sound, clean irregular surface free of any deposit or discoloration.

On formed construction joints the formwork shall be treated with a suitable retarding agent and stripped at a time to permit high pressure washing and cleaning as described above.

Where construction joint preparation is not carried out as described above, the surface shall be wet sand blasted or scabbled after the concrete has hardened sufficiently to prevent the displacement or loosening of the coarse aggregate, followed by wire brushing and washing with high pressure air and water jets. A bush hammered surface or a surface in which the large aggregate pieces have been removed by chipping will not be considered an acceptable alternative to scabbling. The roughness of a scabbled or sand blasted surface shall be similar to that achieved by green cutting.

The Contractor shall take all care to prevent subsequent contamination of prepared surfaces and should this occur shall re-clean surfaces by wet sand blasting before placing the next concrete lift.

Before placing concrete on construction joints where curing has ceased and which have dried out, the surface shall be kept continuously wet for 48 hours if it has been dry for longer than 7 days and 24 hours if it has been dry for less than 7 days

Shortly before concreting is commenced the surfaces to receive concrete shall be thoroughly cleaned of all loose concrete, shavings, dust and extraneous material by washing with high pressure water jets, and any standing water shall be blown off with clean compressed air. Any standing water in or on the construction joint surface shall be mopped up or blown away by means of compressed air jets. Properly formed windows, at the level of the previous pour, shall be provided in the formwork to permit the proper cleaning of the surfaces before concreting recommences.



If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of cement and sand mixed in the same ratio as the cement and sand in the concrete mixture, immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure a complete bond with the adjacent layer.

No mortar or concrete or other material may be placed in position on or against a construction joint until the joint has been inspected and passed by the Engineer."

Add the following sub-clause:.

"PSG 5.5.7.4 Construction Joint between the Existing Concrete and New Concrete

In addition to the requirements of clause 5.5.7.3 c) the rate tendered shall allow for the following:

- a) Insitu concrete surface shall be scabbled thoroughly to expose uncontaminated concrete aggregate.
- b) The scabbled surface shall be brushed with a wire brush and high-pressure water jetted to remove any loose aggregate.
- c) The surface shall be thoroughly soaked for 24 hours and all free water removed from the surface before pouring of concrete
- d) Mortar, if approved by the Engineer in writing, shall be applied immediately before placement of concrete and shall be treated with an approved latex bonding-agent used in accordance with the manufacturers specification."

Add the following sub-clause:.

PSG 5.5.7.5 Water stops (New Clause)

"Water stops shall be continuous. Factory made intersection and abrupt changes of direction pieces shall be incorporated and all joints shall be hot butt-welded in accordance with the manufacturer's instructions. Intersections of water stops with a dissimilar pattern (e.g. rearguard S type, with hydrofoil type) shall be made using purpose made junction pieces with minimum leg lengths of 300 mm.

The greatest care shall be taken to ensure that water stops are fully bedded in the surrounding concrete, that they are maintained in the correct position and alignment while concrete is being placed and that the concrete is properly compacted in the area surrounding the water bar.

Butt joints in PVC water stops shall be formed in accordance with manufacturer's instruction and shall have a tensile strength not less than 75% of that of the original material. Splices and joints shall be made such that all ribs in the original cross-section are maintained continuously and the joint is dense, homogeneous and free of all porosity. The Contractor shall test under the direction of the Engineer joints made in water stops of each type of material used. Prior to use, all water stops shall be carefully stored and handled to avoid damage or contamination by oil, grease, etc. Rubber and plastic water stops shall be stored in a cool well ventilated place, away from the sunlight.

The Contractor shall construct the joints to the degree of accuracy required by the manufacturers of the various joint components specified or to Degree I accuracy as defined in terms of Sub-clause 6, which ever gives the higher degree of accuracy."



PSG 5.5.8 Curing and Protection

Add the following to sub clause (c):

"Should the Contractor elect to cure Dam Concrete by means of water spray, he shall supply, erect and maintain a fog spray system to cover the whole structure to be water cured. The system shall be manned, or, have the capacity to run on an automatic timer that can provide the correct curing for a continuous 24-hour period. The system shall be operational during all the casting stages and curing shall be maintained for a minimum curing period of 14 days. The contractor shall only be permitted to place concrete when the system is functioning to the approval of the Engineer".

Add the following to sub clause (e):

"Curing compound shall, if approved by the Engineer in writing, shall be a white resin-based compound containing no water and complying with ASTM C 309 and applied immediately after placing the concrete."

Add the following new sub clause (f):

"Where curing by retention of formwork is used as the only method of curing the concrete, it must be left in place for the minimum period specified in Clause 5.5.8 but in no instance shall it be less than 7 days. The materials used for formwork shall take into account properties such as thermal insulation and moisture absorption when assessing the suitability of the material, to the approval of the Engineer.

If impermeable curing membranes are to be used as a curing method, they shall be installed at the same time as formwork is removed and no portion of a concrete surface may be left unprotected for a period in excess of 2 hours. If the surface is an unformed finish e.g. top of deck slab, then the surface must be protected immediately by appropriate methods approved by the Engineer after it is finished, without damage to that surface, since it is vulnerable to plastic shrinkage cracking due to high rates of evaporation while the concrete is still in a plastic state. Plastic shrinkage and settlement shall not be permitted on any of the structural elements since it compromises the durability of the concrete."

PSG 5.5.9 Abnormal Climatic Conditions

Add a new sub clause 5.5.9.4:

"The temperature of concrete delivered to site shall be within the range 10 ° C to 30 ° C. Concrete which has a temperature outside of this range shall not be placed in the structure.

The rate of hydration of the cement in the concrete shall be such that the concrete can be placed and properly compacted within 2 hours after the addition of water to the mix ingredients. The initial set of the concrete shall not be unduly delayed due to inappropriateness of admixtures or cement type, which could promote bleeding.

No concrete shall be placed in ambient temperatures in excess of 28 ° C. When ambient temperatures are in excess 25 ° C all reasonable measures shall be taken to ensure that concrete is placed under as cold conditions as possible, e.g. Shielding of stockpiled aggregates from exposure to direct sunlight, cooling of aggregate stockpiles by spraying with water and the design of mixing-water storage for the maintenance of the minimum practical temperature. Furthermore, windbreaks shall be erected, if necessary, to protect concrete against early dehydration prior to implementation of curing procedures.



Should cracking occur as a result of excessive concrete placement temperatures, inadequate protection or curing of concrete during or subsequent to placement and this cracking is considered by the Engineer to be deleterious to the integrity or impermeability of the structure, the Contractor shall replace or repair, the Engineer's satisfaction, this section and any other whose functional purpose is affected by the cracked section of concrete."

PSG 5.5.10 Concrete surfaces

PSG 5.5.10.1 Add to the end of the paragraph :-

"Hydraulic structures with curved or sloping surfaces not cast against formwork shall be thoroughly consolidated by means of temporary holding forms (and not by means of screed guides and strike-off). The desired shape shall be achieved by using strong, solidly anchored ribs between which rows of form panels are placed, row-by-row upwards as the lift space is filled, and removed starting row-by-row at the bottom when the concrete will no longer bulge out."

Add the following after Subclause 5.5.10.

"Wood-floated finish

Where wood floating is specified or scheduled, the surface shall first be given a finish as specified in sub-clause 5.5.10.1 of SANS 1200 G and, after the concrete has hardened sufficiently, it shall be floated to a uniform surface free of trowel marks. The screeded surface shall be wood-floated, either by hand or machine, only sufficiently to produce a uniform surface free from screed marks."

NOTE: A degree of Accuracy II is required for wood-floated surfaces, or as per PSG 6.2.3, as applicable.

Steel-floated finish

Where steel floating is specified or scheduled, the surface shall be treated as specified in wood-floated finish except that, when the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the screeded surface shall be steel-trowelled under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.

NOTE : A degree of Accuracy II is required for steel-floated surfaces, or as per PSG 6.2.3, as applicable.

Special surface finish at overflow sections

Where a special surface finish is specified, the surface shall be given a finish as specified in sub-clause 5.5.10.1 of SANS 1200 G and, after the concrete has hardened sufficiently, it shall be floated to the relevant tolerances specified in PSG 6.2.3. Rubbing with carborundum stone after the concrete has hardened will be permitted but plastering will not under any circumstances be permitted."

PSG 5.5.11 Watertight concrete

General

All the reinforced concrete structures and elements that form part of this Project shall be regarded as water-retaining structures and shall be subject to the requirements below, in addition to the requirements of SANS 1200 G as amended.



The Contractor is responsible for ensuring water tightness in accordance with the requirement of this specification. The works shall not be certified complete until the structures have been proved, by testing, to be watertight. The structure shall be considered water tight in the absence of water seepage and leaks, or white carbonation marks on the downstream surface of the structure.

Design of concrete mix

The concrete mix to be used in water-retaining structures shall have a water/cement ratio not exceeding 0,48 and, to ensure workability, water-reducing admixtures of approved manufacture shall be used in preference to increasing the cement content (see also sub-clause 3.5 of SANS 1200 G).

The minimum cementitious materials content shall be 250 kg/m³ and the maximum cement content shall not exceed 450 kg/m³ for mixes containing Fly-ash cement and 400 kg/m³ for mixes containing only Portland cement. A minimum of 30% of Fly Ash shall be used.

The 28-day cube strength of watertight concrete shall not be less than 30 MPa.

PSG 5.5.13 Grouting

Where grouting in of rebar dowels and/or anchors into concrete or hard rock is specified on the drawings, the requirements of Particular Specification PPS 5 - Drilling and Grouting for Dowel Bars shall replace the provisions of PSG 5.5.13 Grouting.

PSG 5.5.15 Records

The following shall be added as Clause (d):

"d) The Contractor shall implement and operate an approved quality control programme to ensure that work to be inspected by the Engineer is checked and rectified prior to the Engineer's visit."

Add the following Clause:

PSG 5.5.16 Building Pipes into Concrete

Except with written approval of the Engineer, no pipes other than those shown on the drawings shall be embedded in concrete, and the approval of the Engineer for the position of all services to be embedded shall be obtained before concreting commences. The clear space between pipes of any kind embedded in reinforced concrete and the clear space between such pipes and reinforcement shall not at any point be less than:

- (a) 40 mm; or
- (b) 5 mm plus the maximum size of coarse aggregate, whichever is the greater

Where entry holes for pipes/specials have been provided in the well walls, the Contractor shall be responsible for the grouting-in of such pipes/specials, regardless of whether or not these have been supplied by himself.

Before commencing the positioning in holes of any pipes/specials the Contractor shall:

- (a) remove all shuttering and boxing remaining in the holes;
- (b) make any alterations required to the position and shape of the holes.;
- (c) thoroughly clean the sides of the holes so as to obtain a satisfactory bond surface for the new concrete; and



- (d) free all surfaces of the pipes/specials of all coatings and thoroughly scrape and clean the pipes/specials.

After accurately positioning the pipes/specials in their respective holes, the Contractor shall fix the pipes/specials in the holes.

Immediately before grouting is undertaken, by the placing of mortar and concrete around the pipes the surface of the existing concrete shall be saturated with water. All surplus water shall be removed and the surface covered with a layer, approximately 12 mm thick, of mortar consisting of 3 parts of concrete sand and 1 part of cement.

The concrete ingredients shall be mixed and placed as dry as possible to obtain a dense, waterproof concrete. Where a watertight seal is required, the concrete shall be carefully worked around the puddle flange, of any, and the pipe barrel or body of the special, and shall be vibrated in layers so as to obviate any falling away from pipe/special surfaces of the concrete already placed. The whole shall, when set, form a dense, homogeneous, and waterproof mass. A spare vibrator with an independent power source shall be kept in readiness to ensure continuity of placing in the event of the breakdown of the duty vibrator.

Smooth formwork, suitably strengthened for use with a vibrator, shall be provided for facing the concrete around each pipe/special.

Add new clause:

PSG 5.5.17 Water Proofing of Joints

All joints formed in concrete sections, whether indicated on the drawings or whether agreed to in terms of the concrete placement method statement, shall be water proof. The contractor shall supply samples of all proposed sealers along with the relevant manufacturer's details for approval by the Engineer.

If waterproofing is specified on the drawings by the installation of water bar for the expansion joints, or where deemed prudent by the Contractor as a necessary precaution, and agreed to by the Engineer, the following shall apply:

a) Use of water bar

Construction joints (or contraction joints) shown on the drawings are necessary joints with respect to the shrinkage of the concrete after casting as well as to match the joint positions in the existing structure. An as-built jointing drawing shall be prepared by the Contractor to record the location of all water stops and construction joints made by the Contractor, in addition to or at variance to the specified joints and submitted for purposes of record and approval by the Engineer.

The Contractor shall provide technical support for such jointing arrangements that account the concrete design mix proposed, water bar supplier specifications and standard or particular details provided on the drawings.

The water bar selected shall take into consideration the existing water bar in the structure, since it must be bonded to the existing water bar in order to ensure continuous water proofing.

b) Swellable Water-stops

The use of a swellable water stop to provide an integral seal between new and old concrete shall be permitted or detailed on the drawings and as approved by the Engineer. In such applications the contractor shall strictly adhere to manufacturer's specifications.



Add the following sub-clause:.

PSG 5.5.18 Construction of Concrete Facing

PSG 5.5.18.1 General

The Contractor shall submit a programme showing the sequence of casting of plinth and concrete face elements. In addition, the Contractor shall submit a Method Statement for the approval of the Engineer 7 days prior to commencing the work.

Construction of the concrete face shall not commence until the plinth for the section has been completed and until the Hardfill above that section has been completed to NOC level. Staged construction of the face slab will be considered subject to the submission of a Method Statement approved by the Engineer.

PSG 5.5.18.2 Concrete Face Slab

The concrete face slabs shall be cast by slipform. In confined or irregular areas the Engineer may approve the use of hand placing. The width of the slabs shall be between 8 m to 13 m and shall be dependent upon the plant supplied by the Contractor, which shall be supplied at tender stage as part of the method statements required. The thickness of the slab shall be in accordance with the Drawings. The actual width of a concrete slipform panel will vary according to the dimensions on the drawings as dictated by the internal joints in the dam, and as dictated by the foundation shape. The formwork system shall be capable of slip forming panels of variable length by means of internal and easily moveable end stops.

The concrete face slabs shall be cast continuously in vertical lanes. Except where approved by the Engineer, horizontal construction joints will not be permitted, and the Contractor shall ensure that the production rates are sufficient to achieve this. The advance of the slipform shall be between 2 to 5 m per hour.

(a) Slipform Construction

Slipforms shall be of rigid construction capable of resisting the working loads imposed upon them. The width of slipform shall be adequate to overlap adjacent poured slabs. The face of the form shall be of steel.

The length of the slipform along the slope shall be such that with the proposed concrete mix and slipform speed, concrete emerging from the slipform will not slump.

The slipform design shall be submitted to the Engineer for approval. Requirements for the slipform are as follows:

- The form shall have two platforms – one for vibrating concrete and one for trowelling, floating and finishing the slab.
- The form shall be operated by synchronised hydraulic jacks or, winches located at the crest.
- Distribution of concrete in front of the slipform shall be by a conveyor equipped with a striker to direct the concrete to the point of deposition.
- The form shall be light and stable. It shall be prevented from floating during concreting by vibrating ahead of the slipform.



(b) Slipforming Trial

The Engineer's prior approval of the position for the slipforming trial shall be obtained. The trials shall include each type of slipform proposed to be used in constructing the concrete face. Where necessary, trials shall be conducted for "leader slab" and "follower slab" casting sequences.

Following slipforming trials and before proceeding with further slipforming, the Contractor shall modify his slipform or slipform operation if the trials prove unsuccessful.

(c) Preparation for Slipforming

The following preparatory work shall be completed prior to the execution of any work on a slipformed bay of the concrete face slab:

- The Contractor shall erect temporary stepped walkways from the crest of the dam down the face along each side of the slab to be worked on;
- Installation of slipform rails on a suitable base. The base shall not impinge upon the area in which concrete is to be placed or damage the drainage layers; and
- Positioning of reinforcement.

Prior to setting any slipform rails, the Contractor shall survey the entire face on a 2 m grid to determine the variation in the face profile from design lines and levels. The results of the survey together with the Contractor's proposals for setting the alignment and levels of the slipform rails shall be submitted to the Engineer within 2 days of the survey having been carried out. Slipform rails shall be set so that the concrete face slab, when constructed, follows the profile of the dam as surveyed as closely as possible at the required thickness.

Slipform rails and side forms shall be fixed to the Hardfill face in such a manner that they can be accurately aligned and do not become dislodged or misaligned during the construction of the face slab.

The Contractor may use the side forms as slipform rails with appropriate arrangements in the design to ensure that the form does not move or become misaligned during the construction of the face slab.

Any damage to the prepared Hardfill face or drainage layers caused by these preliminary works shall be made good.

(d) Transportation and Placing of Concrete

The method of transporting the concrete from the dam crest to the face and of placing the concrete shall be such that segregation of the mix does not occur. Concrete, mortar, rails, reinforcement, waterstops and other materials shall be transported by rubber tyre mounted trolleys or other means to avoid damage to the upstream face.

The Concrete shall be cast from the bottom to the top of the dam. The Concrete shall be vibrated in front of the slipform machine which shall be properly held in position during vibration. Insertion of vibrators under the slipform will not be permitted.

Finishing of the face slab shall be done by experienced personnel working from the trowelling platform of the slipform.

The Contractor shall ensure that, as far as possible, the surface is constructed using uniform construction techniques and materials, including the use of a single brand and type of cement.



(e) Curing

When the concrete surface has hardened sufficiently not to be damaged by water action, it shall be water cured for a period of not less than 21 days.

Curing shall be provided by installing a perforated spray hose located at the crest of the face panels. This water will not be permitted to enter the river unless treated and in compliance with the Specification.

(f) Repair of Concrete Face

Any slumping or other damage of the concrete emerging from the slipform, including blowholes larger than 5 mm diameter, shall be repaired immediately by hand screeding. Any other necessary repairs shall be carried out in accordance with the relevant provisions.

Add the following clause:

PSG 5.16 Filling of River Diversion Pipe with Cementitious grout

Prior to grouting, the Contractor shall:

- Clean the pipe internally to the satisfaction of the Engineer;
- Seal all outlets, openings and joints as required;
- Install grout injection points, vents and monitoring points where necessary, and;
- Submit a grouting method statement detailing the sequence of operations, pumping pressures, venting arrangements and contingency measures.

Construction shall be carried out continuously or in approved stages to ensure complete filling of the pipe. Vent points shall remain open until grout free from air and water is discharged. Any additional grouting required to compensate for settlement shall be carried out at no additional cost.

PSG 6 TOLERANCES

PSG 6.2.3 Specified permissible deviations

In general the permissible deviations on concrete work shall be to Degree of Accuracy II except for surfaces subject to hydraulic flow, as specified hereinafter as a continuation of table 6.2.3. Add the following after (g):

(h) Concrete surfaces subject to hydraulic flow

(1) Variations from specified lines

Hardened concrete surfaces shall be checked by the Contractor and will be subject to such inspection and measurement as is necessary to determine whether the tolerances specified in Table 6.2.3(a) are realized

Variation is defined as the distance of and actual point on a structure from the position of that point as specified on the applicable drawings

Table 6.2.3(a): Tolerance for specified lines

Surface Description	Tolerance
(i) Curved Ogee Spillway Capping	



(a) Crest level variation	-10 mm to + 10 mm
(b) Dimensional variation	-20 mm to + 20 mm
(ii) Downstream faces of dam	-10 mm to + 30 mm
(iii) Upstream faces of dam	-10 mm to + 30 mm

(2) Concrete Surface Irregularities

a) General

Bulges, depressions and offsets are defined as concrete surface irregularities. Concrete surface irregularities are classified as abrupt or gradual and are measured relative to the actual concrete surface. See Table 6.2.3(b).

b) Abrupt Surface Irregularities

Abrupt surface irregularities are defined as offset such as those caused by misplaced or loose forms, loose knots in form lumber, or other similar forming faults. Abrupt surface irregularities are measured using a short straight edge, at least 200 mm long, held firmly against the concrete surface over the irregularity and determining the magnitude of the offset by direct measurement.

c) Gradual Surface Irregularities

Gradual surface irregularities are defined as bulges and depressions resulting in gradual changes on the concrete surface. Gradual surface irregularities are determined by measuring the offsets from a template conforming to the specified shape of the surface under examination. Such templates shall be provided by the Contractor at his own expense and shall be of appropriate dimensions to facilitate effective measurement of gradual surface irregularities. The magnitude of a gradual surface irregularity defined as a measure of the rate of change of the actual concrete surface slope from that specified. The Contractor shall take regular measurement, using the appropriate templates, to ensure that all surfaces fall within the specified tolerance in table 6.2.3(b)

Table 6.2.3(b) Tolerances for Surface Irregularities

Surface Description	Tolerance
(i) Abrupt irregularities on spillway ogee crest and weir capping	
(a) Parallel to flow	± 4 mm
(b) Non-parallel to flow	± 2 mm
(ii) Abrupt Irregularities on dam downstream faces	
(a) Parallel to flow	± 10 mm
(b) Non-parallel to flow	± 5 mm
(iii) Gradual Irregularities on spillway ogee crest capping	
(a) Measured perpendicular and parallel to flow	± 2 mm
(b) Measured perpendicular to flow	± 2 mm
(c) Measured parallel to flow	± 1 mm
(iv) Gradual Irregularities on dam downstream faces	
(a) Measured perpendicular and parallel to flow	± 4 mm
(b) Measured perpendicular to flow	± 5 mm
(c) Measured parallel to flow	± 2 mm

(3) Repair of Hardened Concrete not falling within specified tolerances

Hardened concrete not falling within the specified tolerances shall be repaired in a manner approved by the Engineer. The finish achieved by the repair shall ensure compliance with specified tolerances and a uniform surface appearance with adjacent existing concrete.



Any residual abrupt irregularities remaining after removal of formwork or surface forming shall be removed by grinding to achieve a transition of 1 in 25 between the surfaces adjacent to the irregularity.

Any ground surfaces may require sealing and or hardening of the surface by a suitable construction repair material acceptable to the Engineer. “

PSG 7 TESTS

PSG 7.1 FACILITIES AND FREQUENCY OF SAMPLING

PSG 7.1.2 Frequency of sampling.

PSG 7.1.2.5 Testing frequency for durability criteria.

Testing for durability shall be carried out during the design phase such that 4 complete tests are conducted. During construction, testing will comprise one complete set of tests for every 25 m³ for the first 1 000m³ and thereafter one set for every 100m³.

The cost of all concrete quality acceptance testing shall be deemed to be included in the price of the rate tendered for the concrete at the rate of one complete set of tests for every 200 m³ of concrete programmed to be used on site.

PSG 7.2 Testing

PSG 7.2.1 General

Add the following:

The execution of all sampling and testing shall be the responsibility of the Contractor and shall be carried out in accordance with standard methods. The Engineer shall conduct a programme of quality assurance in order to ensure that quality control standards and specifications are satisfied, and the Contractor must obtain approval from the Engineer for his programme.

The Contractor shall allow in his tendered rates for the cost of quality or process control testing.

PSG 7.2.2 Site Testing

Add the following:

The slump, measured in accordance with SANS Method 862, shall be recorded for each batch of concrete sampled. Limits for the acceptable consistency of slump values shall be set by the Engineer following receipt and acceptance of the Contractor's design for strength concrete.

PSG 7.2.4 Early-strength Testing

Add the following to this clause:

Of each sample of four cubes, one cube shall be tested at 7 days and the remaining three cubes at 28 days.



PSG 7.2.5 Durability criteria testing

Before any concrete may be used on site, a laboratory testing programme will be undertaken and the final results submitted to the Engineer at least a week prior to the concrete being used on site. These results should indicate the values attained at 28 days.

The following parameters should be presented utilizing the test method indicated.

- Cement type
 - The generally accepted nomenclature as detailed in the latest edition of Fulton's Concrete Technology should be given.
- Concrete cover to reinforcement
 - For concrete within structures, an approved electromagnetic cover-meter should be used to establish cover to reinforcement. This instrument shall be calibrated by direct measurement to exposed reinforcing bars.
- Preparation of specimens, Oxygen permeability, Sorptivity, and Conductivity
 - Part 1 of "Concrete Durability Index Testing- Research Monograph No 4" will be used for: a) Sample preparation
 - Part 2 for b) Oxygen permeability
 - Part 3 for c) Water Sorptivity
 - Part 4 for d) Chloride conductivity

Replace the entire section 7.3 with the following:

PSG 7.3 ACCEPTANCE CRITERIA FOR STRENGTH CONCRETE

PSG 7.3.1 Strength outside Specified range.

Should any valid test result obtained on concrete of a specific grade show that the strength is more than 3 MPa below or more than 10 MPa above the specified strength, the concrete yielding such result will be deemed not to satisfy the requirements of the specification. Should an examination carried out in accordance with PSG7.3.4 satisfy the Engineer that the structural adequacy and durability of the part of the structure in which the concrete has been used is not impaired, the concrete shall be accepted and the mix design and other factors influencing the quality shall be reviewed in order to ensure that further concrete cast will be of acceptable quality.

PSG7.3.2 Criteria for Three Valid Test Results.

The following criteria shall apply where three consecutive valid test results are obtained:

- a) The average of any three consecutive valid test results obtained on concrete of a specific grade shall exceed the specified strength by at least 2 MPa.
- b) If the criterion given in (a) above is not met but the said average is at least equal to the specified strength, the concrete cast shall be accepted but the mix design and standard of control shall be reviewed and adjusted as necessary.
- c) The average of any three consecutive valid test results obtained on concrete of a specific grade not shall exceed the specified strength by more than a factor of 125%.

Should the said average result fall outside the range of the specified strengths, the Engineer will investigate, in accordance with PSG 7.3.4, the part of the structure in which concrete represented by such result has been used.



PSG7.3.3 Provision for Statistical Assessment.

Should a concreting operation be of such magnitude or the sampling of such frequency that 30 or more valid test results have become available within 3 months, the Contractor may choose, at the discretion of the Engineer, to have results assessed statistically instead of in terms of PSG 7.3.2. In such case, the average of all the test results of a specific grade of concrete at any stage shall be between 1,7 and 2.1 standard deviations of the specified strength. If the average of such test results fails to meet this requirement, the mix design shall be adjusted to ensure compliance with this criterion.

PSG 7.3.4 Procedure for Examination of Concrete.

If, after evaluation of the test results in terms of PSG 7.3.1 and PSG 7.3.2 or PSG 7.3.3, as relevant, an examination of the concrete in the structure is indicated, one or more of the procedures in the sequence given below may be adopted at the discretion of the Engineer to determine the acceptability or otherwise of concrete in particular sections of the structure:

- a) An assessment of the stress level in the structure concerned in relation to the test result obtained,
- b) non-destructive testing, subject to similar concrete of proved acceptable quality being available in comparable members in the same construction as a reference (impact hammers and ultrasonic testing are two examples of such test techniques that may be used, provided that the apparatus has been previously calibrated) ,
- c) the testing of drilled cores in accordance with the relevant SABS standard methods;
- d) full-scale load tests in accordance with SABS 0100 under terms and conditions agreed upon between the Engineer and the Contractor.
- e) measurement of cracks in the concrete, with crack widths in excess of 0.2mm being unacceptable.

PSG 7.3.5 Replacement or Strengthening of Concrete.

Where load tests are, in the opinion of the Engineer, unsuitable or impractical, or if an examination in terms of PSG 7.3.4 does not show the concrete strength or cracking to be acceptable, or if a portion of the structure fails to pass the tests, the Contractor shall, on the instructions and directions of the Engineer, either replace or strengthen by approved means

- a) each section that failed, is cracked unacceptably or contains concrete that failed, as relevant; and
- b) any other section, irrespective of strength, the functional purpose of which is affected by the section or concrete referred to in (a) above.

The Contractor shall bear the cost of any replacement or strengthening referred to in this subclause as well as any other remedial measures that may be ordered to restore the durability of the concrete to that achievable by concrete of the strength required in terms of the specification.

Add the following additional subclauses after subclause 7.3.5:



PSG 7.3.6 Quality Control

The test results obtained by a ready-mixed production facility as part of its quality control system shall not be acceptable for evaluation of batching and mixing of the concrete.

PSG 7.3.7 Acceptance limits for additional durability criteria

It is inherent in any test programme that the values obtained in carefully controlled laboratory experiments will be better than those obtained from field tests. Thus statistical techniques must be used to predict what the target values must be, to correspond to the minimum values specified. Table 7.3.1 details the criteria which will be used in the adjudication of concrete quality.

Table 7.3.1: Criteria to be used in the adjudication of concrete quality

Category	Oxygen permeability index (OPI)	Sorptivity	Chloride conductivity
<i>Laboratory</i>	>10.0	< 6	< 0.75
<i>Full acceptance</i>	> 9.0	< 12	<1.5
<i>Remedial acceptance *</i>	8.75-9.0	12-15	1.5-2.5
<i>Rejection *</i>	< 8.75	> 15	> 2.5

* Requires suitable remedial works for the Contractor's account."

PSG 8 MEASUREMENT AND PAYMENT

PSG 8.1 Measurement and rates

PSG 8.1.2 Reinforcement

PSG 8.1.2.1 Add c) after clause b) :- "Galvanized reinforcement and anchor rods shall be measured separately from non-galvanized reinforcement to allow for the pricing of the galvanizing."

PSG 8.1.2.2 Replace subparagraph (a) with the following:

"The mass of steel bars will be measured as the total of the steel, irrespective of diameters."

PSG 8.1.2.3 (a) Delete the words "nominal size 25 mm" in the first line of this subparagraph
Delete subparagraph (b).

PSG 8.1.2.4 New clause – Filling of diversion pipe

The filling of the redundant river diversion pipe shall be measured by the cubic metre (m³) of grout placed, calculated from the approved batch records or delivery quantities accepted by the Engineer. No separate measurement shall be made for cleaning of the pipe, temporary bulkheads or end seals, grout injection and vent pipes, pumping equipment, testing, method, statements, temporary works, or any other incidental work required to complete the operation.

PSG 8.2 Scheduled Formwork Items

Add the following:



PSG 8.2.7 Sliding Formwork.....Unit : m²

Where indicated on the drawings that sliding formwork will be required for construction, these surfaces shall be formed as per PSG 5.2.6.

Measurement will be as for SANS 1200 G Item 8.2.2.

The rate tendered shall include full compensation for the supply, erection and use of sliding formwork, jacking equipment, alignment control, repair of blemishes on the concrete surfaces and subsequent dismantling

PSG 8.3 Scheduled Reinforcement Items

Add the following:

Where pull-out bars are scheduled, the tendered rates shall include additionally for the placement at the surface of the concrete, the subsequent removal of surrounding concrete as per PSG 5.5.5 for construction joints and the straightening of the reinforcement for splicing to new sections

Add the following payment item

PSG 8.3.4 Anchor Rods (Dowels) Unit: t
(State the type of steel, diameter and galvanizing)

PSG 8.3.5 Spillway Facing Tie-rod Unit: No

The rate tendered shall include full compensation for all preparation of surfaces, supplying, manufacture, welding and installation of high tensile threaded bar and coil washers, as well as removal of steel cone and plugging with approved non-shrink mortar as indicated on the Drawings.

PSG 8.4 Scheduled Concrete Items

PSG 8.4.1 Prescribed Mix Concrete

The rates for prescribed mix concrete shall include additionally for the forming//screeding of the surfaces of the concrete.

PSG 8.5 Joints

Replace the clause with the following:

"The unit of measurement shall be linear meter of jointing material (water-bar or sealant) or square meter of joint filler (soft board or "Jointex" or similar) or number of individual jointing items (bolts, plates etc as per the drawings), as applicable.

The forming of the concrete surface of the joint will be measured, for the first pour only, under the scheduled formwork items. The rates tendered for the jointing materials, as described above, shall include for full compensation for the supply of all materials, plant, equipment and labour etc. to install the relevant materials in the joint and shall be considered extra over the formed concrete surface. As such, all additional work, inconvenience, stays, props, surface preparation, cut-outs, etc. required shall be considered to be compensated under the pay item for the applicable jointing material.

Where proprietary products, or similar approved, have been specified for use in the joints, these shall be installed, welded etc. strictly in accordance with the manufacturer's specifications.



Forming of construction joints will not be measured and paid for separately.”

Add the following additional payment items:

“PSG 8.9 Building pipes into Concrete Work Unit: No
(State pipe diameter)

The unit of measurement shall be the number of pipes installed complete as detailed on the drawings.

The tendered rate shall cover the costs of creating the void in the base concrete member to the necessary size, the building in the pipes into the member as specified, including holding the pipe in position, cutting of the pipe if necessary, jointing and sealing and cutting of reinforcement as required.

“PSG 8.10 Concreting of face slabs Unit: m³

Measurement of concrete face slab will be the volume of concrete placed and compacted in the face slabs, calculated from the dimensions and levels shown on the Drawings.

The rates tendered for placing and compaction of concrete in the face slabs shall include full compensation for the supply of concrete and all work required to construct the concrete face slabs within specified thickness, placing the slabs with the slipform, finishing and the curing of the concrete. Forming of the upstream face shall be included in this rate.

Formed construction joints as shown on the Drawings will be measured separately. Reinforcement for face slabs will be measured separately.

“PSG 8.11 Filling of Diversion Pipe Unit: m³

Measurement of for filling the redundant river diversion pipe with cementitious grout shall include full compensation for supply, mixing, transport and placing of grout; all cement, admixtures, water and other approved materials; cleaning and preparation of the pipe; installation and removal of temporary works; grout injection and venting operations; labour, plant and equipment; quality control and testing; and all incidentals necessary to complete the work in accordance with the Specification.



PSH STRUCTURAL STEELWORK

PSH 8 MEASUREMENT AND PAYMENT

PSH 8.3 Scheduled Items

Add to all relevant pay items that the unit of measurement can additionally be the Metre (m) or Number (No) of items as described, or as shown on the Drawings.



PSL MEDIUM PRESSURE PIPELINES

PSL 2 INTERPRETATION

PSL 2.1 References

PSL 2.1.2 Supporting Specification

Add the following to this sub-clause :

- ANSI B16.9 specification of seamless carbon steel fittings
- SANS 719 : Electric welded low carbon steel pipes for aqueous fluids (ordinary duties)
- API 1104 : API Standard for welding pipelines and related facilities
- BS4515 : Field welding of carbon steel pipelines
- SANS 1123 : For flanges and accessories
- SANS 135 : For bolts
- SIS 05590-1967 : Swedish Code of Practice for surface treatment
- API 5L : API Specification for line pipe
- ANSI B36.10 : Wrought steel and wrought iron pipe
- BS 534
- SANS 10044 : Welding procedures and welders
- BS 1449
- BS 4870
- ISO 2531: General Technical specification for Ductile Iron Pressure Pipelines
- ISO 4179: Cement Mortar Lining

PSL 2.4 Abbreviations

Add the following to the list:

DI: Ductile Iron

PSL 3 MATERIALS

PSL 3.4 Steel Pipes, Fittings and Specials

PSL 3.4.2 Pipes of Nominal Bore up to 150mm

Replace this clause with the following:

“Specifications will be as for pipes of nominal bore over 150 mm.”

PSL 3.4.3 Pipes of Nominal Bore over 150 mm

Replace this clause with the following:

“All mild steel pipes and fittings other than screwed and socketed pipes, shall comply with the requirements of SANS 719, grade 300W. Specials shall be manufactured from straight pipes in accordance with the relevant requirements of BS534. All welding in pipes and specials shall be electric fusion welding.

Before leaving the factory all mild steel pipes and fittings shall be protected against corrosion in accordance with the relevant Particular Specification.

Plain ends of pipes and fittings shall be covered and protected against damage while being transported from the factory to the Site.



Wall thickness of pipes and fittings shall be as follows:

- | | |
|--|--------|
| • up to 350 mm diameter : | 4.5 mm |
| • over 350 mm up to 650 mm diameter: | 6 mm |
| • over 650 mm up to 1050 mm diameter: | 8 mm |
| • over 1050 mm up to 1750 mm diameter: | 10 mm |
| • over 1750 mm : | 12 mm |

PSL 3.4.4 Fittings and Specials

Add the following to this sub-clause :

“All pipe specials shall be accurately made to the sizes and dimensions specified or given on the drawings and/or Schedule.

Wrought steel bends for use with seamless pipes shall be at least medium radius elbows (radius = 2.0 times pipe diameter) made from ASTM A 234 WPB steel or equal, to ANSI B16.9.

Unless otherwise specified, segmented steel bends shall be made with a radius equal to 2.0 times the pipe diameter. If details of segmented bends are not provided, the bends shall have one mitre weld each, up to and including a deflection angle of 22.5° and two mitre welds each up to and including 45°, and three mitre welds each up to and including 90°.

All other fittings and specials (excluding pipe bends) to be in accordance with SANS 719 unless otherwise indicated on the drawing.

The vertical axis of all fabricated steel items shall be accurately identified by using paint marks on the pipe ends.”

PSL 3.4.5 **Welding Operators and Procedures**

Add additional clause after 3.4.4:

PSL 3.4.5.1 **Competence of Workmen**

“The Contractor shall employ only competent and coded welders and shall submit certificates proving the competence of welders. The Engineer will ask for additional competence tests if and when required.”

PSL 3.4.5.2 **Welding Procedure**

“Welding is to conform to the latest edition of API 1104 and BS 4515 field welding of carbon steel pipelines.

Before the start of any welding work under this Contract, the Contractor shall submit his proposed welding procedures of the various types of welds to the Engineer for approval. The Engineer may require procedures to be qualified by destructive testing.

Once the welding procedures have been approved, no modifications will be allowed without the consent of the Engineer in writing.

No welding shall be done until the welding procedures and welders have been properly qualified in accordance with the procedure and performance qualification test requirements of SANS 10044. Exception may be allowed if the fabricator can submit records of such tests which have been made by an independent inspection authority.”



PSL 3.7 OTHER TYPES OF PIPES (Clause 3.7)

PSL 3.7.1 uPVC Pipes

Replace with the following:

“uPVC pipe shall comply with all the requirements of SANS 966 Part 1 and shall be fitted with “Forsheda Anger Lock” joints or similar approved pipe and joints. The bidder may wish to utilise another product from another supplier, but he shall prove to the satisfaction of the engineer that the jointing system is equal or superior to this system. This shall be done prior to the order of any materials.

All fittings for pipes of nominal diameter 250mm or less, shall be class 25 bitumen dipped Cast Iron conforming to SANS 936, Grade 42 (19) and SANS 966 for socket dimensions.

All fittings for pipes of nominal diameter 315mm or more shall be manufactured as specified for steel pipes, shall be plain ended and shall be supplied and installed complete with the necessary “Viking Johnson” coupling, to be included in the price for such fitting.”

PSL 3.7.3 Ductile Iron Pipes

Add new clause after 3.7.2:

“Ductile iron pipes and fittings shall comply with ISO 2531 and shall be cement mortar lined to ISO 4179. External coating shall be sprayed metallic zinc (min 200 g/m²), covered with bituminous paint (pore sealer), all to ISO 8179.”

PSL 3.7.3.1 Jointing

“All jointing shall be “SANDARD” “push-in” type to standard NF A 48-870, or similar approved. Gaskets shall be EPDM rubber to ISO 4633.”

PSL 3.7.3.2 Fittings and specials

“Fittings and specials for ductile iron piping shall be of the “STANDARD TT” range of socketed fittings, all conforming to the same specifications and pressure classes as the main pipeline in which they are to be installed.”

PSL 3.8 Jointing Materials (Clause 3.8)

PSL 3.8.2 Flexible Couplings (Clause 3.8.2)

Add the following:

“Flexible couplings shall be

- a) “Viking Johnson” type, complying with AWWA C219, BS 534, BS 4772 and SANS 1808.”; or
- b) “Wrap around” type, complying with XXXXXX, e.g. Arpol, Straub;

as specified.”

PSL 3.8.2.5 Bracing of Flexible Couplings

Add additional Clause after 3.8.2.4:



"The rate Tendered shall include for the supply of pipe clamps, tie rods, bolt nuts and washers as detailed on the drawing and installed across flexible couplings before painting."

PSL 3.8.3 Flanges and Accessories

Add the following:

"The requirements of SANS 1123 are applicable.

All flanges for pipes of nominal bore up to 150 mm shall be full face slip-on flanges made of ASTM 105 grade 1 steel to ANSI B16.5.

All flanges for pipes of nominal bore exceeding 150 mm shall be full face flanges made of grade 43 steel to BS 4360 (or equal). Bolts shall be made from grade B steel to ASTM A307.

Stainless steel bolts are to be used for all stainless-steel flanges.

Wall or puddle flanges shall be made of flat iron, 75 mm x 8 mm thick, welded to pipe specials on both sides of the flange.

Where stainless steel flanges are to be bolted to mild steel flanges, isolating bushes and washers are to be used to electrically isolate two connected pipe sections. Gaskets used shall have adequate isolating capacity in terms of cathodic protection requirements."

PSL 3.8.4 Loose Flanges

Add the following to this sub-clause :

"Slip-on flanges, when required, shall be welded inside and outside.

There shall be a distance from the face of the flange to the pipe end equal to the pipe wall thickness plus 3 mm. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.

Unless otherwise indicated, the flange bolt holes shall be orientated to straddle the vertical centreline in the case of vertical flange face. For horizontal flange face, bolt holes shall straddle the north-south centrelines."

PSL 3.9 **Corrosion Protection**

PSL 3.9.2 Steel Pipes

Replace clauses 3.9.2.1 and 3.9.2.2 with the following, which shall also be applicable to all fittings made of steel.

"All steel pipes and specials are to be lined and coated with an approved epoxy system (COPON or approved similar) to give a total dry film thickness of at least 250 microns. i.e. all surfaces to be coated. The details of the proposed corrosion protection system shall be submitted to the Engineer prior to ordering of materials for approval.

All pipes, specials and fittings installed below ground level are to be coated and wrapped with a double layer of bitumen-impregnated glass fibre complying with the requirements for Type 1 of SANS 1130 to form a coating of average thickness 5 mm and of minimum thickness 4.5 mm and, on completion of the coating, white washing of the sheathing."



PSL 3.9.3 Protection against electrolytic corrosion

Add the following:

“All underground flanges, flange adapters and flexible couplings, including all bolts, nuts and washers, are to be cleaned properly, given a uniform coat of petroleum-based primer, a petroleum mastic applied in all corners, around bolts, nuts, etc., wrapped with a petroleum based impregnated tape (DENSO or similar approved) and a polyethylene outer wrap.

All underground welded joints and fittings shall be cleaned properly, given a uniform coat of petroleum-based primer, coated and wrapped with a petroleum based impregnated tape (DENSO or similar approved) and a polyethylene outer wrap.

Welded joints to be repaired to the original specification.

Unprotected inside surfaces of pipes and specials, especially after site welding, shall be treated in accordance with the type of lining specified for the particular pipe sections.

The electrical continuity between mild steel and stainless-steel pipe connections (or any other dissimilar metals) shall be broken by the installation of isolation kits, certified fit for this isolation purpose.”

PSL 3.10 **Valves**

All valves shall conform to the specifications and requirements of the following standard DWAF specifications (bound into this document):

- DWS 2510/01 General Valve Specification
- DWS 2510/03 Gate Valves
- DWS 2510/03 Butterfly Valves
- DWS 2510/03 Non-return Valves

PSL 5 **CONSTRUCTION**

PSL 5.1 **Laying**

PSL 5.1.1 General

Add the following to this sub-clause :

“Where the pipes or specials are to be cast or grouted into concrete walls, the relevant requirements of SANS 12000G will apply. Details of the sealants required are indicated on the drawings. The Contractor shall supply the Engineer well in advance with a method statement for his approval.”

PSL 5.1.4 Depth of Cover

Add the following to this sub-clause :

“The minimum cover over pipes shall be 1 000 mm.”

PSL 5.2 **Jointing Methods**

PSL 5.2.2 Flanges (Steel Pipelines)

Add the following to this sub-clause :



“Pipes shall not be aligned and levelled such that the pipes, specials and valves strain the flexible couplings. All precautions shall be taken to ensure watertightness for every type of coupling.

Where specified, pipes on both sides of flexible couplings shall be anchored across the coupling with tie rods or straps to prevent them pulling out.”

PSL 5.2.3 Welding (Steel Pipelines of diameter 600 mm or greater)

Refer also to Clause PSL 3.1.4.

PSL 5.3 **Setting of Valves, Specials and Fittings**

Add the following to this sub-clause :

“Valves shall be jointed such as to remain operative when the downstream pipe is removed.

All valves shall be placed as and where indicated on the drawing.”

PSL 6 **TOLERANCES**

PSL 6.1 General

Add the following to this sub-clauses :

“The tolerance for pipes, fittings and flanges as laid down in the various standards listed in Clause PSL 2.1 shall apply to all items manufactured under this specification.”

PSL 7 **TESTING**

Add the following sub-clauses :

PSL 7.1.1 Inspection (Additional Clause 7.1.1 under 7.1)

“The Contractor shall be responsible for supplying pipes and specials which comply with the specification in every way, and he shall arrange for such inspection of his own work as well as work done by others as may be necessary to ensure this.

All welded steel items shall receive a 100% visual inspection of all welds after they have been cleaned, and all visible defects shall be rectified.

The Employer reserves the right to appoint suitable qualified inspectors to inspect all stages of the manufacturing process in the Contractor's workshop and in those of his suppliers, on either a part time or a full-time basis. The Contractor shall have no claim for moderate inconvenience due to the inspection procedure.

Where testing or additional testing reveals defects, the cost of re-testing required and making good shall be for the Contractor's account.

Work to be inspected should not be painted or obscured in any way prior to being tested.”

PSL 7.1.2 Standard of Acceptance (Additional Clause 7.1.2 under 7.1)

“The Standard of acceptance of welding shall be laid down in API 1104: Standard for welding pipe lines and related facilities, for API 5L line pipe.”



PSL 7.1.3 Marking (Additional Clause 7.1.3 under 7.1)

"All individual pipe fillings and pipe specials shall be clearly marked with the appropriate reference numbers for identifying purposes. Reference numbers shall be legibly painted and also stamped on the one end of each pipework item.

The position of a weld test shall be clearly recorded and related to a pipe number."

PSL 7.2 **Initial Tests on Welding Steel Pipes**

PSL 7.2.1 Dye-Penetrant Test

Add the following to this sub-clause :

"The Contractor shall perform non-destructive testing on complete welds being not less than 10% of the total welding performed, in addition to every weld for steel specials."

PSL 7.2.2 Radiographic Examination

Add the following sub-clauses:

"Testing for X-ray examination shall be carried out as specified in BS 2600 : Methods of Radiographic Examination of Fusion Welded Butt Welds in Steel.

The Contractor shall allow for X-ray tests on 1% of all welds performed by an automatic process and on 2½% of all welds performed manually or by a semi-automatic process. The cost of this work shall be deemed to have been included in the rates Tendered for steel pipes and specials.

Testing for ultrasonic examination shall be carried out as specified in BS 3923, 1968, Part 1 : Manual Examination of Fusion Welded Butt Joints in Ferritic Steel."

PSL 7.2.3 Magnetic Particle Examination (Additional Clause after 7.2.2)

"Testing shall be carried out to BS 4397, 1969, Methods of Magnetic Particle Testing of Welds."

PSL 7.2.4 Paraffin Test (Additional Clause after 7.2.2)

"All fabricated steel bends, fittings and specials which cannot readily be pressured tested in the works shall receive a paraffin test on all welds to ensure that they are completely watertight. Alternatively other liquid penetrants may be used."

PSL 7.2.5 Destructive Tests (Additional Clause after 7.2.2)

"The Engineer receives the right to call on the Contractor to perform destructive tests such as transverse tensile, root bend and flatter tests on test specimens cut from the pipes. Separate payment will be made for such tests if they are called for, but the Contractor shall accept that the cutting out of a specimen and its testing may cause a moderate disruption of his work."

PSL 7.3 **STANDARD HYDRAULIC PIPE TEST**

PSL 7.3.1 **Test Pressure and Time of Test**

Add the following to this sub-clause :



“No testing shall be carried out without prior approval of the Engineer. This does not absolve the Contractor from his total responsibility.

For uPVC pipes and their fittings, the maximum working pressure to be used for testing purposes shall be the nominal pressure class of the uPVC pipes to be installed. i.e. field test pressures shall be 1.25 times the nominal pressure class of the uPVC pipes.

For Ductile Iron pipelines and their fittings, the maximum working pressure to be used for testing purposes shall be 30 bar i.e. field test pressures shall be 37.5 bar.

For steel pipes, the maximum working pressure to be used for testing purposes shall be 10 bar i.e. field test pressures shall be 13 bar.

The Contractor shall be responsible for providing temporary sealing devices (end caps, Vetta bags or similar) to blank off pipe ends for testing.”

PSL 8 MEASUREMENT AND PAYMENT

PSL 8.1 General

Add the following:

“The lining and coating of all pipes, specials and fittings shall be included in the price per unit of complete item. The painting of all pipes, sluice gates, etc. shall be included in the price per unit of the complete item.

The corrosion protection of all underground welded pipes, fittings, flanges, flange adapters and flexible couplings as specified under clause PSL 3.3, shall be included in the price per unit of complete item.

All equipment and sealing mechanisms to undertake the hydraulic pipe testing shall be included in the rates for the supply and installation of the pipes and fittings.

The cost of preparing, for jointing, the ends of all new pipes, be they cut or not, shall be included in the rates for items 8.2.1 to 8.2.4.”



PSLB BEDDING (PIPES)

PSLB 3 MATERIALS

PSLB 3.1 Selected Granular Material

Add the following:

“For toe drains, selected granular material shall consist of a combination of 13.2 mm stone for concrete as per SANS 1083 and filter material as per PPS3, in the configuration as shown on the drawings.

For all other pipes, selected granular material shall be river sand conforming to the specification given.”

PSLB 3.2 Selected Fill Material

Add the following:

“Selected fill material shall be silty gravel and sand with 12-35% fines and a liquid limit less than 40% of the following soil groups as designated by the Unified Soil Classification, ASTM D2487: GM, GC, GM-GC, SM, SC, SM-SC. This material shall be obtained from trench excavation but shall be sieved to ensure that no particles > 13 mm are included.”

PSLB 5 CONSTRUCTION

PSLB 5.1 General

PSLB 5.1.2 Details of bedding

Replace with the following:

“Pipes shall be bedded and protected in accordance with the details shown on the Drawings. These drawings have been based on drawing LB 2, and the same classes and definitions (as amended above) of materials apply.”

PSLB 8 MEASUREMENT AND PAYMENT

PSLB 8.1 Principles (clause 8.1)

PSLB 8.1.3 Volume of bedding materials

Add the following:

“The depth of each bedding section will be shown on the Drawings. By means of the clarification of the specification, the volume displaced by the pipe will not be paid for.

Bedding for toe drain pipes shall be measured neat as shown on the drawings, up to the top of the stone layer, where after the material in the trench will be considered filter material and measured under SANS1200 DE.”

PSLB 8.1.5 Disposal of Displaced Material

Replace the clause with the following:

“The requirements of PSDB-5.6 shall apply.”



PSLB 8.1.5 Freehaul

Amend the clause to reflect unlimited freehaul in accordance with PSDB-5.6

PSLB 8.2 **Scheduled Items** (clause 8.2)

PSLB 8.2.1 Provision of Bedding from trench Excavation

All material obtained from the trench and used as bedding in the trench will be considered to be transported within the freehaul distances.

Omit any reference to a specific freehaul distance.

PSLB 8.2.2 Supply of bedding by importation (Clause 8.2.2, 8.2.2.1, 8.2.2.2 and 8.2.2.3)

Add the following:

“The tendered rates shall also cover the costs of sufficient tests to ensure that material to specification is selected and for the selection process itself. Any royalties shall be included in the rate provided and the Contractor shall timeously negotiate with the land owners for such royalties. No claims shall be entertained with regard to discrepancies in royalties.

All material obtained from the trench, from the site or from the borrow pits for use as bedding, will be considered to be transported within the freehaul distances, irrespective of the distance hauled.”

PSLB 8.2.4 Overhaul of Material for Bedding Cradle and Selected fill blanket (Clause 8.2.5)

Delete this clause.



PSLD SEWERS

The following variations are applicable to the standard specification SANS 1200 LD:

PSLD 3 MATERIALS

PSLD 3.1 Pipes, Fittings and Pipe Joints

PSLD 3.1.5 uPVC Pipes

Add the following:

“The Contract calls for the installation of “Mainlite” , heavy duty sewer piping with z-lock joints from Petzetakis Africa, “Ultracor” heavy duty sewer piping with z-lock joints from DPI, or similar approved heavy duty type of uPVC pipe with 400 MPa Hoop Stiffness, all to SANS1601. The Tenderer may wish to utilize another product from another supplier, but his attention is drawn to Cause 3.2 and PSLD 1.2 in this regard. “Coreflo” pipe is not considered similar and will not be accepted.”

PSLD 3.1.8 Toe Drain Pipes

Add the following clause:

“The Contract calls for the installation of “Drainex”, HDPE sub-soil double walled sandwich construction drain pipe with smooth inner wall and corrugated outer wall from Kaytech or Nextube, or similar approved drain pipe.”

PSLD 3.2 Alternative Materials for Pipes, Fittings, and Joints

In addition to pipe specifications requested, the Contractor shall submit for approval, detailed specifications covering inter alia, the in-situ soil compaction, bedding and backfill material and placement procedures.

PSLD 3.3 Couplings for Pipes of Different Materials

Add new clause:

“Where pipe of one material is to be joined to pipe of a different material, a Viking Johnson Stepped Coupling, or similar approved, shall be used. Where required by the Engineer, the pipe with the lesser internal diameter shall be machined to form a bevel, such that a smooth transition is provided to the larger bore of the connecting pipe. The two pipes shall then be coupled externally to the satisfaction of the Engineer.”

PSLD 3.5 Manholes, Chambers, Etc.

PSLD 3.5.2 Precast Concrete Sections

Add the following:

“The contractor shall submit to the engineer for approval the specifications of the product he wishes to use, and installation shall be done in accordance with the manufacturer's specifications.”



PSLD 3.5.7 Step irons

Replace in this clause “malleable CI step irons of BS 1248” with “Calcemite Step Irons in accordance with BS 1247 Part 2: 1990 Manhole Steps, Section 7”

PSLD 5 CONSTRUCTION

PSLD 5.6 Manholes, Inspection Chambers, Etc.

PSLD 5.6.1 General

Replace part a) with the following:

“Manholes on main sewers diameter 600 mm and less: Pre-cast concrete to the details on the standard drawings.”

PSLD 6 TOLERANCES

PSLD 6.3 Manholes Invert Levels

Decrease the permissible deviation to +/- 20 mm.

PSLD 6.4 Alignment and Grade Between Manholes

Decrease the permissible deviation to 2% of the nominal diameter and add the following:

“Variation in alignment within the allowed tolerances shall be confined to gradual variations only.”

PSLD 7 TESTING

PSLD 7.1 General

PSLD 7.1.6 Replace with the following:

“The following tests shall be performed by the contractor in the presence of the Engineer:

1) An air test followed by a water test.”

PSLD 7.2 Tests and Acceptance/Rejection Criteria

PSLD 7.2.2 Water test

Reduce all permissible loss rates by 50%.

PSLD 7.2.6 Watertightness of Manholes

Replace clause with the following:

“In addition to testing of the pipeline, manholes shall also be tested separately from the pipeline.

The following test is to be carried out on each completed manhole after backfilling:



After blocking the inlet, outlet and all branch pipes with expanding plugs, the manhole shall be completely filled with water and left for 24 hours. At the end of this period enough water shall be added to refill the manhole and in the subsequent 24-hour period the water level shall not drop by more than 75 mm per metre of depth of the manhole measured from the channel invert to the underside of the cover slab.

Rectification, if required, shall be at the Contractor's expense.

The scheduled rate for manholes shall include for watertightness testing.”



PART C3.4: PARTICULAR SPECIFICATIONS



PARTICULAR SPECIFICATIONS

PPS 5: DOWEL BARS	C3.4-3
PPS 6: BLASTING	C3.4-6
PPS 7: RUBBLE MASONRY CONCRETE	C3.4-13
PPS 8: DAYWORKS	C3.4-24
PPS 9: DRILLING AND GROUTING (DAMS)	C3.4-27
PPS 10: HARDFILL DAM CONSTRUCTION.....	C3.4-69
PPS 29: DAM MONITORING INSTRUMENTATION	C3.4-114
<i>DWS 2510.01 SUPPLY OF VALVES.....</i>	<i>C3.4-134</i>
<i>DWS 2510.02 BUTTERFLY VALVES.....</i>	
<i>DWS 2510.03 GATE VALVES</i>	
<i>DWS 2510.04 NON RETURN VALVES.....</i>	
<i>DWS 9900 C3 VALVES, FLOWMETERS AND PIPES.....</i>	

Note: The DWS specifications are available for free download, but will be issued electronically to all tenderer's who attend the compulsory site briefing and provide their details accordingly.



PPS-5

PARTICULAR SPECIFICATION

DRILLING AND GROUTING FOR DOWEL BARS

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PPS 5.5	MEASUREMENT AND PAYMENT
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PPS-5

PARTICULAR SPECIFICATION

DRILLING AND GROUTING FOR DOWEL BARS

PPS 5.1 SCOPE

This specification covers the drilling and grouting of dowel bars into rock and concrete.

PPS 5.2 MATERIALS

Deformed high tensile steel reinforcing bars shall be employed for dowelling into drilled holes of specified diameter. Porous spacers, to be approved by the engineer, shall be employed to ensure the centrality of the dowels in the dowel holes. (Folded PVC sleeves with adequate rigidity and space to allow grout to pass may be considered.)

A cement grout (W/C ratio 0,4/1 by mass) with 150 gm conbex 100 (or an approved equivalent) shrinkage reduction agent and 300 cm³ conplast 337 (or an approved equivalent) air entraining agent per 50 kg of cementitious materials, shall be employed to anchor the dowels into the holes. Alternatively, an approved proprietary pre-packaged cement specifically designed for the production of non-shrink grout may be used. The cementitious materials of the grout shall comprise a blend of 80% Portland Cement, complying with SANS 50197-1 and 20% Fly Ash, complying with SANS 1491. Mixes exhibiting bleed in excess of 1% shall not be acceptable.

Where specified, a proprietary solvent free, thixotropic, moisture insensitive, stable structural epoxy bonding resin with suitable inert fillers will be used for the anchorage of overhead, horizontal and semi-horizontal anchors. In the case of vertical anchors, a medium viscosity solvent free, moisture insensitive, stable structural epoxy bonding resin with suitable inert fillers will be used. Once installed, the epoxy resins shall exhibit the following mechanical properties:

Compressive strength	> 60 MPa	(DIN EN 196)
Bond Strength	> 3 MPa	(DIN EN 1542)
Tensile Strength	> 18 MPa	(ISO 527)

The Contractor shall timeously submit the technical specifications of the proprietary product to the Engineer for approval prior to use.

PPS 5.3 CONSTRUCTION

Hole drilling

As detailed on Drawings, holes shall be drilled to a specified depth into foundation rock or concrete in the positions and orientations indicated. Prior to installation of dowels these holes shall be thoroughly cleaned making use of a high pressure air jet and the depth of the hole recorded. Holes of insufficient depth shall be re-drilled.

Grouting in of bar

The correct quantity of grout required to completely fill the annular gap between the anchor and the sides of the hole shall be calculated (allowing for holes longer than specified)

Subsequent to the previously described cleaning of the dowel holes any water within the holes shall be removed. Each dowel bar shall be located centrally to full depth within its hole, spacers



being employed to ensure centrality and an intimate contact of grout with both the surfaces of the bar and the hole. The dowel bar shall subsequently be removed, the hole filled with specified grout and the bar replaced to full depth.

In the case of the cementitious grout, having installed the dowel bar centrally, the grout shall be topped up to ground level, if necessary and whilst the grout is still fluid, a vibrating poker vibrator, or similar apparatus, shall be brought into contact with the dowel until escaping air bubbles are no longer detected on the surface of the grout column. The grout level shall be repeatedly topped up during this procedure. The grout shall subsequently be allowed to set and any bleed water accumulating on top of the grout column shall be removed and replaced by fresh grout that shall be stirred into the surface of the partially set grout beneath to ensure effective bonding.

In the case of epoxy grout, the anchor shall be gently inserted and centred to allow the grout to fill the entire annular gap to the surface. Additional grout shall not be added if the grout does not fill the annulus to the surface. In such cases the anchor shall be withdrawn and additional grout added before re-insertion.

The anchor shall not be disturbed until the grout has obtained at least 25% of its strength.

In all cases the instructions of the manufacturer of the proprietary material shall be followed.

PPS 5.4 TOLERANCES

Dowel holes shall be located to an accuracy of 50 mm of the specified position and shall be drilled to within a tolerance of 3° of the specified inclination and/or orientation. The holes shall be drilled to within 50mm of the specified depth.

PPS 5.5 MEASUREMENT AND PAYMENT

PPS 5.5.1 Set up for drilling and grouting of holes Unit : No
(Specify diameter and orientation)

The unit of measurement shall be the number of set-ups for holes into which dowel bars are anchored. A set-up shall be measured once only for each hole regardless of the number of times the plant is moved during the drilling and grouting operation. The rate shall cover all costs associated with the set-up for each installed dowel.

PPS 5.5.2 Drilling of dowel holes Unit : m
(Specify diameter and orientation)

The unit of measurement shall be linear metre of hole drilled and the rate shall cover the cost of drilling as well as for cleaning of the hole immediately prior to installation of the dowel, all as specified.

PPS 5.5.3 Anchorage of dowel bars into drilled hole Unit : m
(Specify bar diameter and grout type if not cementitious)

The unit of measurement shall be the linear length of dowel bars anchored (i.e. the grouted length) and the rate shall cover the cost of the provision and fitting of a sufficient number of spacers to ensure centrality of the bar within the hole and provision and compaction of a grout, as specified above, around the dowel bar within the hole, including the cost of all waste.

The supply of the dowel bar itself will be measured under SANS 1200G, provision of reinforcement.



PPS-6

PARTICULAR SPECIFICATION

BLASTING

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PPS-6

BLASTING

PPS 6.1 SCOPE

This section deals with the requirements for blasting methods to be used for excavation of both underground and surface works.

PPS 6.2 DEFINITIONS

- (a) **"Specified excavation or Payment line"** means the excavation profile given on the Drawings or determined by the *Engineer* for the Works, within which no unexcavated or loose material shall occur after the excavation is complete except as allowed within the specified tolerances. It is also the line to which payment for excavation will be made.
- (b) **"Pre-splitting"** comprises drilling a line of closely spaced parallel holes of appropriate diameter, spaced not more than ten times the hole diameter or 600 mm, whichever is the smaller and charging the holes with an appropriate amount (decoupled if necessary) and type of explosive to shear the rock, forming a surface along the line of drill holes.

Either all the holes in a presplit line shall be drilled, charged and detonated simultaneously prior to drilling the production holes for the excavation adjacent to the presplit line, or pre-splitting shall be accomplished by delaying detonation in the production holes to allow the presplit holes to fire first. The first line of production holes next to the presplit face shall be lightly charged to ensure that the presplit face is not damaged when the charges in the production holes are detonated.

- (c) **"Smooth blasting"** comprises the drilling of a number of closely spaced parallel holes along the required excavation surface, with a suitable burden/spacing ratio, loading all the holes lightly with a uniform continuous charge of small diameter explosive and detonating all these charges simultaneously, after the detonation of the main production blast.
- (d) **"Line Drilling"** comprises drilling a line of holes of appropriate diameter spaced not more than twice the hole diameter to form a surface of weakness along which the rock will break. Blasting is not permitted in the line drilled holes, and the first line of production holes next to the line drilled holes shall be lightly charged to avoid damage to the line drilled break surface.
- (e) **"Trim Blasting"** comprises the separate removal of a protective zone of rock which has been purposely left within the specified limits of excavation for flat areas and shallow slopes. Drilling for trim blasting shall consist of a regular pattern of holes at appropriate spacings and angles and to accurate depths.

The holes shall be lightly charged and detonated in relays to lift the rock progressively to form the final excavated surface without shattering the surrounding rock.

- (f) **"Overbreak"** means any excavation which extends beyond the payment line, irrespective of the reason for such excavation.

PPS 6.3 REGULATIONS

The storage of explosives, use of explosives, personnel, transport of explosives, and other matters related to explosives shall be governed by the relevant sections of the Explosives Act (Act No 83 of 1997, as amended), Minerals Act (Act 50 of 1991), the Occupational Health and Safety Act (Act 85 of 1993) and the Construction Regulations, 2014.

No explosives of any kind shall be used without the prior approval in writing of the *Engineer*. Once this approval is granted, the *Contractor* shall be solely responsible for proper storage, transport, importation, security arrangements during transport to the *Contractor's* storage magazine(s) at Site and the correct possession and use of explosives.



The *Contractor* shall keep records in respect of receipt, storage and use of explosives. The *Engineer* shall have the right to inspect explosives magazines and records kept therein in respect of the storage, receipt and issue of explosives.

The *Contractor* shall display in his Site office, and all his explosives magazines, a copy of any applicable Statutory Regulations, and the applicable section of the approved Health and Safety policy and shall supply a copy to the *Engineer*.

A copy of all certificates issued to workmen to permit them to undertake blasting, and to the *Contractor* to cover the purchasing, storage and transport of explosives shall be handed to the *Engineer* before any blasting work is undertaken.

PPS 6.4 SAFETY PRECAUTIONS

The *Contractor* shall store, transport, possess and use explosives in accordance the relevant sections of the Acts referred to in PPS 6.3.

Furthermore, the *Contractor* shall take particular precautions with respect to lightning, such as the use of non-electric detonators or electric detonators specially manufactured for use in such circumstances coupled with the use of lightning warning equipment.

The power circuit used for electric firing of explosives within the tunnel shall be hung on supports other than those used for electric power or communication lines and on the opposite side of the tunnel. Control of this circuit shall be by means of a locking switch with one key.

All electrical equipment, cabling, pipework, ducting, rails and the like used underground shall be grounded to an acceptable installation extending throughout the underground workings and connected to ground outside the tunnel portal.

The *Contractor* shall install and operate a siren of sufficient volume to be easily heard above the general site noise from all points within a radius of 1.0 km of surface blasts. Hand operated sirens will only be approved in areas of restricted access such as tunnel headings where access is fully controlled.

PPS 6.5 GENERAL

The *Contractor* shall submit to the *Engineer* at least 28 days before the commencement of any excavation work, full details of his proposed methods and sequence of excavation and programme for the use of explosives.

Within 2 weeks of receipt of the proposals, the *Engineer* shall indicate approval in part or in whole, in writing, to the *Contractor*. The *Engineer* reserves the right to reject the proposals if, in his opinion, undesirable damage to permanent rock surfaces or existing structures will result from carrying out the blasting as proposed. If approval is withheld, new proposals in whole or in part shall be submitted. No drilling or blasting shall be carried out in areas for which the proposals have not been approved by the *Engineer*, and any changes to the approved methods shall be subject to the *Engineer's* approval.

The work shall be programmed so as to minimise blasting adjacent to previously constructed sections of the Works.

Where blasting is necessary every precaution including the use of blast mats, timber boarding or other means shall be exercised to protect the *works* and persons, animals and property in the vicinity of the Site. The *Contractor* shall accept responsibility for all injury or damage occasioned by any blasting operations and shall make good such damage without any additional payment.

The *Contractor* shall, in particular, note the requirement that he must limit to the maximum extent practicable the spillage of material from surface excavations, whether by blasting or other means, down the adjacent hillside. To this end the *Contractor* shall take all necessary precautions including, if necessary, covering the rock prior to blasting with sufficient loose material to prevent the blasted material being thrown down the adjacent hillside. If, however, during the course of excavation on a hillside, the *Engineer* is of the opinion that insufficient precautions are being taken to minimise the spillage of



material, he may instruct the *Contractor* to adopt further measures to reduce the spillage. No separate payment will be made for any such measures required.

Each separate blast shall be designed in accordance with modern blasting practice to break out the rock with the minimum explosive force. Full details of each blast, unless such blast is in the case of tunnel drives unchanged from the previous one, shall be submitted to the *Engineer* for scrutiny not later than 24 hours prior to the commencement of drilling for that blast. The details shall include the location, depth and area of blast holes, the type, strength, amount, column load and distribution of explosives to be used per hole, per delay and per blast, the sequence and pattern of delays, the maximum expected level of shockwaves on adjacent structures, and the description and purpose of any special methods to be adopted by the *Contractor*.

The approval by the *Engineer* to any blasting proposals shall not relieve the *Contractor* of his responsibilities under the Contract and the Law.

Should the *Contractor* excavate to dimensions in excess of those specified or instructed by the *Engineer*, whether to remove damaged material or for reasons of safety or for his own convenience, he shall at his own expense and when required by the *Engineer*, fill in the excess excavation with concrete of acceptable quality or with other material approved by the *Engineer*, or carry out additional trimming to the satisfaction of the *Engineer*.

The *Contractor* shall provide the *Engineer* each day with a copy of the record for the previous day's excavations. Where applicable the following data shall be recorded for each working area together with such other data as the *Engineer* may request:

- (a) Location of the excavation and position within the excavation;
- (b) Drilling pattern;
- (c) Type and amount of explosive used, including blasting pattern and delays used;
- (d) Details of rock support;
- (e) Surface area of sprayed concrete and location;
- (f) Number and classification of labour and plant;
- (g) Unusual occurrences, rockfalls, unstable or soft ground and inflows of water;
- (h) Progress, delays and reasons for delays; and
- (i) Name of blaster.

PPS 6.6 QUALITY OF EXCAVATED SURFACE AND BLASTING TRIALS

Unless otherwise detailed on the Drawings or instructed by the *Engineer* all blasting work shall be carried out using controlled blasting techniques to minimise any damage to the final profile.

Use shall be made of approved special explosives and/or blasting techniques which will minimise blasting induced fractures, or disturbance, on the rock faces outside the excavation line so preserving the rock in the soundest possible condition.

The surface after blasting shall exhibit a regular fracture plane between barrels without back break and with half barrels visible over the major portion of the surface. The surface shall be scaled down of all loose and hollow sounding rock to leave a solid, intact surface. Light charges shall be used for enlarging or correcting the excavated profile and also for excavating trenches.

The *Contractor* shall incorporate a series of blasting trials in his initial blasting operations to substantiate his proposed methods of blasting. Details of all proposed blasting trials and procedures shall be submitted to the *Engineer* for scrutiny in the normal manner.

A sufficient number of trials in each of the main rock types shall be carried out to substantiate that the depth and spacing of holes, the type and amount of explosive used per hole and the number and sequence of delays has been optimised in order to avoid as far as practicable fracturing or otherwise damaging the ground below or beyond the excavation line or level.

In underground work at least one of the trial blasts shall incorporate the full extent of the face to be excavated and maximum round length. In surface work the minimum depth and length of each trial



section shall be 5 m and 10 m respectively or as otherwise directed by the *Engineer*. The site for the trials shall be agreed with the *Engineer*.

Once the results of the trials are acceptable, such results shall form the basis of whether future controlled blasting is achieving the required standard.

If in the opinion of the *Engineer*, the methods of blasting are at any time causing excessive or undesirable disturbance of the rock mass surrounding the excavated space, he may order the *Contractor* to change his methods of blasting and/or carry out further blasting trials until the desired results are achieved. No additional payment shall be made for any change or further trials ordered by the *Engineer* or any delays resulting therefrom.

If the excavated rock is to be used as rockfill or filter material in the embankment, or concrete aggregate, the *Contractor* shall select his blasting method such that the blasted material is fractured to sizes suitable for the purpose. Secondary blasting is to be avoided.

PPS 6.7 MONITORING OF BLASTS

The *Contractor* shall supply and operate an approved tri-axial particle velocity meter equipped with a permanent paper trace output, which shall be used as and where directed by the *Engineer* to monitor blasting work.

The paper trace output records shall show the time and location of each blast, the type and amount of explosive used, together with any other relevant data. Copies of these records shall accompany the daily records required in terms of PPS 6.5.

PPS 6.8 NOTIFICATION OF BLASTS

The *Contractor* shall notify the *Engineer* of the intention to blast at least 24 hours before that operation is carried out. The notification shall show the location of and the intended time of each blast, and the name of the licensed blaster and shift foreman responsible.

The *Contractor* shall distribute written notification to all organisations on Site 24 hours prior to undertaking surface blasting. Any delay or postponement of any blasts shall be notified to all organisations immediately. The firing of explosives above ground, in tunnels and shafts within a distance of 80 m of a portal which is located within 100 m of any occupied dwelling shall be restricted to between 06:00 and 18:00 daily with the exception of Sundays when no blasting shall be permitted unless authorised by the *Engineer*.

PPS 6.9 BLASTING NEAR STRUCTURES

The *Contractor* shall be responsible for avoiding damage to adjacent structures from fly rock by erecting barricades and/or the use of blast mats or other means approved by the *Engineer*. Should any damage be caused by his operations this shall be made good without any additional payment. The *Contractor* shall exercise special care to avoid damage to concrete, sprayed concrete or pressure grouting already completed.

The unrestricted use of explosives will generally not be permitted in any part of the Works. The amount of explosives that may be detonated shall not result in a ground vibration with a peak particle velocity in excess of 25 mm/sec at the nearest point of any part of the Permanent works to the blasting site. Where circumstances dictate, such as when blasting near to partially cured concrete, the peak particle velocity permitted may be reduced by the *Engineer*.

Blasting shall not be carried out within 50 m of the Permanent Works, unless otherwise agreed to in writing by the *Engineer*.

The *Contractor* shall prepare a photographic record of each structure, especially houses, buildings, ruins, etc., of the local communities within 150 m of any Works, whether on the surface or underground, prior to any blasting taking place.



PPS 6.10 DISPOSAL OF EXPLOSIVES

Should the *Contractor* be granted permission by the relevant Statutory Authority to retain outdated explosives in a site magazine or storage place he shall immediately inform the *Engineer* and if requested to do so, furnish the *Engineer* with a copy of such authorisation. When any explosives are to be destroyed, the *Engineer* shall be informed at least 24 hours before the destruction is due to take place. Under no circumstances may explosives be destroyed in any part of the underground works.

PPS 6.11 CONTROLLED BLASTING

PPS 6.11.1 General

Controlled blasting methods shall comprise pre-splitting, smooth blasting, line drilling or trim blasting techniques.

All charges shall be accurately made up and inserted into the holes at the correct spacing, and all holes shall be correctly stemmed and connected in the correct sequence, with detonators being correctly delayed.

If at any time the methods of drilling and blasting do not produce the desired results of a uniform profile and shear face without overbreak, all within the tolerances specified, the *Contractor* shall be required to undertake further tests as specified in PPS 6.6 until a technique is arrived at that will produce the desired results.

Controlled blasting shall be used on the perimeter of all excavations in rock for the Permanent Works, designated excavations and otherwise where called for by the *Engineer*.

PPS 6.11.2 Drilling

In all controlled blasting, drilling accuracy of perimeter holes is of prime importance and the *Contractor* shall take particular care and make use of sight lines and guide rails in surface work to control the alignment and depth of blast holes. In addition, in underground works use shall be made of drilling equipment with parallel arm controls or such other method of control approved by the *Engineer*. Holes which are likely to protrude more than 100 mm beyond the excavation profile (including any tolerances specified) shall not be charged up, but shall be redrilled.

In both surface and underground works the blast pattern shall be accurately set out and holes shall be collared within 50 mm of the required position. Holes which are overdrilled shall be fully stemmed to the required depth before charging up takes place.

In surface work the length of perimeter holes for any individual lift shall not exceed 10 m or any lesser depth detailed on the Drawings unless the *Contractor* can demonstrate to the *Engineer* that he can stay within the required tolerances, produce a uniform surface, and provide suitable access for all the subsequent necessary scaling, inspection, mapping and installation of the required rock reinforcement and support, in which event the length of holes may be increased to a maximum of 15 m upon written approval by the *Engineer*. All perimeter holes for surface blasting shall be drilled to a depth of 1 m below the bottom of any production holes adjacent to the perimeter plane.

PPS 6.11.3 Use of Explosives

Both cartridge and bulk explosives may be used where appropriate.

In controlled blasting the type, size, decoupling and charge concentration of perimeter and bulk charges shall be within established parameters unless otherwise proven acceptable by site trials.

The bottom charge of a pre-split hole shall not be larger than the line charges unless otherwise directed. The top charge of the pre-splitting hole shall be placed far enough below the collar to avoid overbreaking the final profile.

Adequate stemming shall be used to avoid blow-outs.



PPS 6.12 CHECKING AND CORRECTING THE EXCAVATED PROFILE

The excavated profile shall be checked for line, level and underbreak using methods approved by the *Engineer*. No projections of rock shall protrude within the payment line, except as allowed within the specified tolerances.

The *Contractor* shall submit his proposals for removing any underbreak to the *Engineer* for his approval prior to carrying out any such work of removal. Any work executed or delays, which are due to the *Contractor* having to re-excavate underbreak and then re-install support shall be carried out without additional payment, and no extension of time will be allowed for this work.

PPS 6.13 MEASUREMENT AND PAYMENT

Measurement and Payment for Blasting will be made under SANS 1200 D or SANS 1200 DB, as amended and as applicable.



PPS-7

PARTICULAR SPECIFICATION

RUBBLE MASONRY CONCRETE

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PPS-7

PARTICULAR SPECIFICATION

RUBBLE MASONRY CONCRETE SPECIFICATION

PPS 7.1 SCOPE

This specification covers the requirements for rock masonry walls and structures for the purpose of water retention in civil construction. It covers the basic materials, the plant, the quality, manufacture and curing of the Rubble Masonry Concrete (RMC), tolerances in workmanship, tests and acceptance criteria, and the methods by which the finished structure is to be measured for payment.

PPS 7.2 DEFINITIONS

For the purposes of this specification, the definitions and abbreviations given in SANS 1200A, G and DK and the following definitions shall apply:

- a) "Acceptable/Approved" means to the approval of the Engineer.
- b) "Adequate" means adequate in the opinion of the Engineer.
- c) "Indicated" means indicated or as can be reasonably inferred from the contract, or the drawings, or as in writing by the Engineer.
- d) "Formation" means a surface on which earthworks operations, or a stage of operations, have been completed.
- e) "Foundation" means that part of the ground on which a structure will be constructed.
- f) "Rubble Masonry Concrete" is a monolithic, dense, void free matrix of large stone or rock plums embedded within mortar, similar in nature to "Grouted Pitching" or CSRA S105 "Cement - mortared stone walls".
- g) "Payment line" means the excavation profile given on the Drawings or determined by the Engineer for the Permanent Works and to which payment for excavation will be made.
- h) "Plum" is a solid particle of competent stone or rock with hard surfaces and edges with maximum dimensions not exceeding 700 mm and minimum dimensions not less than 100 mm.

PPS 7.3 MATERIALS

PPS 7.3.1 Cementitious Materials

Only Portland cement (PC), Fly Ash (FA), Ground Granulated Blastfurnace Slag (GGBS) or other approved high quality masonry cement may be used for the mortar of the Rubble Masonry Concrete. All cementitious materials shall comply with the requirements of SANS 50197-1. All cement extenders shall comply with SANS 1491 Parts 1, 2 or 3, as appropriate.

PPS 7.3.2 Stone

PPS 7.3.2.1 Quality



Stone shall be clean, hard, unweathered, and free from fissures and flaking. It shall have a relative density of at least 2.65. Stones with a weathered or stained surface shall be used for all external surfaces. All stone and rock shall be subject to the approval of the Engineer.

Stone used in RMC shall comply with the 10% FACT value for a concrete subject to surface abrasion (110 kN). Stone shall be tested for compliance with the properties indicated in Table PPS 7.1.

Table PPS 7.1: Required RMC Stone Properties

Property	Target Value	Test Method
10% FACT value (kN, minimum)	110	SANS 5842
Soundness & durability (loss in mass, % maximum)	8	ASTM C88
Abrasion resistance (% , maximum)	48	SANS 5846
Content of materials of low density (% , maximum)	2	SANS 5837
Water absorption (% , maximum)	1	SANS 5843

The aggregates used in RMC shall meet the requirements of a structure for which shrinkage is important.

PPS 7.3.2.2 Size

The maximum stone size in any specific member shall be one third of the thickness of the member at the point of placement and/or the maximum weight that can be handled.

PPS 7.3.2.3 Sand and Mortar

The cement used for the filler and binder mortar of the Rubble Masonry Concrete matrix shall comply with the relevant requirements of SANS 50197-1 and the fine aggregate shall comply with the relevant requirements for sand for concrete given in SANS 1083. Sand shall not exhibit any property, which, in the opinion of the Engineer, could adversely affect the mature concrete properties. A maximum sand Fineness Modulus (FM) of 3.2 shall be permissible. The target sand FM shall be less than 2.5

The grading of fine aggregates in RMC mortar shall comply with the requirements indicated in Table PPS 7.2.

Table PPS 7.2: Sand Grading Limits

Sieve Size Apertures (mm)	Mass (%) passing sieve		Test Method
	Lower Limit	Upper Limit	
6.7	100	98	SANS 201
4.75	100	95	
2.36	95	80	
1.18	90	60	
0.60	70	40	
0.30	35	15	
0.15	10	5	
0.075	5	0	
Fineness Modulus	2.0	3.2	

The mortar shall be specified by specified strength, although an indication of the cement/sand ratio anticipated mortar shall be indicated on the project drawings on the basis of functional zones within each particular structure. It remains the Contractor's responsibility to ensure that specified strengths are realised at all times. The results of design mix testing for mortars shall be provided for the Contractor's reference at the Site Inspection. The mortar will vary in composition from one part cement to approximately 4 parts sand to one part cement to approximately 6 parts sand (by volume), dependent on the required structural and water retention function of the relevant zone. Mortar of different water contents, and accordingly consistencies, shall be used for the outer and inner zones of each body of Rubble Masonry Concrete. For the external zones, which effectively form a shutter to the internal body, a drier mortar of a stiff consistency shall be applied, while a wetter, more flowable mix shall be used for the core zone. For surface finishing of the faces of the final structure, a 1 part cement to approximately 4 parts sand mortar of a "sticky" consistency shall be applied. For water retaining components, only RMC comprising 1 part cement + 4 parts sand (by volume) shall be used.

PPS 7.3.3 Water

Water of a suitable quality for concrete construction, in accordance with BS 3148, shall be used for all RMC mortar. When any doubt exists as to the suitability of mixing water, mortar cubes shall be made with the suspect water together with mortar cubes with water of a known purity. The suspect water shall be considered acceptable for use in RMC if the average 28 day strength of 3 mortar cubes made with the suspect water is at least 90% of the average 28 day strength of 3 cubes made with the water of a known purity.



PPS 7.4 TYPICAL RUBBLE MASONRY CONCRETE COMPOSITION

While the realisation of specified strength remains the Contractor's responsibility, for early planning it can be indicated that RMC of the listed specified strengths might often be composed as follows:

For dry materials, a mix of 1 cement + 6 sand and a w/c ratio by mass of 1.05 for a 28 day 9 MPa, assuming zero air voids, the component proportions can be determined as follows:

Table PPS 7.3: Typical RMC Composition for 1 + 6 Mix (dry sand)

Per pocket PC	Cement	Water	Sand
by bulk volume (l)	(1 pocket) 33 l	52.5	198
by absolute volume (l)	15.9	52.5	121
by mass (kg)	50	52.5	321
Per m³ Mortar	Cement	Water	Sand
by bulk volume (l)	(5.27 pockets) 174 l	277	1 045
by absolute volume (l)	84	277	639
by mass (kg)	264	277	1 692

For dry materials, a mix of 1 cement + 4 sand and a w/c ratio by mass of 0.95 for a 28 day 14 MPa strength, assuming zero air voids, the materials proportions can be determined as follows:

Table PPS7.4: Typical RMC Composition for 1 + 4 Mix (dry sand)



Per pocket PC	Cement	Water	Sand
by bulk volume (l)	(1 pocket) 33 l	47.5	132
by absolute volume (l)	15.9	47.5	81
by mass (kg)	50	47.5	214
Per m³ Mortar	Cement	Water	Sand
by bulk volume (l)	(6.94 pockets) 229 l	329	916
by absolute volume (l)	111	329	560
by mass (kg)	347	329	1 485

The mixes proposed by the Contractor shall be submitted to an approved concrete Laboratory with the necessary constituent materials to be tested. The final mix shall be confirmed through the Engineer's approval after first site trials. Any subsequent adjustments to the specified mix shall only be made on approval of the Engineer and after confirmatory testing by the Laboratory, on request.

PPS 7.5 PLANT

Construction using Rubble Masonry Concrete is a predominantly labour-based exercise for which minimal plant is required. Rubble Masonry Concrete will generally be used in construction projects for which the maximum use of labour is of central importance and accordingly it will usually be important to limit the plant functions to a rational minimum, without compromising final quality, durability or structural integrity.

PPS 7.6 CONSTRUCTION

PPS 7.6.1 General

Rubble Masonry Concrete of the type scheduled shall be constructed on prepared surfaces as and where shown on the drawings or as directed.

PPS 7.6.2 Foundation Preparation

PPS 7.6.2.1 Competent Rock Foundation

The foundation onto which structural Rubble Masonry Concrete is to be placed shall be of clean, competent rock with no loose blocks. Unsuitable surface material shall be excavated to expose competent rock which shall be thoroughly cleaned to remove any further loose, fractured, weathered or other deleterious material. The cleaned foundation surface must be approved by the Engineer before placement of Rubble Masonry Concrete is initiated. Once approved, the foundation shall be dampened and brush grouted with a water/cement grout of suitable consistency to fill open joints in the rock surface. Should open joints be wide or filled with deleterious material, the Engineer may



order that these be excavated (if necessary) and filled with concrete to a depth approximately equal to three times the respective width. Foundation preparation shall be completed immediately prior to placement of Rubble Masonry Concrete and in any instances where a delay between preparation and placement is incurred, the preparation shall be repeated without extra payment.

PPS 7.6.2.2 Fill or Ground Foundation

Where non-structural or lightly loaded Rubble Masonry Concrete is to be founded on material other than sound, competent rock, the following shall apply. The foundation shall be excavated to a depth where material of a bearing capacity of at least 75 kPa is evident. The bottom of the excavation shall be thoroughly cleaned of all loose material and dampened immediately prior to placement of a mortar receiving layer for the Rubble Masonry Concrete. Foundation preparation shall be completed immediately prior to placement of Rubble Masonry Concrete and in any instances where a delay between preparation and placement is incurred, the preparation shall be repeated without extra payment.

PPS 7.6.3 Recovery of Rock/Stone Plums

To preserve the environment at the site of the dam, it is preferred that as much as possible of the required quantity of stone be sourced within the dam basin or at sites which will leave the least visual and environmental impact. The proposed source of rock is the excavation for the RMC spillway structure on the left flank.

Small scale controlled blasting shall be applied to open up the rock mass on existing joints, producing a concentrated pile of suitably sized loose rock which can be easily recovered and loaded onto some form of trailer manually for transportation to stockpile. It is envisaged that a maximum of 250 m³ of material would be blasted in any single charge and further that specific caution would be necessary to avoid damage to the immediate environment.

Where stone has been gathered and stockpiled from any source must be inspected and given the approval of the Engineer prior to use. In loading and transporting such material to the dam site, care must be taken to avoid contamination.

The Engineer shall retain the right to require the Contractor to clean and/or sort and dispose of any stone considered unacceptable for use within the body of the RMC dam wall.

Whilst the nature of the equipment available to the Contractor will determine the best method to be adopted for recovering rock, all methods of recovery and sources of rock shall only be exploited once approved by the Engineer.

PPS 7.6.4 Placement of Rubble Masonry Concrete

A sand/cement mortar of a "sticky" consistency and a composition of approximately one part cement to approximately four parts sand (specified strength 14 MPa) shall be applied to the prepared foundation rock to a depth of approximately 175 mm, carefully working the mortar in to fill all recesses, depressions and cavities. The surface of all rock/stone plums shall be clean and free of adhering material and shall be made damp with water before the plums are effectively embedded into the mortar layer until refusal. During



embedding of plums into the mortar matrix, care shall be exercised to ensure that the integrity of the matrix is not disturbed and that the contact formed against the foundation is in no way destroyed or compromised. Rock/stone plums shall be packed as tightly as possible within the matrix, whilst ensuring that all surfaces are entirely covered with a layer of mortar and that stone surfaces are not in direct contact with each other.

Once no further stones may practically be accommodated, mortar shall be worked in to completely fill any cavities or voids within the Rubble Masonry matrix, by spading, rodding, trowelling and/or any other approved methods. On completion of this process, mortar shall be laid over the projecting rocks/stones in preparation for the receipt of the subsequent layer of plums. Stones of a stained or weathered appearance shall be placed in the surface zones, forming external faces and these shall generally be placed in advance of the body of structure using a dry cement/sand mortar. The body of the structure, between the external zones, shall be placed only after the external zones have gained sufficient strength not to be caused to displace outward during placement and compaction of the internal body. The body of the structure shall be placed, retained by the external zones, using a wetter, more flowable cement/sand mortar.

This process shall be repeated until final height is reached, at which point any loose particles etc of mortar shall be removed from the surface of the structure by washing or wire brushing. The surface mortar of the upstream side of the structure shall subsequently be flush pointed to the satisfaction of the Engineer, using a dry cement-rich mortar to fill surface depressions and cavities. The mortar of the downstream surfaces of the structure shall be pointed in such a manner that the final mortar surface is generally recessed approximately 30 mm behind the stone surfaces. Particular care shall be taken to realise the required construction tolerances over areas subject to water spillage. The spillway crest of the wall shall be formed in a dry, cement-rich mortar which shall be steel trowelled to the required tolerances.

The surface of the completed structure shall be cured by continuous wetting, or by another approved method, for a period of ten days.

Where Rubble Masonry Concrete is to be placed on a surface of existing concrete, the surface shall be thoroughly prepared by chipping to expose aggregate, removing loose material and dampening immediately prior to placement. The prepared surface shall be covered with a cement grout of $w/c = 0.5$ to a minimum thickness of 10 mm immediately prior to RMC placement.

Where a thickness of Rubble Masonry Concrete Masonry is specified, that thickness is measured as the distance between pointing mortar surfaces on the respective faces.

Where a water retaining fill embankment is to be placed against RMC, the applicable RMC face shall be cleaned of all projecting and loose material, in such a manner as to ensure that no mortar is projecting beyond the stone surfaces, and the surface shall be dampened and plastered with a 1 cement + 6 sand mortar to a minimum thickness of 15mm over stone faces. The final, plastered surface shall be smooth and free of any honeycombing, loose mortar, overhangs and other abrupt irregularities.

PPS 7.6.5 CONSTRUCTION JOINTS

The location of vertical and horizontal construction joints must be approved by the Engineer. No construction joints steeper than 3 vertical to 1 horizontal shall be allowed.



Where a construction joint is necessary, the joint surface shall be finished by leaving fairly densely packed, firmly embedded large rock/stone plums projecting by approximately 100 mm from the surface in such a manner that the subsequently placed Rubble Masonry Concrete may be effectively keyed to the earlier placed portion of the structure. All loose and ineffectively compacted mortar and rock particles on the old side of the joint shall be chipped away and the surface must be thoroughly cleaned and dampened, without ponding. It remains the Contractor's responsibility to ensure the watertightness of any construction or other joints included.

PPS 7.6.6 RMC CURING

RMC shall be cured for a minimum period of 14 days after placement by maintaining all surfaces in a moist/damp condition.

PPS 7.7 TOLERANCES

PPS 7.7.1 General

The material finish applicable to the spillway crest and all surfaces over which flows are discharged shall be Degree of Accuracy II. For all other surfaces Degree of Accuracy III shall be maintained. Accordingly, the following respective construction tolerances shall be observed:

Table PPS 7.5: Construction Tolerances

Surface Description	Degree of Accuracy	Tolerance (mm)
i) Spillway Crest Level	II	-15 to +15
ii) Spillway Surface Variations	II	-20 to +20
iii) Non Overspill Crest	III	-50 to +50
iv) Other Surfaces	III	-75 to +75
v) Plastered Surfaces	III	-50 to +50

When spillway surfaces are designated to be constructed of concrete, degree of Accuracy I as per SANS1200G will be applicable.

PPS 7.8 TESTS

PPS 7.8.1 Taking and Testing Samples

The Contractor shall carry out sufficient tests to satisfy himself as to the consistency of materials used and the quality of the final mortar produced.

No separate payment shall be made for sampling and testing and all related costs shall be included in the rate tendered for Rubble Masonry Concrete.

PPS 7.8.2 Frequency of Sampling

Mortar shall be sampled in accordance with SANS Method 5861.



In order to establish initial production control, the following sampling frequency shall be applied:

For 28 day strength testing, 3 x 150 mm cubes shall be sampled from one mix for every 30 m³ of RMC placed, with a minimum of 6 cubes per day.

For 7 day strength testing, 3 x 150 mm cubes shall be sampled from the same mix from which the 28 day strength cubes are taken.

For the remainder of the period of RMC placement, at least one set of 3 x 100 mm cubes for 28 day strength and one set for 7 day strength shall be sampled.

PPS 7.8.3 Testing

PPS 7.8.3.1 Consistency

The consistency of sampled mortar shall be tested on site by measurement of slump in accordance with SANS Method 862.

PPS 7.8.3.2 Compressive Strength

The compressive strength of sampled mortar shall be tested in accordance with SANS Method 863.

PPS 7.9 MEASUREMENT AND PAYMENT

PPS 7.9.1 Principles

In-situ Rubble Masonry Concrete will be measured by volume for payment. Each zone of a different mortar cement/sand composition will be measured separately and a respective price tendered accordingly.

The thickness of any particular Rubble Masonry Member shall be measured as the distance between the pointing mortar of the respective faces.

PPS 7.9.2 Scheduled Items

PPS 7.9.2.1 Foundation Preparation

All foundation surface preparation for RMC shall be measured under this item.

a) Preparation of competent rock foundation surface Unit: m²

The rates tendered shall cover the procurement, supply or production of all constituent materials, haulage, the storage/stockpiling of materials, the mixing of grout, the delivery of materials to point of placement, the preparation and cleaning of rock surfaces in accordance with the specified requirements and the brush grouting of exposed rock surfaces.

b) Preparation of fill or ground foundation surface Unit: m²



The rates tendered shall cover the preparation and cleaning of surfaces in accordance with the specified requirements.

PPS 7.9.2.2 Mortar Blinding

All blinding mortar to be placed as a receiving layer on fill or ground foundations shall be measured under this item.

175 mm deep 1 + 3 : Cement + Sand Mortar receiving layer Unit: m²

The rates tendered shall cover the procurement, supply or production of all constituent materials, haulage, the storage/stockpiling of materials, the mixing of mortar, the delivery of materials to point of placement and the placement of mortar to form a receiving layer.

PPS 7.9.2.3 Rubble Masonry Concrete

All Rubble Masonry Concrete Works to be constructed in terms of this Contract shall be measured under this item.

a) 1 part Cement to approximately 4 parts Sand (14 MPa) Unit: m³

b) 1 part Cement to approximately 6 parts Sand (9 MPa) Unit: m³

The rates tendered shall cover the procurement, supply or production of all constituent materials, haulage, the storage/stockpiling of materials, the mixing of mortar, the delivery of materials to point of placement, the preparation and cleaning of rock/stone plums, the placement of mortar and rock/stone plums to form a dense Rubble Masonry Concrete matrix, the filling of any remnant cavities with mortar and the curing of the surfaces of the final structure.

c) Area of Structure to be flush/recess pointed Unit: m²

The rate tendered shall cover the removal of all loose particles etc from the surface, the procurement and supply of all constituent materials, haulage, the storage/stockpiling of materials, the mixing of mortar, the delivery of materials to point of placement and the flush pointing of the surface mortar to form a reasonably regular surface in accordance with the specified tolerances.

d) Area of Structure to be plastered Unit: m²

The rate tendered shall cover the removal of all loose particles etc from the surface, the procurement and supply of all constituent materials, haulage, the storage/stockpiling of materials, the mixing of mortar, the delivery of materials to point of placement and the surface plastering to achieve a reasonably even and regular mortar surface in accordance with the specified tolerances.



PPS-9

PARTICULAR SPECIFICATION

DRILLING AND GROUTING (DAMS)

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APPENDIX A : FORMS FOR DRILLING AND GROUTING RECORDS

APPENDIX B : FORMS FOR CORE DRILLING AND RECOVERY RECORDS

APPENDIX C: GUIDELINES FOR COMPLETING THE SUMMARY DRAWING

APPENDIX D : FIGURES



PPS-9

PARTICULAR SPECIFICATION

DRILLING AND GROUTING (DAMS) SPECIFICATION

PPS 9.1 INTRODUCTION

PPS 9.1.1 Scope

This section deals with the requirements for exploratory drilling and pressure grouting required for the *works* including the following:

- (a) Rotary core drilling into rock and concrete and SPT tests in soil for investigative purposes.
- (b) Drilling of percussion and rotary holes for grouting.
- (c) Water testing in grout and exploratory holes.
- (d) Pressure grouting in grout curtain.
- (e) Pressure grouting to control water ingress.
- (f) Pressure grouting of rock/concrete interfaces.
- (g) Pressure grouting of rock fissures and cavities.
- (h) Pressure grouting of concrete/steel interfaces for built in parts and invert liners.
- (i) Stemming of grout and exploratory holes.
- (k) Cleaning up after grout operations.

PPS 9.1.2 Purpose and Function of drilling and grouting

The foundation of the dam is to be grouted to form a seepage control curtain as illustrated on the applicable drawings, while drainage holes are provided to relieve hydrostatic uplift pressures beneath the wall.

The grouting of joints between construction blocks will be required in order to form monolithic arches between the buttresses, and the recovery of cores from the body of concrete will be necessary to facilitate effective quality control during construction.

PPS 9.1.3 Supporting literature

The grouting methods and procedures described in the documents listed below are considered good practice:

- (a) Foundation grouting for dams
 - Part 1: Investigation - Ancold Bulletin 47, April 1977
 - Part 2: Design - Ancold Bulletin 48, August 1977
 - Part 3: Construction - Ancold Bulletin 50, August 1978
- (b) Grouting Manual
 - Fourth Edition 1981, Water Resources Commission, NSW Australia.

PPS 9.2 DEFINITIONS

The following terms whenever used in this section shall have the following meanings:

- (a) **"Depth"** means the distance from the start of the hole regardless of direction.
- (b) **"Stage"** means a partial or complete length of hole in which water testing and grouting is performed. The following grouting stages shall be applicable to the Works (unless otherwise specified in the Project Specifications or on the drawings):
 - Pre-stage: From collar to 1 metre into the foundation rock mass
 - Stage 1: From 1 m below collar to 5 metres into the foundation rock mass
 - Stage 2: From 6 m below collar to 10 metres into the foundation rock mass (or to the depth indicated on the drawings, if this is less than 10 metre)
 - Stage 3 & deeper: Similarly in increments of 5 m if depth exceeds 11 m below collar.



- (c) **"Pressure grouting in descending stages"** means the procedure of drilling a hole to a limited depth, setting a packer and grouting the hole, permitting the grout injected into the rock around the hole to set sufficiently to prevent its entering the hole when the hole is cleaned, washing out the hole, drilling the hole to a deeper stage, setting a packer at the bottom of the previously grouted stage or elsewhere as directed by the *Engineer*, grouting the new stage, and thus continuing in as many cycles of drilling and grouting as are required.
- (d) **"Pressure grouting in ascending stages"** means the procedure of drilling a hole to full depth in one operation and grouting from the end of the hole towards the surface in successive stages by setting the packers at predetermined depths.
- (e) **"Cavity grouting"** means grouting to fill any voids in rock/concrete or first stage/second stage concrete interfaces around structures.
- (f) **"Consolidation grouting"** means the injection of grout into fissured and jointed rock beneath a grout cap, concrete plinth or other sealing element and around tunnel linings to consolidate the rock mass. Where a concrete plinth is provided, consolidation grouting includes grouting of the contact between the concrete and the rock mass.
- (g) **"Cut-off grouting"** where used on the Drawings means consolidation grouting carried out in specific locations on the tunnel periphery to depths greater than the standard consolidation grouting fans.
- (h) **"Contact grouting"** means grouting of embedded steel to fill any voids at steel/concrete interfaces.
- (i) **"Curtain grouting"** means the injection of grout into a row or rows of holes to a specified depth and inclination below the dam, or into the abutments.
- (j) **"Drain hole"** means the drilling of a hole in the rock to a specified depth and inclination for the purposes of draining water from the rock and preventing the build-up of water pressure in the rock.
- (k) **"Lugeon"** is the measure of permeability of the rock. One lugeon unit signifies a leakage of one litre per minute per metre length of hole per 10 bars of pressure.
- (l) **"Refusal"** is reached when the flow rate of grout pumped into a hole at the maximum specified pressure is equal to or less than one litre per minute per metre length of hole.
- (m) **"Piezometer hole"** means a hole in the rock in which a piezometer standpipe or standpipes are installed to monitor groundwater levels.
- (o) **"P_{max}"** is the maximum grouting pressure, as determined by the *Engineer*, for a particular hole or stage.
- (h) **"Lugeon Unit" or "UL"** One Lugeon unit is defined as a water take of 1 l per minute per metre length of hole tested at a pressure of 1 MPa (10 Bars) and is very approximately equal in value to $1,3 \times 10^{-5}$ cm/s.

For tests carried out at other pressures:

$$UL = \text{water taken in test (litres/metre/min)} \times \frac{1000 \text{ (kPa)}}{P \text{ (kPa)}}$$

where P = gauge pressure in kPa + (10 x Sin Q x l)
 Q = angle of hole from horizontal
 l = half length of stage + length of previous stage(s).



- (i) **“Cement”** All cementitious materials including pozzolans and pseudo-pozzolans.
- (j) **“Drainage hole”** A drainage or pressure relief hole is a hole required to relieve hydrostatic pressure in the rock mass or concrete. It may be drilled from the surface or from a gallery, through concrete or through a pipe embedded in the concrete for this purpose.
- (k) **“Exploratory hole”** A hole drilled to recover a cored sample of as much of the material drilled as is feasible.
- (l) **“Grout take”** Grout take is the consumption of cement by weight (kilogram) per metre length of grouted holes.
- (m) **“Instrumentation drill hole”** A hole drilled for the purpose of placing instruments in the structure or rock.
- (l) **“Upstage grouting”** Upstage grouting shall mean the process of drilling a hole to full depth initially and grouting from the bottom of the hole upward at different depths by means of a packer set at different depths. Upstage grouting shall be performed by attaching a packer to the end of the grout supply pipe, lowering the grout supply pipe into the hole to the top of the lowest section to be grouted, expanding the packer, grouting at the required pressure, allowing the packer to remain in place until there is no back pressure, withdrawing the grout supply pipe to the top of the next higher section to be grouted and thus successively grouting the hole in sections at the specified pressures until the entire hole is completely grouted.
- (m) **“Downstage grouting”** shall mean the process of drilling a hole to a limited depth, grouting to that depth, either washing out the grout hole after the injected grout has attained its initial set or redrilling through holes that are not flushed out, drilling the hole to a further depth after at least 24 hours of grouting the previous portion and then grouting the next stage. Thus the hole is successively drilled and grouted until the required depth is completely grouted to the satisfaction of the Engineer.

Downstage grouting can further be sub-divided into:

- (a) Grouting of all stages with the packer at the surface. This shall include any hole which is completely grouted from base to surface in a single operation.
- (b) Grouting the stages with the packer at the bottom of the previous stage.

PPS 9.3 GENERAL

The general requirements for drilling and grouting of the *works* are shown on the Drawings. However, the final extent of the drilling and grouting will be determined by the conditions which are encountered during the progress of the work. The number, location, spacing, direction, inclination and depth of the drill holes, the order of drilling such holes, the pressure and mixtures to be used for grouting, the depths at which the grout will be injected, the sequence of grouting holes and the pressures for water testing shall all be as determined by the *Engineer*.

Decisions on these matters will depend upon the nature of the rock encountered in the exploratory drilling or in the excavations and the results of the drilling, washing, water testing and grouting trials which shall be carried out by the *Contractor* at the start of the drilling and grouting work. Modifications to the techniques specified in this Specification, the Project Specifications or on the drawings may be required as work proceeds and as knowledge and experience is gained of the natural rock and foundation conditions. The *Contractor* shall alter or vary his operations, if so instructed by the Engineer, to suit such modifications.

In general, the primary holes in the grout curtain will be spaced at 8 m intervals. With the method of split spacing of holes, secondary holes will bring the spacing down to 4 m, followed by tertiary holes bringing the spacing down to 2 m and, if required, quaternary holes bringing the spacing down to 1 m.

Four trial panels, each 16 m long x 12 m deep and incorporating 3 primary holes each shall be



carried out well in advance of the programmed dates for the consolidation and curtain grouting. The same equipment shall be used as for the permanent works. An area large enough to carry out the trial panels shall be designated by the *Engineer*.

Equipment and personnel shall be provided to meet the requirements of the programme with respect to grouting and exploratory work required, which is required to commence early in the Contract period.

The *Contractor* shall not be permitted to proceed with the drilling and grouting of a section of the *works* until a grouting trial has been carried out and the results evaluated by the *Engineer*.

The *Contractor* shall employ an approved specialist Subcontractor to carry out drilling and grouting work unless he can satisfy the *Engineer* that he is experienced in this type of work and possesses the necessary staff and equipment for the proper execution of the work. Drilling shall be performed in a workmanlike manner by competent and experienced operators. The experience and qualifications of the supervisors and operators shall be subject to the prior approval of the *Engineer*. This information shall be submitted at least one month prior to the start of any drilling or grouting. The *Contractor* shall arrange at all times that the drilling and grouting operations are performed under the direct supervision of foremen thoroughly experienced in this type of work and who will be responsible for ensuring that good practice according to the current state of the art is observed.

At least two weeks before work commences, the *Contractor* shall submit to the *Engineer* for his approval full details of the equipment that he proposes to use and his proposed method of carrying out the work. The procedures approved or agreed shall be strictly followed and records shall be accurately kept. The failure of any operator to comply with these requirements shall be sufficient grounds to ban him from carrying out further work.

The *Contractor* shall, as far as practical, programme the work such that drilling of holes and grouting take place at different times or on different shifts to facilitate oral communication during grouting operations. Where this is not possible the *Contractor* shall install a sound absorbent partition between the drilling and grouting operations.

The *Contractor* shall provide for the adequate disposal of all wash water and waste grout resulting from all grouting operations. He shall not allow such water and grout to contaminate any fill, backfill or other Works, and such water or grout shall not be allowed to flow into any watercourse until it has passed through settlement ponds or tanks approved by the *Engineer*.

The *Contractor* shall take all steps necessary to ensure that no pollution is caused as a result of drilling and grouting work. Before work commences, the *Contractor* shall propose methods whereby grout spillage, which occurs as a result of defective equipment, burst pipes or any other reason, shall be handled. These methods shall be subject to the approval of the *Engineer*.

PPS 9.4 GROUT

PPS 9.4.1 Materials

Grout for injection shall consist of a mixture of cement and, where required by the *Engineer*, one or more of the following cement extenders: Fly Ash (FA) or Condensed Silica Fume (CSF). Sand or other additives, including bentonite, shall be used only where directed and in proportions as agreed by the *Engineer* as applicable for the relevant applications.

Where grout is required to fill large cavities the *Contractor* shall obtain the *Engineer's* instructions regarding the possible use of a filler such as sand (see Sub Clause 9.4.1.2). The *Engineer* may require or permit the use of admixtures to control the rate of settings of the grout. The proportions of cementitious material, water and sand and any admixtures used shall be as specified or as directed. No additional payment shall be made for additives unless they have been ordered by the *Engineer*.

Grout that has not been injected within two hours after mixing shall not be used for grouting, and shall be disposed of as directed, and no payment shall be made for any such wasted grout.



Materials for grouting shall comply with the requirements of Section 14 - Concrete and in addition, the following:

PPS 9.4.1.1 Cement (CEM), Fly Ash (FA) and Condensed Silica Fume (CSF)

Cement shall be type CEM I Class 42.5 N (OPC) or CEM I Class 52.5 N (RHC) or Class 42.5 R (RHC) to SANS 50197-1 and passing a 0.090 mm sieve, and not more than 10% shall be retained on a 0.045 mm sieve. The Blaine fineness shall be greater than 440 m²/kg and specific surface > 2500 cm/g. The total alkali content, expressed as the sodium oxide (Na₂O) equivalent, not exceeding 0,6%, where: % Na₂O equivalent = % Na₂O + (0,658 x % K₂O)

Fly Ash and Condensed Silica Fume shall also conform to the requirements of SANS 50197-1.

All cementitious materials shall be obtained from approved sources. Bagged cementitious material shall not be stored for longer than 30 days and shall be delivered in 50 kg paper bags. One 50 kg bag of cementitious material shall be taken as being equivalent to 37,5 litres.

Separate storage facilities shall be provided on the Site for each type of cementitious material used. During transportation, storage and at the place of the grouting activity, all bagged cementitious materials shall be kept covered to provide proper protection against moisture and other factors that may promote deterioration of the materials. Sheds for the storage of bagged cementitious materials shall be dry, well ventilated, weatherproof and watertight. The bags shall not be stored or placed in contact with the floor or ground.

PPS 9.4.1.2 Sand

The sand shall comply with the requirements of the Section 14 - Concrete; except that all sand shall pass a 2.36 mm sieve and not more than 10 % shall pass a 0.075 mm sieve.

PPS 9.4.1.3 Water

In addition to the requirements of the Section 14 - Concrete, water for grouting shall not contain organic matter in suspension or solution, and shall contain no particles larger than 80 microns. The temperature of the water immediately prior to the preparation of grout shall be in the range of 5° to 35°C.

PPS 9.4.1.4 Bentonite

Bentonite used in bentonite/cement grout shall have a Plasticity Index greater than 400. It shall be supplied from an approved source. Test certificates of the properties of the bentonite supplied shall be made available to the *Engineer* on request. When mixed with water the bentonite shall not contain any particle larger than 75 microns and shall not contain any substance detrimental to the setting and hardening of the bentonite/cement.

The *Contractor's* arrangement for delivery and storage of bentonite shall comply with the requirements of SANS 1200, as amended for the delivery and storage of cement.

The *Contractor* shall store at the site of the *works* sufficient bentonite to satisfy grouting requirements for at least ten days.

The bentonite/water slurry base shall be prepared in advance using cement-free water in a high turbulence (colloidal) mixer and kept agitated in a large container for at least 24 hours. Mixers used for grout shall not be permitted to mix the bentonite/water slurry.

PPS 9.4.1.5 Admixtures

Admixtures used shall comply with ASTM C-494, AASHTO M-154 or BS 5075. Admixtures, such as plasticisers, accelerators and retarders, may be used only with the approval of the *Engineer*. In support of the request for the use of an additive the *Contractor* shall submit the results of relevant laboratory tests demonstrating the effectiveness and advantages of the product. Products whose chemical composition is not made known to the *Engineer* will not be approved for use in grout.



PPS 9.4.2 Testing

The *Contractor* shall provide acceptable Marsh flow cones, thermometers, mud balance and measuring cylinders (60 mm diameter) to enable the *Engineer* to check the consistency of the grout at any time. The applicable limits shall be jointly established by laboratory and field tests prior to work commencing.

PPS 9.4.2.1 Density (Mud Balance)

Determination of the relative density of freshly mixed grout shall be with a mud-balance. Readings of relative density taken directly from the calibrated beam shall be converted to a water cement ratio by means of an agreed curve or table.

PPS 9.4.2.2 Viscosity (Marsh Cone)

The fluidity of grout shall be measured with a flow cone, immersion apparatus or viscometer. The instrument shall be accurately calibrated in a laboratory so that the specified viscosity of the grout can be controlled satisfactorily.

The procedure for conducting the flow-cone test for measuring the fluidity of grout shall be as follows: The type of flow cone shall be subject to the approval of the *Engineer*.

Immediately after the grout has been mixed, the pre-wetted flow cone, which is held firmly with its top rim in a level position, shall be filled with grout to the level indicated by the pre-set pointer, whilst the bottom orifice is held closed with a finger.

As soon as the required volume of grout, ($\pm 1\,750\text{ ml}$), is reached, the finger shall be released to allow the grout to flow out freely through the bottom orifice. A stop watch shall be used to determine the flow time for emptying the cone, to the nearest second.

The readings obtained during grouting shall be compared with the times determined in the laboratory for grouts of the specified viscosities.

PPS 9.4.2.3 Bleeding

The bleeding of grout shall be measured in a metal or glass container with an internal diameter of approximately 100 mm and a height of approximately 120 mm. The grout and water levels in the container shall be controlled with a metal bridge into which two adjustable studs A and B are secured. The procedure for determining the bleeding of grout shall be as follows:

Studs A and B in the metal bridge shall be adjusted and locked so that the distance from the lower tips of the studs to the bottom of the container will be approximately 100 mm and 107 mm respectively. The volumes V_A and V_B for the container at the respective levels of the stud settings shall then be determined to the nearest millilitre.

The container shall be filled with freshly mixed grout to a level where the grout will just touch the tip of stud A which points downwards. The bridge shall then be removed and the container tightly sealed to prevent evaporation. The container shall then be stored at 20°C and kept free from vibrations for the entire duration of the test.

Three hours after the grout has been mixed, the container shall be opened and the free (bleed) water poured off. The bridge shall be placed over the container with the tip of stud B pointing downwards and water poured onto the grout with a measuring apparatus until the water level touches the tip of stud B. The volume of water added shall be determined to the nearest millilitre and designated as ΔV .

The percentage of bleeding shall be calculated from the formula.

$$100 - \left\{ \frac{(V_B - \Delta V)}{V_A} \right\} \times 100$$



PPS 9.4.2.4 Test Cubes

For grout in production at each grout mixing station for use in the Works, samples of grout shall be taken by the *Contractor* at the point of mixing or of deposition as instructed by the *Engineer* and in the presence of a representative of the *Engineer*, all in accordance with the sampling procedures described in SANS 5862.

Samples shall be taken on the basis of one for each 20 m³ of grout pumped but in any case not less than one sample per day per mixing station.

The *Contractor* shall cast from each sample, cure and test six test cubes as set out in SANS 5863. Three cubes shall be tested at 7 days and 3 at 28 days.

The average strength of the 3 cubes crushed shall be referred to as one test result.

Grout shall be deemed to comply with the strength specified if the average strength of any 4 consecutive test results exceeds the agreed characteristic strength by 2 MPa and the strength of any test result is not less than the specified characteristic strength minus 3 MPa.

The quantity of grout represented by any group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches. When a test result fails to comply only the particular batch from which the sample was taken shall be deemed to fail to comply.

The *Contractor's* methods of sampling, making of cubes and testing shall not be considered as a valid reason for rejecting the results of such tests on grout placed in the Works. Should test results fail the remedial measures referred to in SC 14.14.3 shall apply.

PPS 9.4.3 Mix

The grout mix is specified as the ratio of water to cementitious material by mass. In principle a single grout mix shall be used for the grout curtain irrespective of depth of hole and location. However, the *Engineer* may require a thicker mix for use in zones of high take and a thinner mix for special cases. In case of major absorptions a cement mortar mix shall be used. The *Contractor* may, however, propose an admixture to render the grout thixotropic instead of using sand.

The appropriate grout mix shall be determined on the basis of grout tests prior to the commencement of the trial panels.

In carrying out the laboratory tests the mixing equipment to be used on the grouting works shall be used. Bentonite slurry shall be prepared in accordance with Sub Clause 9.4.1.4.

Any grout which does not contain a retarder and has not been used within one hour of the time of mixing shall be discarded and disposed of in a manner approved by the *Engineer*.

Initially, grout tests shall be carried out on mixes with water/cement (W:C) ratios of 0.8:1, 1:1, 0.6:1 and 0.4:1, aiming to provide stable mixes with less than 5% settlement at 2 hours and Marsh Cone values of about 35 seconds. Admixtures may be used to reduce Marsh Cone values and compressive strengths at 28 days shall be greater than 25 MPa on 50 x 50 x 50 mm cubes cured under water. One set of cubes shall be tested per day until consistency of results allows testing intervals to be increased.

All grout shall be mixed in a high speed colloidal mixer for at least 1½ minutes from the time the last constituent is added to the mixer.

During grouting operations the following routine tests shall be performed at the collar of the hole as directed by the *Engineer*.

Density	-	Mud balance test
Viscosity	-	Marsh Cone
Bleeding	-	60 mm diameter measuring cylinder



The *Contractor* shall make arrangements for a location close to the hole being grouted where the bleeding test will not be disturbed.

PPS 9.5 EQUIPMENT

PPS 9.5.1 General

The *Contractor* shall provide sufficient drilling and grouting equipment and all necessary ancillary equipment, scaffolding and other accessories to complete the various types of drilling and grouting required. Such equipment shall be of types and capacities approved by the *Engineer* and shall be maintained in first class operating condition at all times.

Where equipment is air driven the *Contractor* shall provide sufficient compressors such that all equipment in use can operate together at the necessary pressure. The use of internal combustion engines for grouting in tunnels and galleries will not be permitted.

Equipment shall be suitable for operation on surface as well as in underground locations and galleries.

Equipment and other items required for drilling and grouting shall be transported along the tunnels or galleries in such a manner to ensure no damage is caused to the finished surfaces of concrete.

The *Contractor* shall not use any drilling and grouting equipment of which full details have not been submitted to the *Engineer* and approved before any drilling or grouting is started. Details shall be submitted at least one month prior to the start of the drilling and grouting activities.

PPS 9.5.2 Drilling Equipment

PPS 9.5.2.1 General

Drilling of grout holes shall be undertaken with water flushed through hollow drill rods. Either pneumatic percussion drilling or rotary type diamond drilling may be used. Tungsten carbide tips or other types may be used with the approval of the *Engineer*. The hole diameter shall be 40 mm at the point of maximum penetration.

The *Contractor* shall provide equipment capable of accurately measuring (to within one degree) the slope and direction of holes and where required the orientation of the core.

If necessary, a stable platform from which to drill shall be provided as part of the temporary works.

PPS 9.5.2.2 Percussion Drills

Percussion drills shall be capable of drilling 50 mm diameter holes for curtain (if authorised by the *Engineer* after test drilling in the grouting trial panels referred to in Sub Clause 9.3) and consolidation grout holes in the dam foundations and to depths of up to 30 m in the case of curtain grouting or such greater depth as shown on the Drawings. For other types of grouting, holes at least 38 mm diameter up to 10 m in length will be required. Such drills shall be provided with a water supply at a minimum pressure of 8 bar at the drill, when all equipment on the same supply is operating together.

PPS 9.5.2.3 Rotary Core Drills

Rotary core drills and associated equipment shall be capable of producing minimum diameter NX series cores from holes drilled in any direction. Drills shall be equipped with hydraulic feed control and double tube core barrels. The equipment shall be capable of drilling and recovering cores to a depth of 50 m.

Rotary core drilling with diamond crowns and swivel type bottom discharge triple tube core barrels for exploratory holes where core recovery will be the primary requirement. The use of split inner barrels or plastic liners for inner barrels shall be adopted where suitable to aid sample recovery.



The rigs shall be equipped with measuring devices capable of automatically measuring and recording drilling parameters such as drilling speed, bit pressure and fluid flow.

PPS 9.5.2.4 Rotary Drills for Cutting Steel

Rotary drills with diamond tipped coring bits of the same diameters as the grout holes shall be available to penetrate any reinforcement which cannot be avoided by sleeved holes.

PPS 9.5.2.5 Standpipes and Casings

Standpipes and casings shall have an internal diameter suitable for the use of packers and the required drill bits.

Casings shall be either solid or perforated and of mild steel, or suitable plastic material. Casings used to support the sides of holes in caving ground shall be mild steel flush screw jointed tubes complying with BS 1387. Plastic casings shall be of a quality and thickness sufficient to resist collapse by earth pressure or self-weight and shall not be subject to cold flow. A minimum pressure class of 1000kPa is required.

Where perforated casing pipes are used they shall have 10 mm diameter drain holes or slots (10 mm x 25 mm), constituting about 10% of the area of the pipe walls.

PPS 9.5.2.6 Storage of Cores and Core Boxes

All core recovered from all boreholes shall be retained and carefully, neatly and securely packed in the correct sequence in approved core boxes, the design of which is given in Figure 9.1 in Appendix D, so as to produce a faithful record of the formation drilled. No core box shall contain core of more than one hole. The borehole number, depths of core and the box shall be marked clearly, neatly and indelibly on boxes as specified in Figure 9.3 in Appendix D.

Core boxes shall be of robust wooden or steel construction to withstand the weight of core and any full boxes which may subsequently be placed upon them and also sufficiently watertight to protect the core from rain on Site or in transit. They shall be made to hold the particular size of core tightly in place in rows separated by securely fitted partitions. Core box lids shall be kept securely fastened to the boxes at all times except when inspected. A sample core box shall be submitted to the *Engineer* for approval prior to manufacture or placing of orders.

Where instructed by the *Engineer*, cores shall be sealed to retain the natural moisture content, by wrapping tightly in thin self-adhesive polythene film (cling wrap) immediately on removal of the sample from the core barrel, followed by wrapping in aluminium foil and completely coating the sample in a layer of wax at least 5 mm thick. The application of the wax shall take place as soon as possible after initial wrapping. During the intervening period the core shall be kept covered with damp sacking and protected from damage.

Core shall be laid in the boxes in correct sequence clearly marked with wooden spacers, giving the depth at any points of interest and marking all points of core loss.

Each sample shall be clearly labelled and an identification sheet shall be wrapped around the sample under the aluminium foil.

The samples and boxes shall be carefully handled to prevent damage and shall be delivered to the *Employer's* core shed.

PPS 9.5.2.7 Photographs of Cores

Before the cores are sampled and as soon as possible after cores have been correctly packed in the core boxes and marked up, the *Contractor* shall photograph the core boxes in colour.

Each photograph will usually show two consecutive core boxes (1-2, 3-4, etc.), both from the same borehole. The core boxes shall be arranged so that all details of the core and markings inside the core box will be clearly visible and easily readable in the photograph, which shall also include colour charts, a linear scale and a title board (Figure 9.2 in Appendix D). To facilitate the clarity, the cores



shall be wetted just before being photographed. The *Contractor* shall submit the photographs in digital format with the information being provided on CD as well as the two colour prints to the *Engineer*.

PPS 9.5.3 Grouting Equipment

PPS 9.5.3.1 General

Grouting equipment shall be capable of effectively batching (with an accuracy of better than 2% for batching by volume or mass), and producing a colloidal mix as specified, and of delivering and pumping grout into the grout holes through grout connections in a continuous uninterrupted flow at any constant pressure up to the limiting pressure specified. Where required, equipment shall be protected against direct sunlight.

The arrangement of the grouting equipment shall be such as to provide a continuous circulation of grout of uniform consistency throughout the grouting system and to permit accurate pressure control at the collar of the hole being grouted at all rates of grout approval. Pressure gauges and valves shall be supplied at the pump, at each hole being grouted, and elsewhere as required to ensure the necessary control of grouting operations. In the case of all grouting activities automatic pressure/time and flow/time and total volume chart recorders shall be connected at the collar of each hole being grouted unless otherwise agreed by the *Engineer*. A new chart shall be used for each hole injected. All grouting circuits shall be so designed as to provide a return line from the site of injection to the holding tank such that a continuous flow of grout is maintained in the delivery line between the grout pump and the collar of the hole being injected.

Computerised systems (Lutin supplied by Lutz or similar approved) may be used for measurements, but these shall be of a robust design capable of operating under all conditions that will exist during grouting operations. One such system is required per injection point with one spare.

All equipment shall be satisfactorily maintained to ensure continuous and efficient performance during all grouting and water testing operations.

Grouting equipment shall be to the following minimum requirements and shall include all associated valves, water flow meters, pressure hoses, pipes, sleeves, casings, packers, fittings and small tools necessary to complete the grouting as specified.

PPS 9.5.3.2 Pumps

Grouting pumps shall be double acting reciprocating, with pressure damping cylinder, positive displacement screw-feed or other type of pump approved by the *Engineer*. Grout pumps for fissure, curtain, cover, cut-off and consolidation grouting shall be capable of injecting grout continuously at a rate of up to 100 litres per minute at pressures between 100 kPa and 1000 kPa (both maxima to be achievable simultaneously). The grout pumps for grouting construction joints and underneath equipment shall be capable of grouting at pressures between 1 kPa and 50 kPa.

The rate of pumping shall be readily and accurately adjustable from zero flow to the maximum capacity. Equipment shall be such that grout consistency can be adjusted without causing an interruption that could result in setting of grout before pumping is resumed.

Pumps shall be equipped with quick acting lubricating plug valves and accurate pressure gauges, reading in bars. Pumps shall be fitted with automatic pressure relief valves unless otherwise agreed by the *Engineer*.

Grout pumps shall be capable of pumping grout at a water:cement ratio of up to 1:3 as well as grout containing other materials such as bentonite, sand or other chemicals.

PPS 9.5.3.3 Mixers

Grout mixers shall be of the high speed colloidal type, with a minimum of 1200 rpm, designed primarily for mixing grout materials, including grout to which sand or additives have been added if required, and of sufficient capacity to ensure that the pumps are supplied with a continuous flow of



thoroughly mixed grout.

PPS 9.5.3.4 Tanks

Tanks for holding grout between mixing and grout injections shall be of the double drum type equipped with mechanical agitators capable of maintaining the solids of the grout in suspension. The feed into the tanks shall be equipped with adequately sized screens to remove any hardened grout or foreign material larger than 1 mm from grout entering the tanks from the mixers and from the grout return lines. The capacity of the holding tanks shall not be less than that of the grout mixer and the tanks shall be fitted with a graduated dip-stick or gauge glass which is capable of recording the volume of grout contained in the tank to within 1 litres.

Constituent materials of the grout shall not segregate during transportation.

PPS 9.5.3.5 Water Meters

Meters for the measurement of water to be used in grout mixes shall be large faced with adjustable volume markers graduated to read to an accuracy of one tenth of a litre at all rates of flow.

PPS 9.5.3.6 Flow Meters

Refer to Sub Clause 9.5.3.1.

PPS 9.5.3.7 Pressure Gauges

Pressure gauges shall be calibrated to read in kPa and have minimum divisions of 10kPa. They shall be equipped with devices which will protect the mechanism of the gauge from being damaged by grout. The gauges shall have a range of approximately twice the expected maximum pressure for the particular hole and shall have an accuracy of $\pm 3\%$.

Gauges shall be provided at the grout pump and at the point of injection.

The *Contractor* shall have an accurately calibrated high-precision master pressure gauge for checking the accuracy of all pressure gauges used in the grouting system. A pressure gauge certified by an approved certification body for calibration of working gauges and a 100% replacement stock of working gauges shall be on hand at all times. Working gauges shall not be used for longer than two shifts, hereafter they shall be cleaned and calibrated. All working gauges shall be marked with a number for identification.

Packers shall be suitable for all pressures and rock conditions, and shall be subject to approval. Mechanically expanded packers may be used at the top of the hole (for downstage grouting) but pneumatic or hydraulic packers shall be used where the hole has to be sealed at depth.

PPS 9.5.3.8 Chart Recorders

Refer to Sub Clause 9.5.3.1.

PPS 9.5.3.9 Packers

Packers shall consist of pneumatic or hydraulic expandable tubes which can be set singly in a grout hole at any depth required. Packers shall be so designed that they can be expanded to seal the holes at the specified depths and that when expanded they shall be capable of withstanding without leakage, water pressures equal to the maximum grout pressures which they will have to withstand.

The *Contractor* shall also have double packers of the pneumatic or hydraulic type at least 1 m in length available for use when required by the *Engineer*.

PPS 9.5.3.10 Connections to Embedded Steel

In areas where concrete is faced with steel and contact grouting is to be carried out, sleeves will be required to screw into the grout holes provided in the steel into which packers can be installed or to which grout connections can be attached. The length of thread on the sleeves shall be limited to



prevent the sleeves being excessively screwed into the holes and blocking the steel/concrete interface. An adequate stock of sleeves shall be made available to enable grout to be injected behind the steel plate, the valves closed off and the pressure maintained in the grout until the initial set has taken place.

PPS 9.5.3.11 Sleeve Pipes

In areas where grouting is to be carried out through concrete, PVC sleeves will be required through which drilling can be undertaken and into which packers can be installed or to which grout connections can be made.

PPS 9.5.3.12 Grouting Delivery Lines

All grout pipes, hoses and fittings shall be capable of withstanding a pressure of 1000kPa and shall be protected from damage or breakage by vehicles, plant, blasting operations, freezing and the like. A return line shall be provided for flushing hoses, to control the rate of pumping and for emergency pressure relief. These shall be connected to the pump side of the recorder gauges at the collar of the grout hole and shall discharge into the holding tanks or to waste containers only. The *Contractor* will not be permitted to discharge grout without such collectors.

The length of grouting hose from the grout pumps to the hole to be grouted shall not exceed 100 m.

PPS 9.5.3.13 Water pressure testing equipment

The *Contractor* shall provide suitable pumps for water pressure testing which shall be capable of delivering at least 100 litres of water per minute against the specified maximum pressure. The pump shall be provided with equipment that allows for the measurement of the rate of flow into the hole to an accuracy of $\pm 2\%$ for flows exceeding 0,5 litres/min. The rate of pumping shall be readily and accurately adjustable from zero flow to the maximum capacity. Pumps shall be equipped with quick acting lubricating plug valves and accurate pressure gauges, reading in bars. Pumps shall be fitted with automatic pressure relief valves unless otherwise agreed by the *Engineer*.

PPS 9.5.3.14 Standby Equipment

During all grouting operations, the *Contractor* shall have available at all times 100% standby equipment of all types to ensure that grouting operations can be continued without significant interruptions caused by breakdowns of equipment. Circuits shall be provided such that standby pumps can be brought into operation within 10 minutes.

PPS 9.5.4 Flushing Equipment

Flushing equipment shall comprise separate pumps, gauges, hoses, nozzels, etc other than that used for flushing and water pressure testing at grout holes. The equipment shall be suitable to pump water into designated locations in structures which require a continuous flow of water to intercept and prevent injected grout from solidifying in unwanted locations.

Pumps shall be capable of delivering at least 300 litres of water per minute against a maximum pressure of 3 bar at the location of injection. The pumps shall be provided with equipment that allows for the measurement of the rate of flow into the hole to an accuracy of $\pm 3\%$ for flows exceeding 10 litres/min. The rate of pumping shall be readily and accurately adjustable from zero flow to the maximum capacity. Pumps shall be equipped with quick acting lubricating plug valves and accurate pressure gauges, reading in bars. Pumps shall be fitted with automatic pressure relief valves unless otherwise agreed by the *Engineer*. Unless suitable storage with intermediate pumping is provided above the crest level of the dam, pumps will be located on barges on the impoundment.

Hoses, nozzles, couplings, etc shall be connected to holes in the concrete faces of structures and shall be capable of withstanding the maximum pressures listed above without dislodgement.

PPS 9.5.5 Displacement gauges

Displacement gauges shall be provided to enable any rock movement during grouting to be measured. A displacement gauge may consist of a screw-adjusted spirit level on a steel straight



edge 2 m long, or other approved device. Displacement gauges shall be required to monitor movement of adjacent blocks during grouting of joints in a concrete wall.

PPS 9.5.6 Communication during Grouting Operations

Where the various individual elements of the plant are located in such positions that communication by normal voice between the hole being injected and the plant is not satisfactory the *Contractor* shall install an effective means of clear oral communication such as a telephone or radio system to the satisfaction of the *Engineer*. If approved communication systems are not available the *Engineer* will stop the work until such system of communication is effected.

PPS 9.6 DRILLING PROCEDURES

PPS 9.6.1 General

The position, direction, inclination, spacing, depth, order and timing of drilling holes for exploratory drilling, drain holes or grouting, shall be as shown on the Drawings or as directed by the *Engineer*. The holes shall be drilled straight in the required direction and inclination, and the length of holes shall be established by reference to the collar level and profiles recorded by the *Contractor* or *Engineer*.

Unless otherwise required, holes shall be started within 250 mm of the specified position or plan or section and shall be drilled in the direction specified within a tolerance of 2% of the length of the hole. The holes shall be drilled to within 0.3m of the specified depth. No hole shall be deepened or drilled within 5 m of freshly grouted holes until the *Engineer* is satisfied that the grout in the rock adjacent to the hole has set sufficiently to prevent it being washed into the hole.

Holes shall be drilled wet and a constant flow of return water, sufficient to ensure that all drill grindings and sludge are completely washed out, shall be maintained at all times. Except where approved by the *Engineer*, the *Contractor* will not be permitted to use rod lubricants or other additives to the drilling water as an aid to drilling or stabilising the holes.

Where packers are to be used in any hole for grouting or water testing, the *Contractor* shall take every precaution to maintain a smooth wall in the hole in order that packers can be set at any location required by the *Engineer*.

No blasting shall be permitted within a radius of 100 metres from completed grout holes.

PPS 9.6.2 Holes through Concrete

Where holes are required through concrete, the *Contractor* will be permitted either to drill the holes or where indicated on Drawings or as instructed by the *Engineer* shall embed PVC sleeves in the concrete through which the rock behind can be drilled.

No drilling shall be carried out in concrete less than 7 days old.

In the case of reinforced linings, the formwork shall be marked by means of plugs or in some other way approved by the *Engineer* to indicate positions where drilling may be carried out without obstruction by reinforcement.

Should steel reinforcement be encountered during the drilling of any hole in concrete, where required by the *Engineer*, drilling shall be discontinued immediately and a new hole shall be drilled alongside. Such discontinued holes shall be stemmed as specified in Sub Clause 9.11. Where it is approved to drill holes through reinforcement, (such as quaternary curtain grout holes and inclined check holes), rates for drilling through concrete shall include the possibility of drilling through reinforcement. Sleeves left in the structure not used for drilling holes shall be stemmed.

PPS 9.6.3 Rotary Core Drilling for Grout Curtain, Piezometers and Exploratory Work

Rotary core drilling is a hole drilled by means of a diamond or a tungsten tipped bit using a double tube or triple tube core barrel from which 100% core recovery is expected. The hole diameter shall be 76 mm (N size) for curtain grouting and exploration work and not less than 102 mm for



piezometer holes.

Unless otherwise instructed by the *Engineer*, every 4th primary hole in the grout curtain shall be cored and comprehensively water tested. All other grout curtain holes shall be rotary drilled (non-cored) holes unless percussion drilling of these holes is permitted in terms of Sub Clause 9.6.5. Grout curtain holes shall be 50 mm diameter or other similar diameter to suit the diameter of the packer to be used.

Drilling for grout curtain holes shall be carried out with water circulation. If water loss is experienced, drilling shall cease and the hole shall be grouted to refusal, irrespective of depth reached, before resuming the drilling operation.

Where support to the sides of the hole is necessary the *Contractor* shall supply and install drillhole casing to a depth approved by the *Engineer*. The casing shall be of sufficient diameter to permit a drillhole of the specified size to be drilled within it.

Unless otherwise directed, drilling fluids other than water may be used, with the approval of the *Engineer*, to improve core recovery and/or to prevent caving-in of drillholes. The additives mixed with water shall be degradable with time. The consistency and properties of the drilling fluid shall be such that it does not effect the samples of cores recovered, render them unacceptable for testing, prevent the accurate description of the profile of the material and does not adversely affect any tests carried out in the drillhole. Bentonite mud shall not be used.

Where approved by the *Engineer* a weak or caving hole may be stabilized by grouting up the hole with cement grout. Stabilisation of a hole by means of inserting reduced size casing, and thereafter continuing the drilling in a reduced size, will only be permitted in exceptional cases where the *Engineer* considers that no other means of stabilisation is practical.

Where required by the *Engineer*, drilled holes shall be protected from being clogged or otherwise damaged by fitting a cap, plug or other suitable device to the collar of the hole.

All curtain grout holes shall be drilled in stages as specified up to a depth as shown on the Drawings or directed by the *Engineer*.

Curtain holes shall be tested for deviation from the vertical or from the direction otherwise specified as directed by the *Engineer*. The *Contractor* shall propose the method for doing this.

Inclined check holes (cored if necessary) will be required to be drilled on the grout curtain, water tested and grouted as directed by the *Engineer*.

Piezometer holes shall be rotary core drilled from the surface for the installation of piezometers in locations as shown on the Drawings or directed by the *Engineer*. The holes shall be vertical, up to 40 m deep and shall be a minimum diameter of 102 mm unless otherwise instructed. Casing will be required for some of these holes.

PPS 9.6.4 Core Recovery and Storage

Where core recovery is ordered or scheduled, the drill string shall be pulled and the core removed as often as necessary to secure the maximum possible length of intact core. The core shall be removed from the core barrel by a method designed to produce minimal disturbance to the core. Extraction under steady carefully applied pressure, the use of split inner barrels or other method approved by the *Engineer* shall be used. The cores shall not be extracted by hammering the barrel or by extrusion under high air or water pressure.

On removal of the core barrel, the cores shall be placed directly into core boxes in correct sequence. Very broken core shall be contained in a transparent plastic sheath, if ordered by the *Engineer*.

Each core box shall be clearly marked with the site name, the borehole number and numbered in sequence for each borehole. No core box shall contain the cores of more than one hole. Wooden spacers shall be provided giving the depth at the end of every "draw". The length of the core



recovered will not be taken as a measure of the depth of the borehole, but this shall be determined by measuring the total length of equipment (core barrel and drill rods) in the hole and subtracting the length of drill rod protruding from the borehole.

Special care shall be taken during the course of drilling to locate geological contacts, zones of weakness, open fissures, cavities and loss of drilling fluid, and the depth at which they occur shall be clearly marked.

The cores shall be kept at the hole during drilling, and the *Contractor* shall ensure that they are protected from the weather and not disturbed. On completion of the drilling of the holes, the *Engineer* may require the cores in their core boxes to be transported to the designated storage shed and stored in an overlay sequence.

Before the core boxes are stacked, they shall be made available to be photographed.

PPS 9.6.5 Percussion Drilling

Percussion drilling may be used for consolidation grout holes and anchor bars, dowels and rock bolts as and where directed by the *Engineer*.

Percussion drilling of grout curtain holes will only be permitted by the *Engineer* if it is proved in trial panels that such drilling produces clean circular holes where packers can be effectively used and it is economical to do so.

Percussion holes shall be flushed clean in terms of Sub Clause 9.6.7.

All holes shall be drilled within the specified tolerances.

PPS 9.6.6 Drainage Holes

Unless otherwise directed, drain or pressure relief holes shall be drilled by percussion drilling and flushed clean. The holes shall be drilled to the diameter and in the direction, inclination and location as indicated in the Drawings or directed by the *Engineer*.

Drainage holes shall not be drilled until all grouting required within the vicinity i.e. within a radius of 50 m of such a drainage hole has been completed to the satisfaction of the *Engineer*.

Drainage holes through concrete and rock shall be lined with an approved slotted PVC sleeve where shown on the Drawings or directed by the *Engineer*. Where drainage holes pass through materials of such a nature that there is a possibility of the holes caving in, the *Contractor* shall obtain the *Engineer's* instructions regarding casing the hole.

On completion of the hole, it shall be suitably sealed off to prevent the ingress of any undesirable material. All threads shall be suitably greased before the fitting of hollow plugs or caps.

PPS 9.6.7 Washing, Protection and Identification

When drilling of a grout, check, drain or exploratory hole has been completed to its final depth or to the bottom of a stage, the hole shall be washed with high pressure water to remove all drill cuttings, sediments, sludge and other loose or foreign materials until the return water is clear, and all downward holes shall be left filled with water to the surface, or to such level as the water will stand.

Each grout, check and exploratory hole shall be protected from becoming clogged or obstructed until it is grouted and, where a grout pipe or standpipe is permanently embedded in rock or concrete, the *Contractor* shall provide a suitable cap to keep the hole sealed. Whether or not a grout pipe or standpipe is used, any hole which becomes obstructed before being grouted shall be cleared or re-drilled to the satisfaction of the *Engineer* without any additional payment.

Each grout, check and exploratory hole shall be numbered as required by the *Engineer* to permit identification of each hole at all times until grouting and checking has been completed in the area.



Drain holes shall be protected against the ingress of dirt until a piezometer or other suitable protective device has been installed.

PPS 9.6.8 Standpipes

Where required by the *Engineer* or where conditions dictate, grout holes shall be provided with standpipes or grout nipples at the head of the hole which shall project approximately 150 mm above the rock or concrete surface and shall be bonded firmly into the surface for a length of not less than 500 mm. The bore of the standpipes shall be adequate to accommodate the size of drilling bits required.

All standpipes shall be cleaned thoroughly of all dirt, grease, grout and mortar before being embedded in the concrete or rock.

PPS 9.6.9 Casings

Where the rock surface is buried beneath an embankment or other materials requiring support, grout casings shall be provided, as directed or approved by the *Engineer*, for the full depth of embankment material penetrated.

On completion of drilling of the hole and with the *Engineer's* permission, the *Contractor* may salvage the casing, provided that the capping gives proper protection to the hole. The *Engineer* may, however, order the casing to remain and the hole to be capped. The *Contractor* shall ensure that casings are of a suitable size and are inserted in such a manner that they can be removed.

PPS 9.6.10 Grout caps

Concrete grout caps shall be used when the surface from which the hole is started comprises soft and weathered material which, in the opinion of the *Engineer*, is unsuitable for the standpipe to be bonded into. Except in the case of holes under water, immediately on completion of the drilling and, where required, water pressure testing of the hole, the hole shall be fitted with a casing of length at least 1 metre and extending 200 mm out of the hole. The casing shall be fitted with a screwed cap, and embedded in a 500 mm x 500 mm x 100 mm deep concrete block marked with the borehole number (or as otherwise ordered).

PPS 9.6.11 Loss of Holes

If jamming of a hole or other cause makes continuation of the drilling impossible the *Contractor* shall immediately inform the *Engineer* and request instructions for siting of a substitute hole or otherwise. If the *Engineer* considers the desired purpose of the hole has been achieved no substitute hole will be necessary.

Should any hole become clogged before its intended purpose has been fulfilled and cannot be cleared to the satisfaction of the *Engineer*, it shall be replaced at the *Contractor's* expense.

Lost holes shall be washed out and grouted.

PPS 9.7 WATER PRESSURE TESTING

PPS 9.7.1 General

Water pressure testing of holes for all types of grouting shall be carried out by using the grouting equipment or alternatively, water may be connected directly to the holes provided that suitable water meters, pressure gauges and equipment are provided to control the pressure.

In conjunction with the drilling and grouting operations, the *Contractor* shall make water tests in grout holes and check holes at any time and at such depths as are required by the *Engineer* to determine the permeability of the rock and the effectiveness of the grouting operations. The *Contractor* shall set packers in the drill holes at locations determined by the *Engineer*, supply all necessary equipment, gauges etc., inject water at pressures determined by the *Engineer* and record the rate of water acceptance.



Unless otherwise directed by the *Engineer* abbreviated water tests shall be conducted in designated holes immediately before grouting. Abbreviated water tests shall be conducted in grout holes in each stage above the water table to wet up the surrounding rock.

Similarly, all cored grout holes shall have a comprehensive water test per stage drilled. The *Engineer* may, at his discretion, instruct comprehensive water tests on other types of holes.

The duration and number of tests may be varied by the *Engineer* to suit particular ground conditions.

PPS 9.7.2 Abbreviated Water Pressure Test

Water shall be pumped into the hole until the pressure rises to the water test pressure specified by the *Engineer*. The pressure shall be maintained constant for five minutes and the rate of flow shall be measured and recorded at 1 minute intervals. If the leakage is too great to enable the required pressure to be attained then the discharge of the pump shall be maintained constant and the pressure recorded at 1 minute intervals.

PPS 9.7.3 Comprehensive Water Pressure Test

Water shall be pumped into the hole in 5 incremental stages up to the pressure specified by the *Engineer* and then reduced in the same stages to zero pressure. The pressure shall be maintained constant for 5 minutes at the end of each pressure increment or decrement and the rate of flow shall be measured and recorded at 1 minute intervals. The pressure at which flow commences on the incremental stage and the pressure at which flow stops on the decremental stage are to be carefully observed and recorded.

PPS 9.8 GROUTING METHODS

PPS 9.8.1 Grouting Procedures

PPS 9.8.1.1 General

The *Contractor* shall continuously supervise grouting operations and measure and regulate the pressures so that they are at all times in accordance with the *Engineer's* requirements. The *Contractor* shall be entirely responsible for any damage resulting from errors that he may make in performing grouting operations. All blanket grouting operations shall be performed in the presence of the *Engineer* or his duly authorised representative.

Grouting will generally be undertaken with a stable mix to be determined in the laboratory. (See Sub Clause 9.4.1).

Careful control of pressures will be required during grouting and water pressure testing as excessive local pressures could crack or buckle the concrete or steel liners or hydrofracture the rock. Pressure chart recorders shall be used during all such injections. Pressures shall be limited to those shown on the Drawings or agreed with the *Engineer* for individual sections of the Permanent works and different grouting procedures. At no time shall grout from any one pump be injected into more than one hole at a time.

Equipment for mixing, holding and pumping the grout shall be maintained as close as possible to the area being grouted and all pipelines and hoses between such equipment and the area being grouted shall be protected wherever necessary to reduce temperature build-up in the lines and the grout.

Grouting of any drill hole within 20 m of a concrete structure or which extends through concrete shall not start until the foundation concrete in the structure is at least 14 days old.

Stage lengths shall be as directed or approved by the *Engineer* and generally not greater than 5 m. Lesser stage lengths may be required near concrete structures.



In the event of drilling water ceasing to return (total or partial water loss), drilling shall be interrupted, the packer placed one metre above the leak and the hole grouted irrespective of depth reached, and drilling resumed.

During grouting the *Contractor* shall take every precaution to prevent the grouting equipment and lines from becoming blocked. He shall accordingly continuously circulate the grout and periodically flush the system with water.

After grouting each stage, the hole shall be cleared of grout by washing or re-drilling as soon as the grout in the rock adjacent to the hole has set sufficiently to prevent it being washed into the hole. Any re-drilling required to clear the grout in a stage of the hole completed prior to testing or re-grouting shall be performed by the *Contractor* to the satisfaction of the *Engineer* without any additional payment, except where grout has been allowed to set in a stage by direction of the *Engineer*.

If a hole absorbs an abnormal amount of grout, generally more than 250 kg/m of cement or as specified on the Drawings, the *Contractor* shall inform the *Engineer* immediately and the rate of injection shall then be reduced or injection shall be carried out intermittently or such other procedure as may be agreed with the *Engineer* shall be adopted.

When water pressure testing and grouting other than contact grouting is carried out adjacent to embedded steel all ports in the steel shall be kept open to prevent the build up of pressure against the liners.

While grouting is proceeding the *Contractor* shall watch for leakage of grout or other untoward happenings. Grout leaks shall be caulked but if this cannot be achieved and the leaks are excessive, grouting shall be stopped and resumed later when the grout already injected into the leaking fissures has hardened. The *Engineer* may order the establishment of level reference points, upheaval gauges, etc., to be observed as a check against uplift. Any appreciable movement shall be taken as an indication that the grout pressures being used are excessive and they shall be immediately relieved.

During grouting any slight movement of the rockmass or the structure is to be recorded. If any movement should occur, the grouting pressure is to be relieved immediately and the *Engineer* alerted.

The *Contractor's* grouting programme shall be such that there is no risk of permanent drains such as pipe drains, or pressure relief drains being blocked by grout. All grouting works shall be completed in any area before permanent drains or drain holes are constructed.

If the pipework or any other part of a drainage system becomes blocked by grout the whole system shall immediately be flushed out with clean water and all grout removed before injection is recommenced.

The temperature of the grout during mixing and grouting shall not exceed 30°C or be lower than 10°C.

In general no holes shall be left open whilst other holes in the vicinity are being grouted. The number of holes to be drilled at any time shall therefore be limited to the number which can be grouted simultaneously with the plant provided. When drilling is interrupted or completed, holes shall be fitted with removable plugs or caps to prevent the ingress of foreign matter. When ordered by the *Engineer* a steel pipe shall be securely grouted or caulked into the hole and shall be protected by a screw cap.

In the event of caving ground being encountered and where, as a result, drilling cannot proceed, the *Engineer* may decide that, as an alternative to the use of casing, such holes shall be grouted with a thick grout to seal and support the hole. The grout shall be left to set and then the hole shall be re-drilled as directed by the *Engineer*. The *Contractor* shall take all measures to ensure that re-drilled holes in set grout do not deviate.



Completed grout holes shall be filled with thick grout as directed by the *Engineer*.

Upon completion of the grouting all concrete, steel or foundation surfaces over which grout has flowed shall be cleaned and restored to their original condition.

Comprehensive records detailing the grouting process and testing are to be maintained throughout. A copy of these records shall be forwarded to the *Engineer* at regular intervals and the *Engineer* is to be kept informed of any changes to the grouting programme and its general progress at all times.

PPS 9.8.1.2 Requirements for Grouting

All grouting operations shall be performed in the presence of the *Engineer*.

Foundation grouting shall not start until the excavations for the foundations at the location of the grouting have been completed as specified nor until the excavation of all foundations within 20 m of the hole have been completed. If for any reason it is necessary to excavate further within 20 m of a hole after the grouting of the hole has started, explosives shall not be used, and the *Engineer* will determine whether or not the hole should be re-grouted and if so, to what extent. The additional grouting will be paid for at scheduled rates, provided that the further excavation was not needed because of the fault or negligence of the *Contractor*.

Grouting shall be undertaken, irrespective of water test results. Repeating a water test after curtain grouting will be unnecessary (unless otherwise directed by the *Engineer*) because water tests undertaken in the inclined check holes across the panels will suffice.

PPS 9.8.1.3 Protection of Embedded Steel

During all grouting around areas of embedded steel, the *Contractor* shall control the grouting pressures with particular care and continuously monitor the internal surface of the steel so that grouting can be stopped at once if any localised pressure causes the steel to deflect.

The *Contractor* shall brush down the steel face to prevent grout spilt on the steel from drying and adhering.

PPS 9.8.1.4 Surface Leaks and Inter-hole Connections

If, during the grouting of any stage, grout is found to flow from nearby grout holes the holes shall be left open until the grout emerging is of the same consistency as the grout being injected whereupon the holes shall be closed and injection continued to completion, provided the pressure in the interconnected holes does not exceed the maximum pressure specified for those holes. Interconnected holes shall also be flushed and water pressure tested to confirm they have been satisfactorily injected.

If, during the grouting of any stage, grout is found to flow from cracks and fissures in the rock surface, such flows or leaks shall be plugged or caulked by the *Contractor* as directed by the *Engineer*. The *Contractor* shall have available on Site at all times sufficient wooden wedges, sacking, lead wool and other materials which can be used to seal surface leaks.

PPS 9.8.2 Curtain Grouting

A grout curtain is to be formed in the foundation rock below the dam and extended beyond the dam extremities as shown on the Drawings. The spacing, diameter and depth of the primary holes shall be as specified on the drawings.

The general method to be adopted will commence with the drilling of one row of primary holes over the full foundation length, as indicated on the Drawings. Every stage of each primary hole shall be grouted regardless of the Lugeon value recorded during water pressure testing of that stage. Secondary holes are to be drilled equidistant between the primary holes and grouted for the pre-stage and each subsequent stage for which the Lugeon value is greater than 3. Should Lugeon values and grout-takes be recorded at any particular location, tertiary grouting shall be required in this area, at points equidistant between the secondary holes, under the direction of the *Engineer*.



Zones where tertiary, quaternary or further series of holes may be necessary will be confirmed by the *Engineer* during the grouting operations on the basis of the preceding grouting records, and as such timeous submission of pressure testing and grouting results is imperative. Holes shall be drilled and grouted only after the adjacent holes of the previous series have been grouted to their full depth.

Grouting of the foundation rockmass will generally be required where water pressure testing reflects a Lugeon value in excess of 3, although all primary holes shall be grouted to full depth, regardless of the Lugeon values recorded.

Drilling of a stage of a subsequent series of holes shall not commence until grouting has been completed one stage ahead of the proposed drilling stage on the previous series of holes. For example, drilling of Stage 2 of a secondary hole shall not commence until grouting of Stage 3 of the primary holes has been completed. This is not applicable when the final stage of a hole of a subsequent series is drilled.

Grout holes shall be flushed to the bottom of the hole with clean water before commencing water pressure testing or grout injection. Flushing shall continue until clean water emerges at the top of the hole. Each stage of each grout hole shall be grouted only after being satisfactorily cleaned and water-tested in accordance with Sub Clause 9.7.

All drill holes for curtain grouting shall be rotary drilled holes as per Sub Clause 9.6.3 unless otherwise directed by the *Engineer* or indicated on the Drawings. Where shown on the drawings, sleeves will be provided in the concrete for such grout holes.

In general, surface packers, seated into solid rock or concrete, shall be used. However, where it is found that grout from lower stages "breaks back" through a previously grouted stage or where there is excessive leakage of grout or where it is found impossible to build up a grout pressure, the *Engineer* may order the *Contractor* to use packers so that only a portion or stage of any hole is grouted separately.

(a) Starting mix and thickening

Grouting shall commence with a cement grout mix of thin consistency (e.g 1.32:1 water:cement) as defined on the drawings, and confirmed in the trial section.

The grout consistency shall be gradually thickened and the injection pressure gradually built up to the required maximum. Should it prove impossible to attain the required pressure with the grout consistency approved, the grout shall be gradually thickened up by adding cement while injection continues at a constant rate until the required maximum pressure is attained.

(b) Completion of grouting

After it has become evident that no further grout take into the hole has occurred during a 15 minute interval, the pressure shall be held for another 15 minutes after which time the packer shall be closed off and left in the hole until wash-out time or for 6 hours from last application of grout in the hole.

Grouting of any hole or stage of a hole shall not be considered complete until the hole or stage refuses to take any grout at the specified maximum pressure for the particular hole or stage of the hole, or until approved by the *Engineer*.

When curtain grouting of a stage is complete, and the grout has taken its initial set, the grout in the hole shall be washed out with a high pressure air and water jet until the wash water runs clear. No further drilling of a hole or stage shall be permitted until at least 24 hours after grouting the previous stage or portion of the stage. Alternatively, the *Engineer* may direct that the grout be left undisturbed for 24 hours and then the hole be re-drilled and washed out. After washing out, the hole shall be drilled a further stage, tested and grouted successively until the specified depth is reached.



(c) Pressures

The injection pressure shall be measured and controlled at the collar of each hole with the return line being used for temporary flushing of hoses and for pressure control.

The actual pressures used for grout injection will vary with the conditions encountered and will be determined during grouting trials as directed by the *Engineer*. Where not indicated on the drawings, a maximum pressure of $(27.d)$ kPa at the top of the hole, where d is the depth of the hole in metres, may be taken as a guide. The pressures shall be as high as practicable but shall be limited so that grout is not wasted by leakage through the rock surface and so as not to cause displacement of rock (hydrofracturing) or concrete and not to cause excessive grout travel. The *Contractor* shall regulate, measure and supervise the grouting operations continuously so that the pressures and volumes of grout injected remain within the limits set and the *Contractor* shall be entirely responsible for any damage which may occur due to errors he may make in grouting operations. Should any movement of the rock or structure be observed during grouting operations, the pressure in the hole shall immediately be released.

The *Contractor* shall, during grouting operations at pressure intervals of at least 50 kPa, take levels from check points to the grouting area to monitor the displacement of rock. Should any uplift be noted the *Contractor* shall immediately reduce the grouting pressure and report the matter to the *Engineer*. The costs of providing uplift check points and reference level points shall be deemed to be covered by the other rates for grouting operations. The *Engineer* shall specify the holes or positions to be monitored.

So as to avoid premature plugging in the event that a rapid build-up of pressure takes place during the thickening process, the grout consistency shall be thinned as may be required or, if necessary, clear water shall be injected.

To achieve the maximum effectiveness of the grouting consistent with economy of materials, the pressure at which grouting is carried out shall generally build up to the maximum permissible pressure and the greater the rate of absorption of grout the lower shall be the grouting pressure. The pressure shall not be permitted to rise towards the maximum until the rate of absorption is reduced.

Automatic pressure relief valves shall be installed in the grouting circuits adjacent to the injection point wherever there is a risk that the grouting pressures used may cause displacement.

(d) Grouting Direction

Curtain grouting shall generally be undertaken with testing done in descending stages and grouting done in ascending stages, except when otherwise instructed by the *Engineer*.

The ascending stage method of grouting shall be performed in successive operations consisting in each case of:

(a) Where water tests are required:

- 1) Drill the hole to the bottom of the first stage to depth, in general, of 5 m or as shown on the drawings, or as directed by the *Engineer*
- 2) Wash out the hole.
- 3) Install the packer into the hole at the top of the stage drilled.
- 4) Carry out a comprehensive or abbreviated water test as applicable, or as directed by the *Engineer*.
- 5) Drill the hole to the bottom of next stage.
- 6) Repeat operations (2) to (5) (generally in stages of 5 m or as directed by the *Engineer*).
- 7) On reaching the bottom of the hole, wash out the hole and place a packer 5 m from the bottom of the hole and grout the stage to refusal at the designated maximum pressure.
- 8) Repeat operation (7) until the packer reaches the collar of the hole.



- (b) Where no water tests are required.
- 1) Drill the hole from collar to the bottom of the hole, stopping when any water loss occurs to grout and stop the water loss before continuing to the bottom.
 - 2) Flush out the hole.
 - 3) Place packer 5 m from the bottom of the hole.
 - 4) Grout the stage to refusal at the designated maximum pressure.
 - 5) Raise the packer to the next stage.
 - 6) Repeat operations (4) to (5) until the packer reaches the collar of the hole.
 - 7) Should the Engineer so direct, water pressure testing (abbreviated or comprehensive) may be done in ascending stages after operation 3.

Should the *Engineer* so direct, the descending methods of grouting and testing shall be performed in successive operations consisting in each case of:

- 1) Drill the hole to the bottom of the first stage to depth, in general, of 5 m, or as shown on the drawings, or as directed by the Engineer.
- 2) Wash out the hole.
- 3) Install a packer into the hole at the top of the stage drilled.
- 4) Carry out an abbreviated or comprehensive water pressure test as applicable, or as directed by the Engineer.
- 5) Grout the hole to refusal at the designated maximum pressure.
- 6) Redrill or flush out the hole once the grout in the rock has stiffened sufficiently not to flow back into the hole and drill the next stage to the same length as under (1)
- 7) Repeat operations (2) to (6) until the hole has reached its final depth and been pressure tested to its final depth if required.
- 8) Backfill the hole with thick grout in accordance with Sub Clause 9.11.
- 9) Where grouting is undertaken below concrete, grout cap or concrete lining, the packer shall be placed in the concrete on the top stage to ensure that the concrete/rock contact is properly sealed.

When grouting any stage, care shall be taken to ensure that grout does not by-pass the packer, either through the rock or past the packer due to poor sealing in the hole. This could result in loss of the packer and the hole. The *Contractor's* Method Statement shall include techniques to ensure that grout bypass does not occur such as filling the hole with water above the packer and monitoring water losses during grouting or keeping the hole flushed by passing water through a small diameter pipe to the top of the packer - (Discoloured flushing water would indicate packer by-pass). As a safety precaution, the *Contractor* shall attach a steel cable to the packer to assist in its removal should it get stuck down the hole.

When grouting holes near the surface of the rock the *Contractor* shall, if any substantial leaks in grout occur through cracks and fissures in the rock, take whatever measures (eg: caulking) that may be necessary to stem the grout flow and prevent the loss of grout. The measures taken shall be at the *Contractor's* expense. The pressure used for grout injection will vary according to the conditions encountered and shall be as directed or approved. In general the upper stages shall be grouted at a low pressure and the deeper stages at a high pressure. The pressure shall generally be as high as possible but shall be limited so as not to cause displacement of rock or concrete.

If during injection of a hole, connection is established with a neighbouring hole, the hole or holes shall be left open until the grout emerging is of the same consistency as the grout being injected. The hole or holes shall then be closed and injection continued to completion. Interconnected holes shall also be flushed after the grout has set and water tested to confirm that they have been satisfactorily injected.

If any grout hole becomes blocked and cannot be flushed out, it shall be reamed out or re-drilled and, should the *Engineer* require, it shall be subjected to a water test before grouting continues. If such action cannot be carried out or is not successful, a new hole shall be drilled alongside the blocked hole.

If the grouting of any hole is interrupted for any reason, the *Contractor* shall immediately wash out the hole being grouted and any adjacent holes into which grout has entered.



PPS 9.8.3 Cavity Grouting

Cavity grouting will only be required at the contact between first and second stage concrete.

Cavity grouting shall be carried out before any other grouting, except fissure grouting, which may be required, but not before the concrete is at least 28 days old unless otherwise agreed by the *Engineer*.

For first stage concrete and steel linings holes of not less than 38 mm diameter shall be drilled through the concrete and continued until penetration into the rock for 300 mm has been proved. The spacing of holes shall be as shown on the Drawings or instructed by the *Engineer* to ensure a full and complete filling of cavities. For grouting of second stage concrete, the *Contractor* shall carry out such grouting through pre-placed manchette pipes. The *Contractor* shall in any case submit a Method Statement to the *Engineer* for approval 7 days prior to commencing work.

Any voids which are detected during drilling shall be noted in the grouting record. In the case of large voids, the *Engineer* will require air release holes to be drilled and a bleed-pipe inserted reaching to the highest point of the void.

Cavity grouting shall be carried out in the sequence and using mix proportions and pressures agreed by the *Engineer*. Generally, injection of grout shall be commenced at the lowest holes to allow air and water to be displaced. When interconnections occur the holes shall be kept open until emerging grout is of the same consistency as the grout being injected, after which the holes shall be closed. Injection shall continue until the hole refuses to accept grout at the specified maximum pressure.

Where large voids have been detected a 1 cement : 2 sand mixture at a water/cement ratio of 0.60 or other mix as approved by the *Engineer* shall be injected.

If the *Engineer* considers that cavity grouting is not complete at the hole spacing adopted, he may instruct additional holes to be drilled and grouted.

Unless directed otherwise by the *Engineer* holes in which cavity grouting is complete shall be left undisturbed for a minimum period of 24 hours before any redrilling is done for the stemming of holes or for the continuation of consolidation grouting.

Unless the holes are subsequently required for other grouting they shall be completely filled in accordance with Sub Clause 9.11.

PPS 9.8.4 Consolidation Grouting

The extent of consolidation grouting required for rock below the footprint of the dam is detailed on the Drawings and/or is set out in the Bill of Quantities.

Grouting pressure will be as shown on the Drawings or as determined by the *Engineer* from the grouting trials.

Unless otherwise directed by the *Engineer*, consolidation grouting in prepared areas below the foot print of Dam shall take place before curtain grouting in those areas. This grouting shall be accomplished using the methods as outlined in Sub Clause 9.8.2. Unless otherwise directed by the *Engineer*, consolidation grouting shall be done in stages not more than 5 m, which will include grouting of the contact between the concrete and the foundation rock. Consolidation grouting depths may vary significantly across the dam footprint and will be taken to a maximum of 12m, or as otherwise directed by the *Engineer*.

Grouting operations for any stage of grouting in a hole shall be preceded by an abbreviated water pressure test, except as otherwise directed by the *Engineer*. Immediately following the injection of water, grout shall be injected at pressures and rates as agreed with the *Engineer*.

Under no circumstances shall the pressure or rate of pumping be increased suddenly or the pressure in the hole being grouted exceed the maximum grouting pressure specified. In the event



that rock is disturbed due to negligence on the part of the *Contractor*, remedial measures to repair the damage as directed by the *Engineer* shall be carried out by the *Contractor* without additional payment.

The grouting of each stage shall be continued in accordance with the agreed procedures until the hole refuses to accept grout at the consistency and pressure agreed with the *Engineer* or until the *Engineer* directs that the injection should be terminated.

After grouting is completed in any hole the back pressure shall be maintained by closing the inlet valve at the collar until the grout has set sufficiently.

PPS 9.8.5 Contact Grouting

Contact grouting of embedded steelwork shall be carried out after all other grouting has been completed, holes have been stemmed as described in Sub Clause 9.11, and in any case not before the concrete surround is at least 28 days old.

The grouting of embedded steelwork shall be appropriate for the design. Detailed procedures shall be agreed with the *Engineer* prior to the start of grouting.

The success of the grouting shall be tested by tapping the embedded steelwork with a copper hammer. Any areas sounding hollow shall be re-grouted where necessary to suit the design requirements. The *Contractor* shall, if necessary drill, tap and subsequently grout additional grout holes at any point in order to fill voids detected. These holes shall be not less than 15 mm diameter and shall be threaded and fitted with screwed plugs, welded into position and finished flush on completion of grouting.

When all grouting has been completed, the threads in all holes shall be cleaned out and greased and all plugs screwed flush into place.

PPS 9.8.6 Contraction joints in a concrete dam

The timing of operations for grouting contraction joints will be determined by the *Engineer* in the light of conditions during construction. This may necessitate the re-establishment on site of the *Contractor* at a later stage specifically for the purpose of joint grouting.

The compartments shall be as defined on the drawings. If a secondary grouting system is required, this shall be as shown on the drawings. The necessary grout pipes shall be cast in place, or cavities and grooves shall be formed, during the construction of the appropriate portions of the Works. The pipe materials shall be as specified on the drawings, Project Specifications or Schedule of Quantities.

In order to distribute the horizontal forces on the concrete blocks arising from pressure testing and grouting operations in any joint, the grouting systems of the corresponding compartments in the joints on each side of the joint being tested or grouted shall, unless they have already been grouted, be pressurised. Measured at the highest point of the compartment, this pressure shall be approximately half that being applied at the joint in question.

Immediately before grouting of a joint compartment commences, the grouting system shall be washed out until the effluent from the outlet of the collecting groove runs clear. The outlet valve shall then be closed and the pressure raised to the pressure specified by the *Engineer* for grouting. If it is not found possible to reach this pressure or if there is an excessive loss of water the *Contractor* shall immediately inform the *Engineer* and obtain his approval regarding the remedial action he proposes to staunch the leak and complete the grouting.

If the pressure test is successfully passed, the outlet valve from the compartment shall be opened and grout shall be introduced into the grouting system. Initially the grout shall be composed of 2 parts of water to 1 part of cement by volume and it shall be thickened gradually to 1 part of water to 2 parts of cement. When the grout emerging from the outlet pipe is of a consistency equal to that being pumped in, the grouting shall be stopped and the upper collecting groove shall be washed out and filled with water. The outlet valve shall then be closed, and the grouting pressure raised to



1 MPa, measured at the highest point of the compartment. This pressure shall be maintained for 15 minutes after grout ceases to be absorbed, and the inlet valve shall then be closed.

The *Contractor* shall provide suitable means for collecting and disposing of grout emanating from the joint. Such grout shall not be reused in the Works. Any grout spilled shall be washed off immediately.

PPS 9.8.7 Flushing of features intersected by grouting holes

Where grout holes intersect, either directly or indirectly, features such as joints, conduits, pipes, drains, etc, in which grout may not harden, these facilities shall be flushed by pumping clean water through such features. Flow volumes and water pressures shall be determined on site by the *Engineer* on the basis of the extent of the features affected.

Generally clean water will be introduced at one accessible end and to exit at another location from where the flushing water shall drain away. Depending on the configuration, water may be recirculated back to the injection point, but in all cases the contractor shall manage the safe disposal of the water in line with Particular Specifications PPS1 and PPS 2.

The *Contractor* shall monitor the water emanating at the exit point for contamination by grout at all time during grouting operations where flushing facilities are required. Where such contamination should be detected the Contractor shall immediately refer the matter to the Engineer for further instructions as to the required further grouting regime. To this end the *Contractor* shall supply suitably personnel and communication systems.

PPS 9.9 CHECK HOLES

In order to check the effectiveness of grouting the *Contractor* may be required to drill additional percussion or cored holes at any location, angle and depth within the range of the adjacent grout holes not less than 14 days after completing grouting in an area to enable water tests and possible supplementary grouting to be carried out. The number of holes required will be approximately 10% of the holes detailed on the Drawings and shall be spread over the grouted area as directed by the *Engineer*.

Except as otherwise required by the *Engineer*, check holes shall be grouted to the same requirements as the original holes.

PPS 9.10 RECORDS

The *Contractor* shall provide to the *Engineer* each day, an accurate record, in duplicate hard copy and electronically on an approved form of all drilling and grouting operations carried out the previous day.

All costs in connection with the records required will be deemed to be covered by the rates for the various items of work concerned.

PPS 9.10.1 Drilling and Grouting Records

The information provided shall include:

- (a) The location, reference number and stage of the holes drilled and grouted;
- (b) The depth of concrete drilled and total depth of hole drilled with measurements of any voids encountered;
- (c) Details of comprehensive and abbreviated water pressure tests giving pressures, pumping times, and water takes;
- (d) Details of grout injections giving pressures, grout consistencies, volumes of grout injected, quantities of other material injected, and injecting times throughout the period of injection;
- (e) Charts from the recording pressure gauges and flow metres;
- (f) Results of mix control tests, times of sampling and location where samples were taken; and
- (g) Remarks on grouting incidents, delays, surface leaks, interconnections, refusals and any



other factors which might influence the effectiveness of the grouting.

A typical form is bound in at the back of this Specification under Appendix A describing the majority of the above. A separate form is required for each stage of a hole.

On completion of the grouting of a hole, within 24 hours, the *Contractor* shall provide the *Engineer* with a fresh and complete log, produced on the spreadsheet, printed in duplicate of the grouting work in that hole.

The *Contractor* shall be responsible for completing the summary drawing(s) of the curtain grouting results. The drawing(s) shall be submitted to the *Engineer*. An example of how the drawing shall be filled in and of the information required, is given in Appendix C at the back of this Specification. This drawing shall be updated daily and be available to the *Engineer* in electronic format at all times. The *Engineer* shall be provided with a hard copy of the updated drawing once a week, or as ordered.

PPS 9.10.2 Exploratory Drilling Records

The information provided shall where applicable include:

- (a) Borehole number and coordinates, angle from vertical and direction if not vertical;
- (b) Name of driller and type of machine;
- (c) Dates of setting up and removal;
- (d) Weather (including cloud cover, degree of sunshine, direction and speed of wind) on each day, including time of weather changes;
- (e) Depth of water in hole before drilling commences each day;
- (f) Date of each advance;
- (g) Calculation of depth for each advance/run;
- (h) Type and number of bit for each advance/run;
- (i) Bit pressure and rotational speed;
- (j) Times of start and finish of each advance/run (to nearest 5 sec), duration of any delays and number of times chuck was raised if applicable;
- (k) Reasons for any core loss;
- (l) Note of any core left behind in borehole;
- (m) Note of any drops of rods due to cavities;
- (n) Location of any exceptionally hard or exceptionally soft layers;
- (o) Use of drill mud and type of drill mud;
- (p) Estimated water or drilling fluid losses or inflow, with location of occurrences;
- (q) Amount and size of casing inserted into borehole;
- (r) Amount and size of casing drilled into borehole;
- (s) Amount and size of casing left in borehole;
- (t) Amount of cement grout poured or pumped into borehole;
- (u) Depth of top of grout after grouting operation;
- (v) Length of grout that required drilling;
- (w) Time of and reason for delays e.g. mechanical, pumps, rods stuck, etc.;
- (x) Details and records of tests or surveys conducted or samples taken;
- (y) Records of core photographs; and
- (z) Any other item that may be of relevance to the interpretation of the core.

PPS 9.11 STEMMING OF HOLES

Upon completion of the grouting and checking of any area, the holes shall be washed using a flushing pipe to remove all loose materials and laitance from grout which has not hardened. The *Contractor* shall then backfill all grout holes with a thick grout mix or dry pack mortar as directed by the *Engineer*.

Filling of upward inclined holes shall be by pressure injection unless a thixotropic grout is used. Filling of downward inclined holes shall be through tremie pipes pushed down to the bottom of the holes and withdrawn slowly as filling proceeds after first blowing all water out of the holes.

The end of each hole shall be filled to a depth equal to the lining thickness with dry pack mortar



which is well rammed in and finished flush with the face of the concrete, or in the case of embedded steel, not more than 5 mm below the steel/concrete interface.

If any hole shows signs of weeping water after being stemmed the hole shall be drilled out, re-grouted and re-stemmed without any additional payment.

PPS 9.12 PLUGGING EXPLORATORY HOLES

Existing exploratory holes on the Site shall be plugged. The *Contractor* shall locate these holes, if necessary by land surveying methods. The work of plugging shall be carried out at an early stage in the Contract, as directed by the *Engineer*, before the standpipes or identification marks are damaged during Site activities. The standpipes or casings shall be removed as specified in Sub Clause 9.6.12

The plugging of existing exploratory holes and holes drilled for the recovery of cores shall be carried out as specified below.

- (a) Where the hole, or portion thereof, is in rock, one-stage grouting using a fairly stiff grout shall be carried out. No water pressure test will be required.
- (b) Where the hole, or portion thereof, is in overburden, which may or may not have a casing, it shall be backfilled with a 1:2 mixture (by volume) of cement and water. If the hole is dry the grout may be poured from the top but, if the hole contains standing water, the grout shall be fed through a tremie pipe, the outlet of the tremie pipe being kept submerged in the grout at all times. If running water is encountered in the hole, the *Engineer* shall direct what procedure is to be followed.
- (c) Where the hole, or portion thereof is in a concrete structure, it shall be backfilled with a 1:1 mixture of cement and water.

PPS 9.13 REPAIR AND CLEAN-UP

Concrete surfaces and foundation surfaces over which grout has flowed shall be cleaned and restored to their original condition.

Upon completion of the grouting, the *Contractor* shall remove all removable grout nipples from grout pipes embedded in concrete or embedded steel. Generally any standpipes shall be cut off 75 mm back from the surface. The curtain grout holes shall be cut off flush with the concrete surface, and the holes shall be filled with grout under the direction of the *Engineer*. Holes in concrete for such connections shall be cleaned of grout spillage and filled with dry pack mortar well rammed in and finished as required by the *Engineer* to restore and match the general surface of the concrete.

On completion of grouting in areas of concrete with a steel liner, the steel surface shall be cleaned of all grout contamination. Only methods of cleaning which will not indent or score the lining shall be used.

PPS 9.14 MEASUREMENT AND PAYMENT

The rates tendered under this section shall not include for the general obligations and work deemed to be covered by the items provided in SANS 1200 A

The rates shall be deemed to include full compensation for all direct resources and delay or disruption not covered by the relevant time related charges in SANS 1200A.

Measurement and payment for all work involved for drilling and grouting shall be made against the following items:



PPS9.14.1 Setting up equipment for drilling grout and drainage holes Unit : number (No)

- a) **Percussion drilling rigs**
- b) **Rotary core drilling rigs**
- c) **Rotary drilling rigs**

Setting up drilling equipment for drilling grout or drainage holes in surface work will be measured by the number of set ups at positions indicated on the Drawings or instructed by the *Engineer* irrespective of the number of stages drilled.

Separate measurement shall be made for consolidation grout holes, curtain grout holes and drainage holes.

The rate tendered shall include full compensation for all work required to set up for drilling and subsequent removal. The rate shall also include for provision of all services to the rig and for taking all precautions against pollution.

PPS9.14.2 Drilling of grout and drainage holes Unit : metre (m)

Measurement shall be the length of hole drilled as detailed on the Drawings or as instructed by the *Engineer*. Distinction shall be made between percussion drilled holes, rotary core drilled holes (N series) and rotary drilled holes (50 mm).

Separate items will be provided for:

i)	0 – 25 m depth
ii)	25 – 50 m depth
iii)	over 50 m depth

and for drilling at inclinations to the vertical

- | | |
|------|-----------|
| i) | 0° - 30° |
| ii) | 31° - 60° |
| iii) | 61° - 90° |

The rate tendered shall cover all variations in strata encountered and the direction and inclination of the hole and include full compensation for all work required to drill the holes to the required depth.

PPS9.14.3 Re-drilling of grouted holes Unit : metre (m)

Measurement shall be the length of hole re-drilled where grout has been allowed to set on instruction of the *Engineer*. Grouted holes re-drilled on account of the *Contractor's* failure to flush out grout before it has set, shall not be measured.

Separate items will be provided for drilling at inclination to the vertical:

- | | |
|------|-----------|
| i) | 0° - 30° |
| ii) | 31° - 60° |
| iii) | 61° - 90° |

The rate shall include full compensation for all work required to redrill grouted holes, irrespective of the depth of grouted hole.

PPS9.14.4 Water pressure tests

- | | |
|---------------------------------------|--------------------|
| a) Abbreviated water pressure tests | Unit : number (No) |
| b) Comprehensive water pressure tests | Unit : number (No) |

Measurement shall be by the number of water tests completed on instruction of the *Engineer*.



The rate tendered shall include full compensation for setting up equipment, conducting the tests over the full range of pressures and for all delays to other work occasioned by the tests.

PPS9.14.5 Cavity grouting

Unit : square metre (m²)

Measurement will be the area of concrete over which cavity grouting is carried out, irrespective of the method used. Materials will not be measured separately.

The rate tendered shall include full compensation for all work required to effect the cavity grouting including stemming of holes and for cleaning up on completion. The rate shall also include for all materials required to fill any voids left by incomplete filling of the concrete lining.

PPS9.14.6 Contact grouting

Unit : square metre (m²)

Measurement will be the area of embedded steelwork grouted. Materials will not be measured separately.

The rate tendered shall include full compensation for contact grouting the embedded steelwork in accordance with the design submitted by the *Contractor* and approved by the *Engineer*. The rate shall include for the removal and subsequent replacement of steel plug caps, setting up equipment, freeing the steel from the concrete encasement by water pressure, grouting including all materials, checking the grouting and re-grouting as necessary including drilling, grouting and repair of extra injection points, cleaning up and all necessary other work for grouting the embedded steelwork.

**PPS9.14.7 Curtain and consolidation grouting for the dam
(Stage Specified)**

Unit : Number (No)

Measurement will be the number of stages successfully grouted as schedules or as directed by the *Engineer*. The rates tendered shall include full compensation for all work required to move to, set up and grout each hole, flushing out after each stage, for stemming of holes and for cleaning up on completion, and for all precautions against pollution by waste grout. The rate shall cover the cost of grouting and redrilling through set grout where holes are not flushed out and for making-good drill holes in concrete

Materials will be measured separately as detailed in item 9.008.

PPS9.14.8 Grouting materials

Fissure, cover, curtain, consolidation and cut-off grouting operation

i)	Type I (Normal)	Unit : tonne (t) or kilogram (kg)
ii)	Type III (High Early Strength)	Unit : tonne (t) or kilogram (kg)
iii)	Fly Ash	Unit : tonne (t) or kilogram (kg)
iv)	CSF	Unit : tonne (t) or kilogram (kg)
v)	Bentonite	Unit : tonne (t) or kilogram (kg)
vi)	Sand	Unit : tonne (t) or kilogram (kg)

Cementitious materials, CSF, Bentonite and sand used will be measured separately on the basis of the quantity actually injected in grouting operations. No payment will be made in the case of any grout which was lost on account of the *Contractor's* failure to comply with the requirements of the Specification or which was rejected by the *Engineer* as being unsuitable for use in grouting operations or for losses from mixes, pumps and lines. Measurement will be the mass injected as calculated from the mix proportions and volumes injected. The mass of water shall not be measured. If sand-cement grout is used the dry mass of sand used in the grouting operation will be measured separately. The rate tendered shall include full compensation for the materials and the work required for mixing and delivery of grout including mixing.



PPS9.14.9 Grouting additives

Unit : Provisional Sum (PS)

Where ordered by the *Engineer* additives used in grouting operation shall be measured separately. Payment shall be made against a Provisional Sum.

PPS9.14.10 Casings

Unit : metre (m)

- (a) Casing for rotary core drill holes
- (b) Extra over (a) for permanent casing
- (c) Casing for rotary drill holes
- (d) Extra over (a) for permanent casing
- (e) Casing for percussion drill holes
- (f) Extra over (c) for permanent casing

Measurement will be by length of temporary casing excluding that length comprising the standpipe. An extra-over rate will be paid for permanent casing ordered by the *Engineer* to remain in the hole. The rates tendered shall include full compensation for the supply and installation of temporary casing and removal on completion. The extra over rate shall include for all costs involved in installing the casing permanently.

Where grout caps are required, these shall be measured under SANS 1200G.

PPS9.14.11 Recovery of cores

- (a) Core recovery

Unit : metre (m)

Measurement of core recovery in all types of material will be the length of core recovered from the core barrel and placed in core boxes. The rates tendered for core recovery shall include full compensation for special methods adopted during core drilling and core extraction to ensure recovery of the greatest possible length of complete core and for placing in core boxes, including orientation to facilitate joint mapping.

- (b) Core boxes

Unit : number (No)

Measurement will be by the number of core boxes required. The rate tendered shall include full compensation for the supply to Site of core boxes, the temporary waterproof storage (if required) on Site of boxes and cores, the photography of boxes and transport to permanent storage on site.

PPS9.14.12 Check holes

Drilling and grouting of check holes as directed by the *Engineer* will be reimbursed under the relevant items 9.002 to 9.009 for the type of grouting being checked. Cored holes will be reimbursed against the relevant items 9.003 and 9.013.

PPS9.14.13 Loss of hole

No payment will be made for a "lost" hole, either for drilling, grouting or in any other respect unless the *Engineer* considers the desired purpose of the hole has been achieved in which case applicable work falling under the measurement Clauses above will be paid for.

PPS9.14.14 Sleeve pipes

Unit : metre (m)

- a) Steel sleeve pipe (diameter specified)
- b) PVC sleeve pipe (diameter specified)

Measurement will be by the length of sleeve pipe installed in concrete as detailed on the Drawings or as ordered by the *Engineer*. The rate tendered shall include full compensation for the supply and installation of sleeve pipe, together with any fittings required, and securing during casting of concrete.



PPS9.14.15 Records

No separate payment will be made for providing the records required in terms of Sub Clause 9.10 and the rates for the items of work concerned shall include full compensation for this work.

PPS9.14.16 Backfilling of exploratory boreholes

Unit : number (No)

Measurement will be the number of boreholes successfully backfilled.

The tendered rate shall include full compensation for all work required to locate the existing borehole, flush the hole with either compressed air or water jet to undo blockages and to pressure grout the hole using a mixture of CEM I (OPC) and water. The end of each hole shall be treated as per Sub Clause 9.11.

The rate shall include all materials and clearing up after grouting each hole. No separate payment will be made for moving and setting up at each hole.

PPS9.14.17 Establishment of flushing systems
(Designate feature to be flushed)

Unit : Sum

The sum shall cover all costs related to the establishment, erection, commissioning, dismantling and removal from site of all pumps, pipes (including all fittings and couplings) nozzles, drains, power or fuel supplies, etc necessary to flush the relevant feature designated.

Payment shall be made in two instalments; 80% on completion of installation and commissioning of the flushing facilities to the approval of the Engineer and 20% following satisfactory dismantling and removal thereof.

PPS9.14.18 Flushing of features
(Designate feature to be flushed)

Unit : number (No)

The unit of measurement will be the number of associated grouting stages during which grouting is undertaken while the designated feature is flushed, as directed by the Engineer.

The rates tendered shall include full compensation for all work required to move to, set up and flush each facility, the flushing of the facility as required by the Engineer, the monitoring of the emanating water, managing the emanating water, etc

PPS9.14.19 Pipes and channels for grouting systems

Unit : metre (m)

The unit of measurement shall be the metre length of pipe or channel required for the grouting system to be used for joint grouting.

The tendered rate shall include full compensation for the supply of all pipes (including all fittings and couplings) and for the installation of the pipe system in the structure including any modification needed to formwork to accommodate the pipe system.

PPS9.14.20 Re-establishment on site for joint grouting

Unit : number (No)

The unit of measurement shall be the number of times for which the *Contractor* must re-establish on Site for joint grouting. The quantity in the Schedule of Quantities shall be regarded as a provisional quantity.

The tendered rate shall cover the costs of materials, transportation and labour.

PPS9.14.21 Grouting joints

Unit : number (No)

The unit of measurement shall be the number of compartments that are satisfactorily grouted.



Separate items shall be scheduled for compartments in the various sections of the Works.

The tendered rate shall include full compensation for all work involved in the grouting of the joints according to the requirements specified in the applicable sub-clause of this specification, including pressurising adjacent compartments (where applicable).

The cost of pipes for the grouting system shall be paid for under Item 9.017. Materials will be measured separately as detailed in item 9.008.

DRILLING AND GROUTING RECORDS

CONTRACT NO. :

PAGE.....A

LOCATION IN WORKS :

CHAINAGE:

TYPE OF GROUTING:.....

OPERATOR:

HOLE REFERENCE NO. : HOLE SEQUENCE: STAGE: STAGE DEPTH: m TO m

R.L. AT COLLAR :

INCLINATION (TO VERTICAL): degrees

ORIENTATION: degrees

DRILLING

Bit Size Type of drilling

Date	Depth of hole (m)	

WATER PRESSURE TEST

Gauge number

Date	Collar pressure (kPa)	Time			Water Take			Lugeon (UL)	REMARKS (level(s) of packer(s), length of test section, level of water in hole before testing, any loss of pressure, etc.)
		From	To	Run time (5 min)	Begin (litres)	End (litres)	Injected (litres)		
		1 st Run							
		2 nd Run							
		3 rd Run							
		4 th Run							
		5 th Run							

ENGINEER: DATE:

DRILLING AND GROUTING RECORDS (CONT.)

PAGE B

HOLE REFERENCE NO.: HOLE SEQUENCE: STAGE: STAGE DEPTH: m TO m

GROUTING RECORDS 1 x 50 kg cementitious material = 37,5 litres

Gauge number Type of grouting: Length of state: m

Date	Time			W/C by Volume	Pockets added to mixer			Grout			Grout take (cement + PFA/ CSF) (pockets)	Stand- pipe pressure (kPa)	Remarks (leaks, inter-connections, uplift, waste details, plant difficulties, refusals additives, etc.)
	From	To	Time (mins)					In Tank		Injected (litres)			
					Cement	PFA or CSF	Total	Start (litres)	Finish (litres)				
	:	:											
	:	:											
	:	:											
	:	:											
	:	:											
	:	:											
	:	:											
	:	:											
Totals								pockets				pockets	= _____ kg/m

ENGINEER:

DATE:

DRILLER'S LOG

PAGE

HOLE REFERENCE NO. : OPERATOR: MACHINE:

Date									
Start depth (m)									
Time	From	:	:	:	:	:	:	:	:
	To	:	:	:	:	:	:	:	:
	Delays/Drilling (mins)								
Drill string	Total length of rods	1,50 m (No)/(m)							
		3,00 m (No)/(m)							
		, m (No)/(m)							
		, m (No)/(m)							
	Total length of adaptor	, m (No)/(m)							
		, m (No)/(m)							
	Length of quill	, m (No)/(m)	1		1		1		1
	Total drill string (m)								
	Stick up (m)								
Hole depth (m)									
Run length (m)									

Recovery (m)					
Core left in hole* (m)					
Water return (estimate) (%)					
Water colour					
Bit No.					
Bit pressure (kPa)					
Rotation speed (RPM)					
Formation					

* Indicate if recovered in next run

Add other records and remarks on separate sheet or on back

CORE DRILLING AND RECOVERY RECORDS**PAGE**

CONTRACT NO.....:

LOCATION IN WORKS: CHAINAGE: TYPE OF DRILL:

OPERATOR:

HOLE REFERENCE NO.:

CO-ORDINATES: X.....

Y

R.L. AT COLLAR :

INCLINATION (TO VERTICAL): degrees

ORIENTATION: degrees

DRILLING

Bit Size Type of drilling

Core drilling data (from Driller's log)							Hydrological data						
Date	Depth of hole	Depth		Depth drilled (m)	Core recovered (m)	Formation	Section tested		Water loss		Duration of test (mins)	Pressure applied (kPa)	Water R.L.
		From (m)	To (m)				From (m)	To (m)	(litre)	(mins)			

ENGINEER: DATE:

APPENDIX C

GUIDELINES FOR COMPLETING THE SUMMARY DRAWING

METHOD FOR PRESENTATION OF GROUT RECORDS

1. At the top of the hole indicate the hole sequence:

P	=	Primary hole
S	=	Secondary hole
T	=	Tertiary hole
K	=	Quaternary hole
Q	=	Quinary hole

2. Indicate the end of a stage with a stage number "N" (i.e. 1, 2, 3, etc.) and the cumulative vertical depth of the hole in the rock foundation "V" at either end of the short line transverse to the grout hole line.

3. Draw in the grout hole where, for each stage, the thickness of the line represents the grout take as shown in the table below:

Grout take in stage (kg cementitious material/m)	Required line thickness for grout hole stage (mm)
0 - 50	0,35
50 - 100	1,0
100 - 200	2,0
200 plus	3,0

4. Write grout record "X:Y:Z:R" on grout line for the specific stage, where:

X =	Lugeon value for stage (l/min/m/MPa)
Y =	Grout take of stage expressed in kilogram of cementitious material per metre run of stage
Z =	Drilled length of stage in metres (i.e. actual length along the incline)
R =	Remarks on the validity of the results or of the problems encountered during the operation

Three major incidents shall be recorded as follows:

A =	Normal grouting with normal readings
B =	Suspect readings
C =	Hole not grouted under required specifications for foundation grouting;

which shall be followed by one of the following:

1 =	No specific problems encountered
2 =	Surface leaks experienced
3 =	Leaks through to other holes experienced
4 =	Fissures encountered
5 =	Cavities encountered
6 =	Problems experienced with grouting equipment

5. Letter sizes shall be limited to a height of 2,5 mm and using a pen thickness in all cases of least 0,25 mm.

6. The *Contractor* shall be responsible to provide the "As Built" rock line on the drawing. The *Engineer* shall provide the necessary data on the proposed excavation line.

Appendix D Figures

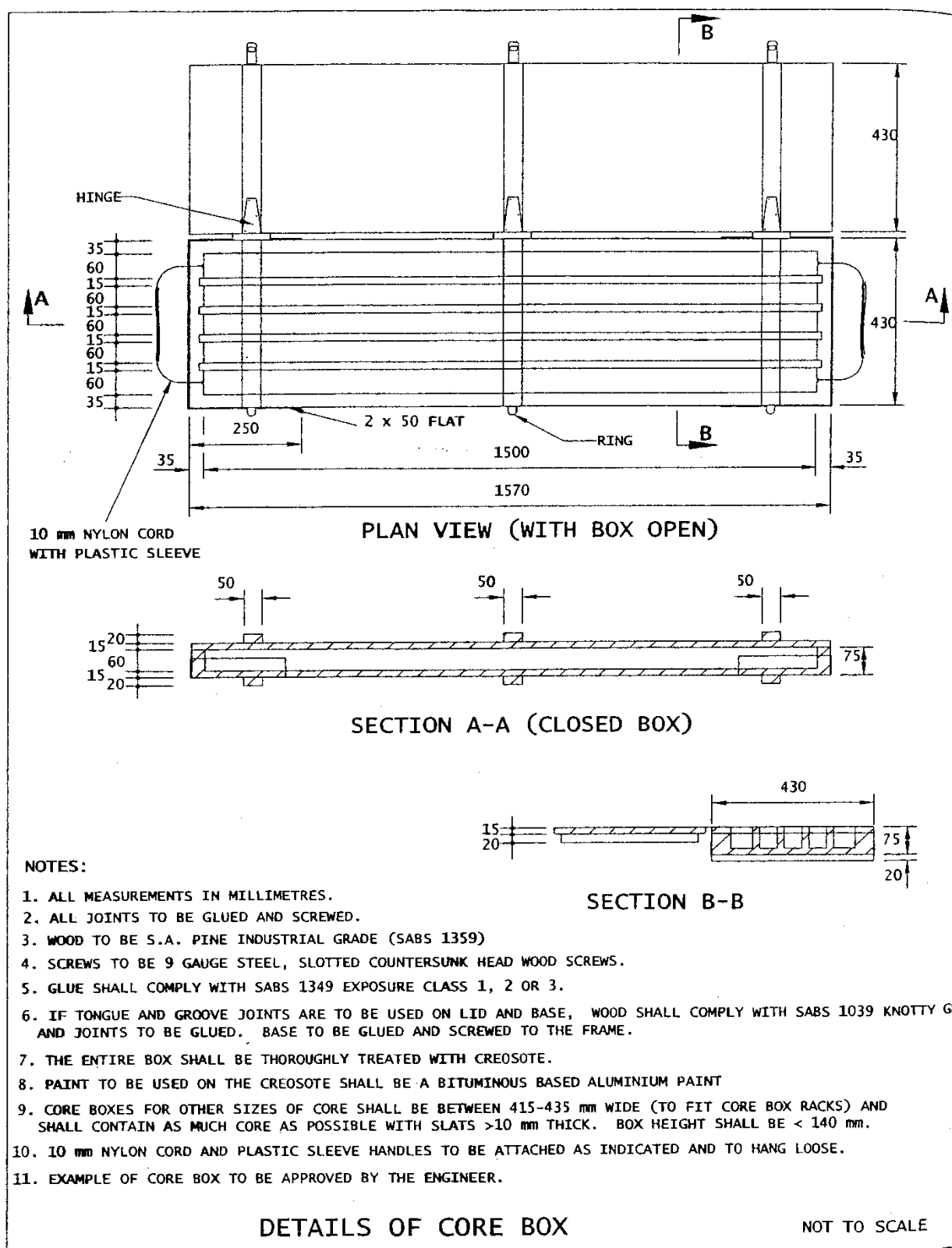


Figure 9.1 Details of Core Box

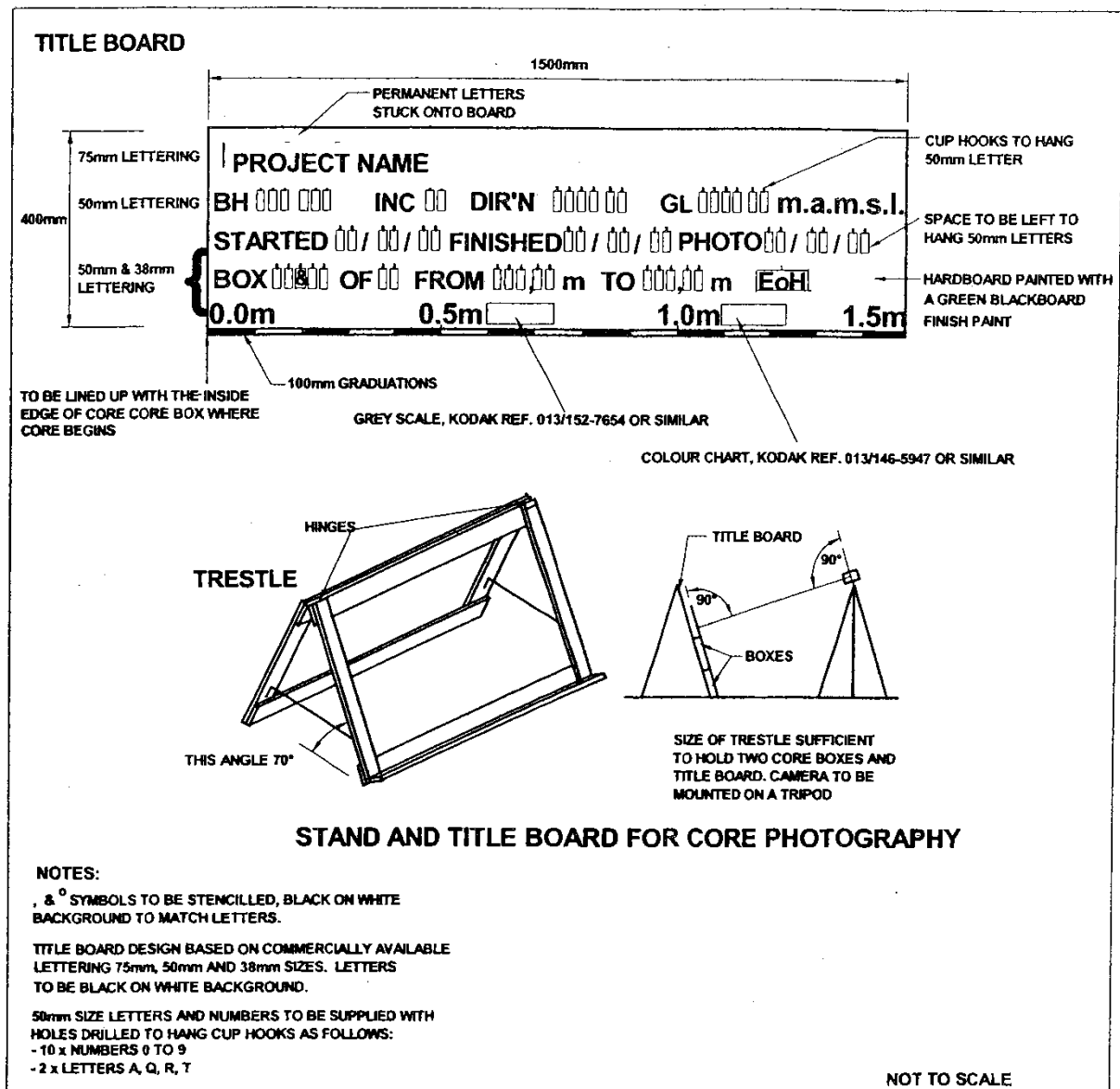


Figure 9.2 Stand and Title Board for Core Photography

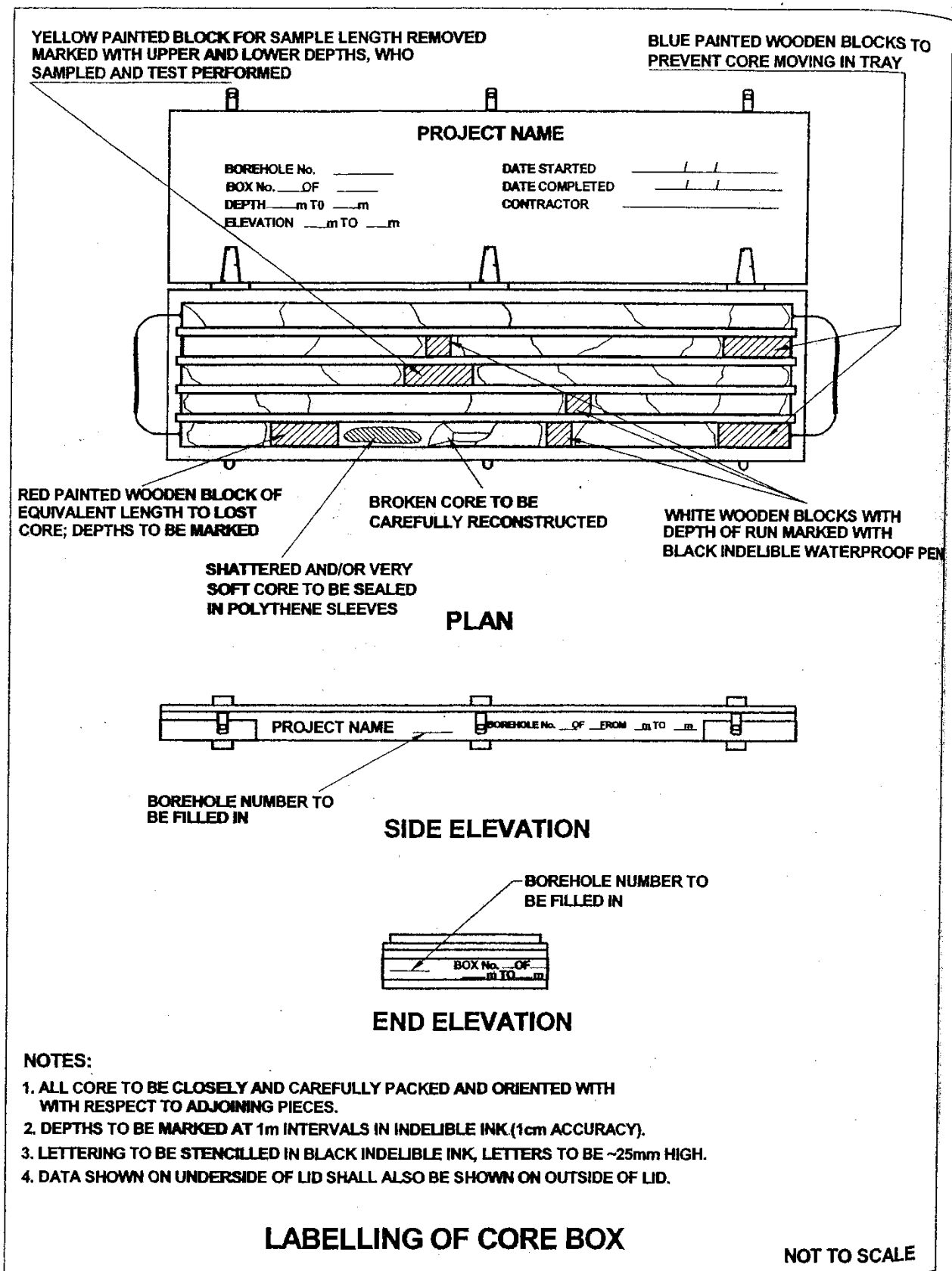


Figure 9.3 Labelling of Core Box



PPS-10.

PARTICULAR SPECIFICATION

HARDFILL DAM CONSTRUCTION

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PPS-10.

PARTICULAR SPECIFICATION .

HARDFILL DAM CONSTRUCTION.

PPS10.1 SCOPE

This specification addresses the material supply, manufacturing, transporting, placing, compacting and curing of Hardfill, utilising a Mechanical Stabiliser/Recycler.

Hardfill and RCC materials differ mainly by the following aspects:

- The cementitious content of Hardfill is lower than for a Concrete or RCC dam.
- Limited vertical shrinkage joints in Hardfill.
- Limited horizontal lift joint treatment.
- Simplified quality control tests.

Hardfill is a combination of fine and coarse sized aggregate, and composite pozzolanic cement that is blended with water to a damp consistency that permits hauling and spreading with earth moving equipment and compaction with steel drum vibratory rollers.

This specification is applicable for Hardfill dams for which water-tightness is created by an upstream impervious barrier, attached to the body of the Hardfill structure. This barrier will be constructed using slip formed concrete with waterstopped joints for impermeability, as specified in the Concrete Specifications.

PPS10.2 INTERPRETATION

PPS10.2.1 Supporting Specifications

This specification shall be supported by, and read in conjunction with,

- a) The Project Specifications.
- b) The Scope of Work.
- c) The Earthworks Specification (specifically SANS 1200D, but also all related specifications).
- d) The Concrete Specification (specifically SANS 1200G, but also all related specifications).
- e) The Drilling & Grouting Specification (PPS9).
- f) The applicable South African Bureau of Standards (SABS), American Society for Testing and Materials (ASTM) and British (BS) Standards.

In view of the fact that Hardfill is a type of concrete, the related requirements of the Concrete Specification remain applicable and this specification is accordingly supplementary, defining primarily the particular requirements for concrete compacted in bulk using a vibratory roller. For items not specifically addressed in this specification, the provisions of the Concrete Specification shall be deemed to apply.

For all constituent materials of the Hardfill, the requirements of the applicable standards of the South African Bureau of Standards (SABS) and the British Standards Institution shall be deemed to apply. It is the *Contractor's* responsibility to procure a copy of the applicable standards. All testing, unless otherwise specified, shall conform with the recommended methods and practices of these standards.

Applicable BS and SABS standards and specifications include, inter alia, the following:

- | | |
|------------------|--|
| - SANS 1491 | Parts 1 & 2: Portland Cement Extenders – Ground Granulated Blast-Furnace Slag and Fly Ash. |
| - SANS 1083 | Aggregates from Natural Sources. Aggregates for Concrete. |
| - SANS 1090 | Aggregates from Natural Sources. Fine Aggregates for Plaster & Mortar. |
| - SANS 3001-AG1 | Particle Size Analysis of Aggregates by Sieving. |
| - SANS 3001-GR20 | Moisture Content by Oven-drying. |
| - SANS 50196 | Methods of Testing Cement Part 1: Determination of Strength. |
| - SANS 50197-1 | Cement Part 1: Composition, specifications & conformity criteria for common cements. |
| - SANS 50197-2 | Cement Part 2: Conformity Evaluation. |
| - SANS 5863 | Compressive Strength of Hardened Concrete. |



- SANS 5865 Concrete Tests – The Sampling of Fresh Concrete, Making, Curing and Strength Testing of Concrete Test Specimens
- SANS 5847 Organic Impurities in Fine Aggregate / Aggregate Cleanliness.
- SANS 10100-2 Concrete Building Material and the Execution of work.
- BS 812 Part 105 Testing of Aggregates - Methods for Determination of Particle Shape.
- BS 1881 Testing Concrete, including requirements applicable to modified VeBe apparatus and concrete cube moulds.

Other important, applicable standards include the following international standards:

- ASTM C1170-91(1998) Standard Test Methods for Determining Consistency and Density of Roller Compacted Concrete using a Vibrating Table.
- ASTM C403M Standard test method for determining the time of setting of concrete mixtures by measuring the penetration resistance.
- ASTM C494 (type D & G) Standard specification for chemical admixtures for concrete for set-retarding and water reducing admixtures.
- ASTM D5607 Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force
- ASTM C260 Standard specification for air entraining admixtures.
- IS-7746 In Situ Shear test on Rock – Code of Practice.
- ASTM and USACE CRD-C572 as set out in Table 7 for waterstops.
- ICOLD Bulletin No.177

PPS10.2.2 Application

This specification contains clauses which are specifically applicable to batching, mixing, conveyance, placement, compaction and testing for Hardfill and shall be read in conjunction with the Project Specification and the Concrete Specification, but shall take precedence over the Concrete Specification where a contradiction, or conflict exists. The provision of SANS 1200 Earthworks will apply to the execution of quarrying activities, although payment for such activities are made though the rates for the Hardfill material itself.

PPS10.2.3 Parameters

The Hardfill mix design approach shall be based on establishing an approved diamond-shape acceptance envelope in the strength-aggregate gradation–moisture content space. For the purpose of this specification, Hardfill is defined as a “Strength Concrete”, in accordance with the applicable definitions of the concrete Specifications.

The cementitious materials to be used in Hardfill shall generally comprise Ordinary Portland Cement, Portland blended cements and pozzolans. The process of the mix development programme shall determine the total quantity of cementitious materials to be used and the respective proportions.

PPS10.2.4 Definitions

The definitions defined in the Project Specification shall apply, with the following:

- Aggregate Fines: The aggregate fines are defined as the total amount of material in the aggregate smaller than 75 microns. The amount of non-plastic aggregate fines in Hardfill could be up to 14% of the total fine aggregate.
- Cementitious Paste: The Cementitious Paste fraction of Hardfill is defined as the absolute volume of cementitious materials, liquid admixtures, air and free water.
- Coarse Aggregate: The term coarse aggregate shall be used for aggregate of which at least 95 % by mass is coarser than 4.75 mm.
- Concrete Grade: Concrete Grade defines the Specified Strength and the maximum aggregate size of a concrete, i.e. Grade 20/50 = 20 MPa with 50 mm maximum aggregate size. In the case of Hardfill, the Specified Strength is at 60 days age.
- Continuous Layer Placement: Continuous layer placement refers to Hardfill construction in continuous, largely horizontal layers, whereby Hardfill is placed in a continuous operation across the full surface area of the dam wall at a particular level, usually from one abutment to the other. Typically placement is advanced in longitudinal strips parallel to the dam axis (perpendicular to the river)



	starting each layer from the upstream strip in one abutment and finishing at the downstream side on the opposite abutment.
<u>Crack Inducer:</u>	The term "Crack Inducer" is used for the system incorporated into the upstream (and downstream) face concrete to induce shrinkage cracking in the facing concrete on the alignment of a joint in the Hardfill.
<u>Crack Director:</u>	The term "Crack Director" is used for the system incorporated into the Hardfill layers to induce thermal shrinkage cracking on the alignment of a joint.
<u>CVC:</u>	Conventional vibrated concrete. Mass concrete compacted with an immersion vibrator.
<u>Diamond-Shape Acceptance Envelope:</u>	The region in strength-gradation-moisture content space established from laboratory testing of the coarsest and finest projected production gradations. The envelope defines the range of moisture contents and aggregate gradations for which Hardfill: - achieves or exceeds the specified design compressive strength. - exhibits acceptable workability and compactability. - can be mixed, transported, placed and compacted without excessive adhesion, segregation or handling difficulties. - achieves the required fresh and compacted density. - remains suitable for practical construction operations.
<u>Facing (or Skin) Concrete:</u>	Facing (or Skin) Concrete is an impermeable mass concrete placed against formwork, or other surface forming the external face of the Hardfill body, where indicated on the drawings or directed by the <i>Engineer</i> .
<u>Filler Concrete:</u>	Filler Concrete or dental concrete is mass concrete placed where indicated on the drawings or directed by the <i>Engineer</i> , generally around items built into the interior of an Hardfill structure, or to prepare the foundation for acceptance of Hardfill.
<u>Fine Aggregate:</u>	The term fine aggregate shall be used for aggregate of which not more than 10 % by mass is retained on the 4.75 mm sieve and of which at least 80 % shall not pass through a 150 micron sieve. This limit shall be 75% for Hardfill fine aggregate.
<u>Fines:</u>	The Fines are defined as the total volume of material in the Hardfill mix smaller than 75 microns (cementitious, pozzolan & non-plastic aggregate fines).
<u>Full-Scale Trial (FST):</u>	The Full-Scale Trial is an embankment constructed in Hardfill for the purpose of testing plant, mixes, procedures and various other aspects of Hardfill construction in advance of the main dam wall.
<u>GE-Hardfill:</u>	Grout Enriched Hardfill is Hardfill to which an additional cementitious grout (by mass) is added at the top of the layer before spreading the Hardfill and which is compacted by immersion vibrator. This concrete may be used where rollers cannot reach, around reinforcement, as well as against formwork.
<u>GEVR:</u>	GEVR, or Grout Enriched Vibrated Hardfill is a form of GE-Hardfill to which an additional cementitious grout is added at the bottom of the layer before spreading the Hardfill and which is compacted by immersion vibrator. This concrete may be used where rollers cannot reach, around reinforcement, as well as against formwork.
<u>Mixing Platform</u>	A hardstand flat area prepared on which Hardfill shall be mixed using a Mechanical Stabiliser/Recycler, following a controlled placement, mixing and water adjustment procedure.
<u>Mortar:</u>	The Mortar fraction of the Hardfill mix is defined as the absolute volume of the paste and the fine aggregate (passing 4.75 mm sieve).
<u>Non-Continuous Layer Placement:</u>	Non-continuous layer placement refers to Hardfill placement that is not continuous across the full surface area of the dam at a particular level. This can take the form of several layers placed over a limited area of



the dam surface, or placement in inclined layers – this method is not used under this specification.

Hardfill:

Hardfill is a zero slump concrete designed to be mixed and transported by high capacity equipment, spread by bulldozer and compacted by vibratory roller in layers. The generic term "Hardfill mixes" shall include all grades of Hardfill, as well as Bedding, GEVR, GE-Hardfill, etc.

Bedding:

The Hardfill Bedding is a workable mortar, or highly sanded concrete placed on the prepared foundation, or on a prepared compacted Hardfill surface, to receive fresh concrete or Hardfill.

Paste/Mortar Ratio:

The paste / mortar (p/m) ratio of Hardfill is defined as the respective absolute volume of paste / mortar.

Sand/Aggregate Ratio:

The sand / aggregate (s/a) ratio of Hardfill is defined as the weight of fine aggregate (<4,75 mm) / the total aggregate weight.

Total Paste:

The Total Paste fraction of Hardfill is defined as the absolute volume of cementitious materials, liquid admixtures, non-plastic aggregate fines, air and free water.

Void Ratio in Fine Aggregate:

Volume of voids determined in the compacted bulk density test of fine aggregate using the tamping rod procedure.

Specified/Characteristic Strength:

The design Hardfill strength, representing the compressive crushing strength of a 150 mm cube after curing in a bath of water at a constant temperature of between 22 and 25 °C for 60 days since mixing.

PPS10.3 COMPOSITION

PPS10.3.1 General

Hardfill shall be composed of Portland Cement, or Portland blended cement (with Fly Ash (FA) or a natural pozzolan) fine aggregate, coarse aggregate (or a single aggregate meeting overall grading requirements) and water, all well mixed and brought to the proper consistency. The use of admixtures shall be permitted with the *Engineer's* acceptance.

All concretes, including Hardfill, and the constituent materials thereof, and all methods and testing procedures shall conform to the applicable standards of South African Bureau of Standards (SABS) unless otherwise specified.

PPS10.3.2 Hardfill Mix Approach

While initial laboratory testing is required, the Hardfill mixes shall only be finalised on completion of the Full-Scale Trial.

The Hardfill mix design approach shall be based on establishing an approved diamond-shape acceptance envelope in the strength–gradation–moisture content space. The envelope shall define the range within which the Hardfill satisfies the specified requirements for density, compactability, workability, segregation resistance and compressive strength. The proposed production mix shall lie near the centre of the approved envelope to provide allowance for normal construction variability but remain within the envelope.

The applicable Hardfill mix shall target 80 kg/m³ of cementitious materials. The final cementitious content may be varied within the range specified in Table 5 where demonstrated through the mix design development process and approved by the *Engineer*. The GEVR and/or GE-Hardfill that is to be used against the foundation, formwork, extruded in-situ facing elements, pre-cast facing units, galleries and other concrete structures shall comprise Hardfill aggregates mixed with a Mechanical Stabiliser/Recycler as part of the overall Hardfill production. It shall be placed as Hardfill, enriched with cementitious grout and compacted as CVC.

PPS10.3.3 Hardfill Mix Control

The proportions of the Hardfill mixes shall be changed as necessary, with the acceptance of the *Engineer*. No Hardfill shall be placed on the dam without the written approval of the *Engineer*. The *Contractor* shall be responsible for the consistency of the materials and the mix properties throughout construction.

Minor modifications and optimisation of the mix during the course of construction may be undertaken, with the approval of the *Engineer*. Adjustments shall be made to the batch weights including cement, pozzolan



and water, to maintain the necessary consistency to prevent segregation within the Hardfill and allow full compaction as determined. The *Engineer* retains the right to direct any changes as and when they consider that the *Contractor's* procedures are not fully effective.

PPS10.3.4 Hardfill Consistency

The consistency of the Hardfill under working circumstances shall be closely monitored and optimised during the construction of the Full-Scale Trial on the basis of the requirements necessary for adequate hauling, spreading and compacting. Changes shall be directed based on visual examination of the Hardfill during the spreading and compaction process; on the VeBe time, when it varies outside the range considered ideal for compaction as determined by the *Engineer* using VeBe apparatus, and when the in-situ density, as determined by means of a nuclear density gauge, varies outside the allowable range.

PPS10.3.5 Responsibility for Mix Design

Hardfill is a strength concrete and the *Contractor* shall be responsible for the design of the Hardfill mixes and for ensuring that all Hardfill placed in the *Works* meets the requirements of the Specification.

Typical limiting Hardfill mix characteristics are indicated in Table 1. The listed parameters shall be seen as the range allowable on the basis of an objective of producing Hardfill with the required performance characteristics encompassed in this Specification.

Table 1 Hardfill Parameter Definition

Concrete Grade	Density kg/m ³		Fines Volume (litre)	w/c ratio		VeBe time (s)		Agg. Size (mm)	Sand/agg. Ratio		P/M Ratio
	Min.	Max.	Min.	Min.	Max.	Min.	Max.	Max.	Min.	Max.	Min.
Hardfill .	2250	2350	20	1.2	1.7	20	35	40	0.28	0.46	0.35

All Hardfill placed under this Contract shall be Grade 5/40. (60 day characteristic cube strength of 5MPa utilising 40mm maximum sized aggregate). The associated GEVR and/or GE-Hardfill shall be Grade 20/40.

PPS10.3.6 Materials

PPS10.3.6.1 Cementitious Materials

Only Ordinary Portland Cement (CEM I), or a Portland composite cements (CEM II or IV, with extenders only being pozzolanic material) shall be used in Hardfill. All cements shall conform to SANS 50197 Parts 1 & 2 and careful consideration shall be given to thermal design issues should a cement with a heat of hydration at 7 days of greater than 300 KJ/kg (75 calories per gram) be used. The Fly Ash (FA) component shall conform with the requirements of SANS 1491 Part 2.

Only cement with a total alkali content, expressed as the sodium oxide (Na₂O) equivalent, not exceeding 0,6%, where % Na₂O equivalent = % Na₂O + (0,658 x % K₂O) will be acceptable. Should it not be possible to obtain cement with a total equivalent alkali content as low as 0.6%, then the potential occurrence of alkali aggregate reaction (both alkali silica and alkali-carbonate) with the specific aggregates to be applied must be investigated through laboratory testing at the expense of the *Contractor*.

Cement supply to the site shall be in the form of pre-mixed 50kg bags unless the Engineer approves bulk delivery for use with an approved mechanical cement spreader and suitable silo storage facilities complying with the applicable storage, calibration and quality-control requirements.

PPS10.3.6.2 Aggregates

The sum of the percentages of all deleterious substances in aggregate, as delivered to the Mixing Platform shall not exceed 2 percent by mass. All aggregates shall conform to the requirements of SANS 1083 and 1090 with sieving done in accordance with SANS 3001-AG1 and shaped to meet the requirements of BS812 Part 105 as per .

a) Moisture Content

The free moisture content of the fine aggregate, as placed in the Mixing Platform, shall be controlled so as not to exceed 6 percent expressed as a percent by weight of the saturated surface dry aggregates.

The moisture content of the coarse aggregate shall be controlled so that the aggregates placed on the Mixing Platform with the least amount of free moisture and the least variation in free moisture practicable



under the specific site conditions. Under no circumstances shall coarse aggregate be delivered to the Mixing Platform "dripping wet."

The maximum moisture content of the combined fine and coarse aggregate shall permit sufficient additional water to be dosed during final mixing (refer to PPS10.6.5) to achieve the target moisture content within the approved diamond-shape acceptance envelope. Moisture variation during aggregate production and Hardfill mixing shall be controlled so that the final mixed material remains within the approved envelope and satisfies the specified consistency and compaction requirements.

b) Quality

The *Engineer* may direct that samples of the proposed aggregates be submitted to an acceptable laboratory to determine the following properties in accordance with SANS 1083:

- 1) Soundness.
- 2) Alkali-reactivity.
- 3) Shrinkage.

In instances when the results of the above tests, in the opinion of the *Engineer*, suggest that the proposed aggregates indicate significantly worse performance under any of the above tests than aggregates of similar mineral composition that have successfully been used in concrete, use of these aggregates shall not be sanctioned.

c) Coarse Source Aggregate

i) General

Coarse aggregate shall consist of natural gravel or crushed rock, or a mixture of the two and shall be well, evenly and consistently graded. All coarse aggregates for the production of Hardfill at the Ntsonyini Dam shall be of Doloritic origin. Contamination from the underlying mudstones in the quarry/foundation excavations shall be avoided through careful quality control and selective excavation techniques.

The aggregate shall be of a hard and durable quality, roughly cubic in shape and clean and free of dirt, dust and other deposits such as clay and mud.

The aggregate shall not contain any components detrimental to the making of good quality concrete, such as chlorides, shale, mica or any other similar flaky substances. The aggregate shall not be so elongated or flaky in form that compaction, density, strength, durability or workability of the concrete, or Hardfill made therefrom is adversely affected.

ii) Grading and Particle Distribution

The coarse aggregate to be applied for Hardfill dam construction shall originate from a single source and crushed using a suitable crushing plant to produce optimal particle shapes and distribution.

iii) Particle Shape and Grading

The coarse aggregate shall have a limited number of flaky or elongated particles such that the sum of the Flakiness and Elongation Indices of each size of coarse aggregate shall be less than 35% when tested in accordance with BS812 Part 105. Sampling and testing of both fine and coarse aggregate shall be performed in accordance with the SABS Standard. All test samples shall be taken in sufficient time to permit adequate testing and examination of results before used in Hardfill.

iv) Quality

In addition and amendment to the requirements of SANS 1083 "Aggregates from natural sources", the coarse aggregate for Hardfill shall fulfil the requirements of Table 2.



Table 2 Coarse Aggregate Properties

Property	Requirements
Form / particle shape.	The percentage voids shall be less than 48.
Water Absorption.	Water absorption shall not exceed 1 percent by mass.
Materials passing the 75 micron sieve.	such that in combination with the fine aggregate the percentage passing meets the requirements of Table 4.
Light material.	The percentage of light material, for example coal and lignite, shall not exceed 1% by mass.
Aggregate Crushing Value.	Maximum 38%
10% Fact.	Minimum 70 kN.

d) Fine Source Aggregate (Sand)

i) General

Fine aggregate shall be good quality, clean river or crusher produced material, or a suitable blend thereof. The material shall be free of organic material, clay, humus, shale, dirt, dust, coal or any other impurity likely to be detrimental to the making of quality concrete and shall be washed if necessary. The texture of the sand shall be coarse and consist of hard, sharp grains.

ii) Grading and Particle Distribution

The sand shall be well and evenly graded. Significant attention shall be given to ensuring that the correct grading of the aggregate, as delivered to the Mixing Platform, is maintained and if variations are outside allowable limits, corrective measures must be implemented immediately.

The grading of the fine aggregate as delivered to the Mixing Platform shall be such that the cumulative percentage passing any sieve shall not vary by more than 4% points from that finally specified for the particular gradation selected. The grading of the fine aggregate shall also be controlled so that the fineness moduli of at least four of any five consecutive test samples of the fine aggregate as delivered to the mixer shall not vary by more than 0.20 from the fineness modulus of the fixed gradation selected by the *Contractor* and approved by the *Engineer*.

In order to achieve the grading requirements specified above, it may be necessary to blend fine aggregates from more than one source. Particular care shall be applied to ensure that the fine aggregate grading is not deficient in the 0.150 to 1.18 mm fraction. Depending on the overall cementitious materials content of the Hardfill mix to be developed, some benefit is likely to be gained in overall Hardfill consistency properties in an increased proportion of material across this grading fraction.

The *Contractor* may choose to separate the fine aggregate into two or more sizes or classifications, but the uniformity of grading of the separate sizes shall be controlled so that they may be combined throughout the job in fixed proportions established during the first 30 days of concrete placement.

iii) Quality

In addition to the requirements of SANS 1083 "Aggregates from natural sources", the fine aggregate for Hardfill shall fulfil the requirements of Table 3.

Table 3 Fine Aggregate Properties

Property	Requirements
Form / particle shape.	The percentage voids shall be less than 48.
Water Absorption.	Water absorption shall not exceed 1 percent by mass.
Light material.	The percentage of light material, for example coal and lignite, shall not exceed 1% by mass.
Soluble, harmful. Impurities.	The strength of mortar cubes made with the unwashed sand shall not be less than 85% of the strength of mortar cubes made with the same sand washed.

e) Combined Aggregate

Following combination and initial mixing, the combined aggregate grading limits are indicated in Table 4.



Table 4 Allowable Combined Aggregate Grading Bands

Sieve Size (mm)	Percentage passing indicated sieve size	
	Maximum.	Minimum.
47	100	100
40	100	90
26.5	90	65
19	76	51
9.5	58	37
4.75	46	28
2.36	37	20.5
1.18	30	15.5
0.425	22	10
0.3	20	8.5
0.075	14	5

The *Contractor* shall be permitted to manufacture a single aggregate in a multiple stage crushing and screening plant that meets the requirements of Table 4 and PPS10.3.6.2 c) and d) as per their individual portions (greater or less than 4.75mm) provided this can consistently be assured.

PPS10.3.6.3 Water

Water used for Hardfill mix manufacture shall comply with the requirements of the Concrete Specifications. The water used for washing, or cooling aggregate and for mixing and curing Hardfill shall be fresh and free of deleterious amounts of oil, acid, salt, alkali, organic, or any other harmful substances.

PPS10.3.6.4 Admixtures

The provisions of the Concrete Specifications shall apply. Acceptance of water-reducing set retarding admixtures shall be based on compliance with ASTM C 494, type D & G.

Satisfactory facilities for ready procurement of adequate test sample admixtures shall be provided. Tests shall be carried out for all admixtures to be used in associated Concrete or Hardfill. Admixtures shall not contain chlorides and shall conform to the following applicable standards:

- Set-retarding admixtures ASTM C494 (type D &G)
- Water reducing admixtures ASTM C494 (type D & G)
- Air entraining admixtures ASTM C260.

PPS10.3.6.5 Deteriorated Material

Material which has deteriorated, or which has been contaminated or otherwise damaged shall not be used. Such material shall be removed from the site without delay.

PPS10.4 MATERIALS DELIVERY, STORAGE AND HANDLING

PPS10.4.1 Cementitious Materials

PPS10.4.1.1 General

Cementitious materials shall be delivered to site in pre-mixed 50 kg pockets, unless bulk delivery is approved by the Engineer.

PPS10.4.1.2 Storage

Immediately upon receipt at the construction site, cementitious materials shall be stored in a dry, weather-tight, and properly ventilated structure. All storage facilities at the site shall be subject to acceptance and shall be such as to permit easy access for inspection and identification. The cementitious materials storage facilities shall be painted in a reflective colour and protected from direct sunlight as far as possible. Cementitious materials should not be delivered to site at temperatures above 60°C.

Sufficient cementitious materials shall be in storage to complete concrete requirements for ten operating days of continuous placement during peak production periods. In order that cement may not become unduly aged after delivery, any cementitious materials which has been stored at the site for more than 60 days or more shall be used before cement of lesser age.



PPS10.4.2 Aggregates

PPS10.4.2.1 Bulk Storage

The provisions of the Concrete Specifications shall apply. Aggregate shall be stored in such a manner as to prevent the inclusion of foreign materials. All aggregates shall be stored in free-draining areas safe from the influence of floodwater.

In addition, the *Contractor* shall ensure that supply rates and storage facilities for aggregates are sufficient for the rate of Hardfill placement applicable. At least 40% of the full requirement of aggregate for Hardfill placement shall be stockpiled before the start of Hardfill placing for the dam. The total quantity of all aggregate required shall have been delivered to the stockpiles one month ahead of the planned completion date of the Hardfill placement for the dam. The *Contractor* shall conduct the loading operations to ensure that the stockpiles shall be maintained in a safe condition and so that wastage of materials is kept to a minimum.

The heights of the stockpiles shall be limited so that segregation is minimised. The *Contractor* shall use care in loading and handling material from stockpiles so that aggregate shall not become contaminated with soil or other foreign material. Traffic on top of the stockpiles shall only be permitted with wheeled equipment and after it has been proven that this traffic does not break the aggregate particles and does not affect the gradation beyond the specified limits. Working with tracked equipment on top of the stockpiles shall not be allowed.

PPS10.4.2.2 Mixing Platform Stockpiles

A minimum supply of aggregates sufficient for two week's production shall always be available in stockpiles close to the Mixing Platform. Storage facilities and arrangements shall be configured to prevent contamination between different aggregate sizes.

Aggregate stockpiles at the Mixing Platform shall be located and orientated such that heat absorption as a result of direct exposure to solar radiation is minimized. Processes for recovering aggregate from the stockpiles shall specifically avoid areas exposed to direct sunlight, such as loading from the shaded side. Protective measures, such as shade cloth or steel roofs, shall be provided over all stockpile areas actively, or likely to be, used on the day of production and active measures, such as evaporative water/mist spraying, shall be applied to the coarse aggregate fractions during daylight hours and throughout the year.

PPS10.5 PLANT

PPS10.5.1 General

All plant shall be suitable for the production of good quality Hardfill under the conditions applicable on the site. The use of equipment that shall not properly mix, handle or place Hardfill of acceptable quality shall not be permitted. All plant shall be maintained in good working order and shall be of adequate capacity to comfortably meet the requirements of peak production on a sustained basis. If it becomes necessary to consider an accelerated production rate and the *Contractor's* existing plant is of inadequate capacity, they shall provide appropriate additional equipment. The *Contractor* shall ensure that adequate plant is available and operational to meet the necessary production requirements and shall take all measures necessary to eliminate any production "bottlenecks" that might be encountered. All plant shall be operated by trained and experienced personnel.

All Hardfill batching, mixing, placement and compaction plant and equipment shall be in place and ready at least 15 days before initiation of the construction of the Full-Scale Trial.

The total capacity of the production personnel, plant and conveyance equipment shall be capable of producing a peak of 1865 cubic metres of Hardfill per day on consecutive days. This capacity is based on producing sufficient mixed Hardfill to place the maximum layer volume on the dam, with a minimum required placement rate of one complete layer per day extending from abutment to abutment and between the upstream and downstream forms.

Where required by the Mixing Platform layout, production planning shall allow for the progressive preparation of new mixing lanes immediately after preceding lanes have been cleared, so that the required daily production capacity and placement tempo can be achieved. All production personnel, plant, conveyance equipment and Mixing Platform operations shall be coordinated and arranged to maintain this output while also preparing the Mixing Platform for the following day's production. The capability of the full range of plant to meet full capacity production for a sustained period of at least two days shall be demonstrated during the construction of the Full-Scale Trial. Hardfill produced in excess of the requirement



of the material in the trial section shall be utilised to construct haulage roads which shall be used as part of the construction of the dam, and the cost thereof shall be included in the trial mix allowances.

Should it not be possible to successfully demonstrate these production requirements, within the framework of producing uniformly high quality Hardfill, appropriate rectification or an increase in plant capacity shall be required with immediate effect. The specified production test shall be repeated until acceptable compliance is achieved.

For the production trials on the Full-Scale Trial, the final conveyance systems for the main dam shall be used.

All plant and equipment shall be maintained in good operating condition. The equipment shall not leak or drip oil, grease or other visible contamination onto the Hardfill surface. All equipment re-entering the dam surfaces must be cleaned of all contaminants by an approved method.

For critical production, conveyance, placement, compaction and quality-control plant, the *Contractor* shall prepare and maintain a plant redundancy plan identifying the plant items whose failure could materially affect continuity of Hardfill production or placement, the proposed standby arrangements, and the anticipated time required to restore production. This shall include, but not be limited to, the Stabiliser/Recycler and water truck, articulated front-end loader, motor grader and spreading dozer. Direct on-site standby plant shall not be required for every critical item, provided that the *Contractor* demonstrates to the satisfaction of the *Engineer* that equivalent replacement plant, or suitable repair resources and spare parts, are available from off-site sources and can be mobilised, delivered to site, commissioned and made operational within 24 hours of the relevant plant failure. The redundancy plan shall include contact details of suppliers or owners, transport arrangements, mobilisation procedures, and evidence that the proposed off-site resources will remain available for the duration of the Hardfill placement works. The acceptance of off-site standby arrangements shall not relieve the *Contractor* of responsibility for achieving the specified production rates, maintaining continuous placement operations, or preventing defects arising from plant breakdowns.

PPS10.5.2 Mixing Plant

PPS10.5.2.1 General

Mixing of Hardfill constituents shall be undertaken using a hydraulic all-wheel drive Mechanical Stabiliser/Recycler, Wirtgen WR 240 and water truck combination, or equal approved. The Equipment shall have a mixing width of 2.4 m and a depth of 500 mm. Moisture dosage shall be controlled with a resolution of 0.1 percentage point and an accuracy of ± 0.05 percentage point, based on the defined layer density and thickness. The associated water truck for dosing shall provide a minimum of 20 000 litres, and be capable of being driven by the mechanical stabiliser.

Should the mixing plant at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

PPS10.5.2.2 Ancillary Plant for Mixing

In addition to the Mechanical Stabiliser/Recycler, the Hardfill mixing process shall be supported by the use of the following ancillary equipment:

- Articulated front-end loader fitted with a general-purpose bucket of capacity not less than 2.0 m³ and shall be capable of safely and efficiently loading the articulated trucks specified in Clause PPS10.5.3.2.
- Smooth drum Vibratory Roller as per Clause PPS10.5.6 a).
- Self propelled motor grader of not less than 170 hp, fitted with a minimum 3.6 m hydraulically controlled moldboard, suitable for road formation, shaping and accurate trimming and fitted with laser grade control systems capable of finishing layer works withing ± 10 mm accuracy. The motor grader shall not be used to spread Hardfill on the dam placement surface.
- Compatible laser based level monitoring control equipment.
- Laboratory equipment (see Clause PPS10.5.14).

All ancillary plant shall be suitable for moving, loading, trimming levelling, etc. Hardfill materials as described herein.



Not mandatory, but the following additional ancillary equipment shall expedite mixing and improve quality assurance:

- Purpose-designed mechanical cement spreader capable of accurately and uniformly applying dry cement at the specified rate (kg/m^2). The spreader shall provide adjustable spread width, controlled discharge, and effective dust suppression. Calibration shall be demonstrated to the satisfaction of the *Engineer* prior to use.
- Provision of a cement spreader shall allow the use of cement supply in bulk to be stored on site in silos in lieu of bags as per Clause PPS10.3.6.1.

PPS10.5.3 Conveyance and Transporting Equipment

PPS10.5.3.1 General

Methods and equipment for handling, hauling and depositing the mixtures shall be designed in detail by the *Contractor*. All conveyance equipment that leaves the surface of the dam for any reason, must be cleaned of all contaminants by an approved method before returning to the dam surface. No mechanical maintenance of any equipment or plant may be undertaken on the dam surface.

PPS10.5.3.2 Dump Trucks

Fresh Hardfill shall be conveyed from the Mixing Platform to the dam site in articulated dump trucks of capacity no greater than 37 tonne. The *Contractor* shall ensure that the bodies of all dump trucks are sound and that no material is lost during transit from the mixer to the placement area.

There shall also be no tendency for the Hardfill to hang-up on any part of the body of the truck during offloading. Hardfill shall be dumped with the truck positioned on top of Hardfill that has just been spread and not on the compacted surface of the previous layer. This operation eliminates segregation in the dumped Hardfill and can only be avoided when a device such as a spreaderbox on the dump bed is used.

Typical concrete hopper trucks shall not be used for Hardfill conveyance. The final conveyance procedures shall be defined by a series of sketches, to be approved by the *Engineer*, once these have been established through the Hardfill Full-Scale Trial.

Road trucks will not be permitted for conveyance of mixed Hardfill.

PPS10.5.3.3 Chutes

If a chute is used to transport or place the Hardfill, the *Contractor* shall ensure that the capacity of the chute is sufficient for the necessary rate of Hardfill placement. There shall also be no segregation of material when falling through the chute, or during any stage of transportation and any segregated material at the end of the chute shall be remixed before placement.

PPS10.5.4 Spreading Equipment

Spreading of the Hardfill after dumping shall be by means of a laser-guided bulldozer. Self-propelled motor graders will not be permitted. The spreading method applied shall not cause any segregation or breakage of the constituent Hardfill materials. The control of the equipment shall be such that the layers are spread evenly to an accuracy of plus or minus 50 mm. The level to which succeeding layers are placed shall be controlled using a laser system that automatically adjusts the blade of the spreading bulldozer.

There shall be a minimum of one operating dozer. The dozers shall be equipped with well-maintained street pads, or grousers, which are cut to a maximum projection of 20 mm, and shall have a "U" blade and lateral wings to prevent segregation. The dozer should be the size of a CAT D4, or D5, as appropriate for the placement rate to be achieved. A small wheel dozer or a front-end loader with operator shall be available to assist with deposition and spreading of Hardfill as needed in confined areas, at the abutments and at other locations as approved or directed. At least one compact loader (Bobcat S250, or A300, or similar) shall be kept permanently on the placement surface for the delivery of Hardfill to restricted areas and for removal of rejected Hardfill. Spreader box mounted on a dozer or front-end loader or other spreading and re-mixing equipment shall not be used. The operation of a dozer or other tracked vehicle on any Hardfill other than fresh uncompacted Hardfill shall not be permitted. Where the movement of a dozer on a compacted, or partially compacted Hardfill surface is unavoidable, the surface shall be protected as indicated here below and in case any damage occurs this material shall be removed to expose competent Hardfill and the appropriate surface preparation shall be applied before placement of the subsequent layer.

When it is necessary to remove a tracked vehicle from the dam surface, or move the dozer from one abutment to the other, such movements shall be made by loading the vehicle onto a rubber-tired trailer, by



providing protective pads such as conveyor belt between the grousers and Hardfill surface, or by providing some other approved protective device.

PPS10.5.5 GEVR/GE-Hardfill (Grout Enriched Vibrated Hardfill) Equipment

Grout for GEVR/GE-Hardfill shall either be mixed in a grout mixing plant external to the dam and pumped through pipes to the point of placement, or mixed in a truck mounted with a grout mixing plant that is moved on the lift as required. The distribution of the grout to the point of placement shall be made in the bucket of a front-end loader, directly by pipes, small buckets or conveyed by some other approved means. Experience has demonstrated significant advantage in the first mentioned system. Appropriate immersion vibrators of diameter greater than 100mm shall be used to ensure an even and complete distribution of grout within the grout enriched Hardfill and an appropriate self-propelled double drum vibratory roller and a vibratory plate-compactor shall be provided to compact the interface between the Hardfill and the grout enriched Hardfill. All plant used shall be so configured as to ensure that the grout is fresh when poured and compacted.

PPS10.5.6 Compacting Equipment

The Hardfill shall be compacted to a density as defined in Clause PPS10.6.8 by means of an approved self-propelled smooth drum vibratory roller. Where large rollers are unable to compact the Hardfill satisfactorily, for example alongside pre-placed vertical surfaces, a grout enriched Hardfill shall be used and the interface with the Hardfill shall be compacted with approved small vibratory rollers and vibrating plate compactors. The thickness of the compacted layer shall be determined during trials on the Full-Scale Trial. The target final layer thickness shall generally be 300 mm.

a) Self-Propelled Vibratory Rollers

Vibratory Rollers shall be self-propelled. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The rollers shall be equipped with a reversible cam to allow the compaction action in both forward and reverse directions. The large compactors shall have a gross weight between 10 t and 12 t, producing a minimum dynamic force of 125 kg/cm of drum width at an operating frequency of at least 25 Hz and variable amplitude within an approximate range of 0.70 mm to 1.70 mm. The roller drum shall be a minimum diameter of 1 400 mm and more than 2 100 mm in width. The roller shall be operated at speeds not exceeding 2.5 km per hour. The engine driving the eccentric mass shall have a rating of not less than 70 KW.

All vibratory rollers shall be properly maintained to ensure the maximum compactive effort of each roller is being achieved. All vibratory rollers operating on each layer of Hardfill shall be of the same make and model number.

Within the range of the operational capability of the equipment, the *Engineer* may direct or allow variations to the frequency and speed of operation, which result in maximum density at the fastest production rate. At least two large self-propelled vibratory rollers meeting these requirements shall be maintained (with operators) on the placement area at all times during placement, and one at the mixing platform during Hardfill manufacture.

b) Vibrating Plates and Small Vibratory Rollers

Small double smooth drum vibratory rollers with a gross weight between 1.5 t and 3.0 t, which are capable of operating within 150-300 mm of a vertical face, shall be used to compact the Hardfill in areas where the larger vibratory rollers specified above cannot manoeuvre. These shall also be used to compact the interface between Hardfill and grout enriched, or immersion vibrated Hardfill, or facing kerbs. The dynamic force produced by the small rollers shall be at least 10 kg/cm of drum width and the vibrating frequency shall be at least 55 Hz. Both drums should vibrate simultaneously with these minimum parameters and the drums shall be approximately 1000 mm wide. Reversible vibratory plate compactors shall be used to finish the compaction of the Hardfill surfaces along the abutment slopes, along the upstream and downstream formwork and other areas where the small vibratory rollers specified above cannot manoeuvre. They shall have an operating weight between 60 and 150 kilograms, and a minimum vibrating frequency of 60 Hz. The amount of compaction required shall be as necessary for the particular equipment to provide the same degree of compaction as would be attained with ten passes of the large self-propelled vibratory roller specified above. At least two small rollers and three plate compactors in good operating condition shall be maintained on the placement area during all production operations.



c) Immersion Vibrators

GEVR/GE-Hardfill shall be used in narrow areas of the layer of difficult access for the small rollers. The conventional slump concrete, the GEVR/GE-Hardfill and the Hardfill / slump concrete interface shall be consolidated by immersion vibrators. The head diameter, frequency (measured immersed) and average amplitude (measured in air) of the vibrators shall conform to the following requirements:

Head Diameter (mm)	Frequency (cycles per minute)	Amplitude (mm)
100-150	7 000 – 10 500	0.75 - 1.5.

In no case shall vibrators be used to transport material within the formwork. Vibration shall be systematic, with emphasis on closely spaced insertions. The duration shall be sufficient to produce good consolidation. There shall be adequate air pressure available for air vibrators and adequate voltage for electric vibrators. At least five immersion vibrators shall be kept in operation at the point of facing concrete placement to ensure that facing concrete is compacted with minimum delay. Spare vibrators shall be available to maintain production in the event of a breakdown.

In addition, the *Contractor* may mount a group (4 to 6) of hydraulic immersion vibrators on a wheeled item of plant, such as a small skid-steer loader, to allow a greater compaction effort and consequently more rapid GEVR/GE-Hardfill compaction.

PPS10.5.7 Surface Preparation Equipment

a) Portable Pressure Washer

Portable pressure washers shall be used (and designed) for washing and cleaning the Hardfill layer and lift surfaces, as required during the regular course of Hardfill placement. The units shall facilitate the removal (without damaging or undercutting coarse size aggregates) of all loose materials, grime, dirt, oil, or any hard packed or loose contaminants from the Hardfill surface during all weather conditions expected at the project site. The portable high pressure washers shall have a nozzle gun and hose capable of easily being handled by one labourer. The washer shall be capable of developing a working pressure of not less than 250 bars at the nozzle and shall have a discharge capacity between 25 and 100 litres per minute.

b) Hand Cleaning Tools

Nylon brooms shall be used to clean the Hardfill surfaces. Large sponges and buckets shall be provided to mop up any standing water. Compressors with air hoses shall be used to remove loose material from the surfaces.

c) Mechanical Brush

As alternative to hand methods, a rotating highway-type brush, carried on a wheeled front end loader, 30 - 35 ton operating weight, or similar equipment may be used for lift surface clean up. Different types of brush materials shall be used, depending on the operation, with a minimum of three nylon or synthetic material tines.

PPS10.5.8 Other Equipment

All other equipment necessary for successful Hardfill production, but not discussed within this specification (or determined to be necessary during the course of the work) shall be approved prior to actual use. The use of such equipment shall not result in any damage to the Hardfill. Equipment shall be maintained in good operating condition and operated by skilled personnel.

PPS10.5.9 Nuclear Density Gauge

Readings to determine the density of both uncompacted and compacted Hardfill shall be made using nuclear density gauges supplied by the *Contractor*. The gauge shall be capable of taking readings to a depth of 300 mm. At least three gauges in full working order shall be retained on site for the duration of Hardfill placement. (two at the Mixing Platform and one on the dam) The *Engineer* shall have access to the gauges at all times and shall be allowed to use them for quality assurance check tests. A listing (on the *Contractor's* license for operation of the nuclear gauges) of all certified personnel of the *Engineer* who are to use the nuclear gauges shall be provided. On-site nuclear density gauge training shall be provided for both *Contractor* quality control and *Engineer* quality assurance personnel.



PPS10.5.10 Formwork

The requirements of the concrete specification shall apply.

All formwork shall be designed and constructed in such a manner to ensure that the concrete can be placed and compacted to the required shapes, finishes, positions, levels and dimensions as shown on the drawings. The formwork shall be capable of resisting all dead and live loads to which it is subjected and shall be maintained rigidly in position. Special attention shall be given to the design of the formwork and the anchoring system. All formwork shall be designed for the specific characteristics of the Hardfill/GEVR/GE-Hardfill, as applicable, and the placement methods and rates applied.

The types of ties used and their spacing shall be such that the required finish is achieved and shall not be marred by the subsequent corrosion of ties. The formwork and the formwork joints shall be sufficiently tight to prevent any loss of mortar or grout.

Stripping of formwork shall not be commenced until the supported Hardfill has achieved sufficient strength to fully support itself and any subsequent layers placed thereafter.

Recesses resulting from removal of form ties shall be patched using a method and materials to be approved by the *Engineer*.

PPS10.5.11 Temperature Reading Equipment

The *Contractor* shall supply the following equipment:

- a) A digital type immersion thermometer to measure Hardfill placement temperature on the dam wall and another at the Mixing Platform. It shall have a penetration probe length of approximately 700 mm and temperature range of -10 °C to +50 °C (to an accuracy of 1.0 °C).
- b) A mercury thermometer to measure the ambient temperature at the site of Hardfill placement. The thermometer shall have a temperature range of -10 °C to +50 °C (to an accuracy of 0.5 °C).

PPS10.5.12 Sampling Facilities

The site shall be equipped with adequate facilities and equipment to allow the sampling of Hardfill at the point of placement. After measuring the temperature of the mixed Hardfill, a representative sample, of approximately 500 kg, shall be transported directly to the site laboratory without delay. The sampling device shall be capable of obtaining samples from the mixing lanes at the Mixing Platform. The sampling container shall be approved, shall have a sealing lid and a capacity of at least 500 kg and shall have a gate at the bottom for discharge of the sample from the container to the damp lab floor. The sample shall be mechanically transferred to a mechanical screening device having an approximate screening area of 600 mm wide by 750 mm long with 37 mm square openings. A 6.25 mm steel plate shall be placed on the floor underneath the screening device, and this shall extend a minimum of 1.2 m along the length of one side and shall provide a minimum of 4.5 m of working space. Waste from the tested samples shall be disposed of immediately.

PPS10.5.13 Laboratory Areas

A concrete testing laboratory with a minimum floor area of 100 m² shall be required on site. This laboratory shall be provided with electrical power and air conditioning, and shall be equipped with 60 m² of open floor area and 10 m² of tabletop / bench area. An additional covered area of 70 to 75 m² must be provided to house the curing baths and at least one office shall be provided for the use of the *Engineer*.

PPS10.5.14 Laboratory Equipment

The following lists the absolute minimum major equipment for the site laboratory:

- a) A cube press capable of crushing 150 mm square Hardfill cubes up to 40 MPa strength.
- b) Two sets of grading screens each for the coarse and fine aggregates.
- c) A large capacity microwave and convection oven.
- d) Running water and electric power supply.
- e) A scale accurate to 10 g, with a capacity of 250 kg.
- f) A scale accurate to 1 g, with a capacity of 12 kg.
- g) A nuclear density measurement device, capable of measurement at 300 mm depth.
- h) Two (2) modified VeBe apparatus, in accordance with BS 1881 (paragraph 3.1), with a surcharge mass of 10 kg and a total moving mass of 12.5 kg ± 100 g. The *Contractor* shall make use of a VeBe pot made of steel-edged Plexiglass, rather than steel, as a better visualization of the precise moment that the Hardfill liquefies is possible.



- i) Vibrating table capable of compacting at least 9N^o 150-mm cubes at the same time.
- j) A PC for data recording and processing of mix design variation.
- k) Concrete thermometers.
- l) A laboratory pan concrete mixer (vertical axis) capable of mixing at least 150 ℓ of zero-slump Hardfill.
- m) Cubic metal moulds complying with the requirements of BS 1881. 100 No. 150 mm moulds.
- n) Curing baths, with a water temperature thermostatically controlled to between 22 and 25 °C, of an adequate capacity to store 500 No. 150 mm concrete cubes and core segments.
- o) A slump cone with a rod.
- p) Penetrometer (as described in ASTM C403M).
- q) 15 No. 150 x 150 x 300 mm steel moulds for mortar samples used in the setting time tests.
- r) Mechanical sieve of large capacity for sieving 5-mm mortar out of the Hardfill mix.
- s) Two (2) galvanised curing tanks fitted with thermostatically controlled temperature to maintain curing water up to 92°C (accelerated curing). The tanks shall be capable of storing each 50N^o cubes 150 mm size.

It is the *Contractor's* responsibility to ensure that he is in possession of all of the necessary equipment and testing apparatus to execute all required testing and quality control procedures. The *Contractor* shall further ensure that all equipment is properly maintained in a fully functional and accurate condition for the duration of construction and that all necessary calibrations are regularly completed in accordance with the national standards requirements. A copy of the full range of specified testing procedures shall be kept in the laboratory at all times.

PPS10.5.15 Hardfill Quality Records

For the purposes of producing records of placed Hardfill quality, an adequate number of diamond core drills capable of drilling 150 mm diameter cores to vertical depths of 35 m and horizontal depths of 10 m shall be required. Adequate spare core barrels and bits shall be made available to ensure the continuity of this drilling work. Furthermore, platforms shall be created to allow the drilling of cores on a continuous basis from the downstream face of the dam, as and where necessary. A facility shall be included to allow the vertical and horizontal movement of these platforms freely up and across the face of the dam.

PPS10.5.16 Safety Barriers

Effective and acceptable temporary guardrails shall be provided at the top of the formwork and on the crest at the upstream and downstream edge of each layer to protect workers from falling, to prevent loss of tools or debris over the edge and to protect any personnel below from falling objects.

PPS10.5.17 Communication Equipment

A dedicated telephone or radio communication system shall be provided, maintained and operated between the Mixing Platform and the placement site. Mixing and placing Hardfill shall not be carried out in the absence of this operable communications system.

PPS10.6 CONSTRUCTION

PPS10.6.1 General

Hardfill shall generally be transported in dump trucks and placed in layers of 300mm (compacted) on the dam wall.

PPS10.6.2 Hardfill Mix Specification

The Hardfill mix shall comply with the strength requirements of this specification. The Hardfill mixes shall only be deemed to be final once proved through construction of the Full-Scale Trial. All Hardfill mixes are Strength Concrete. The mixture proportions of the Hardfill shall be within the ranges given in Table 5.

The quantities indicated in **Table 6** shall be considered as tender mixes and shall be used for pricing of the BOQ rates for the Hardfill mixes. During development of an appropriate Hardfill mix with the approved materials, the *Contractor* shall, in consultation with the *Engineer*, develop optimal, final mixes to be used in the Works.

Once the *Engineer* has approved these mixes, the *Contractor* may proceed with the placement of Hardfill. The cementitious content of the approved mixes shall be fixed for payment purposes and any increase in cementitious materials content from the Hardfill tender mixes shall be paid separately and any saving in a



reduction of cementitious materials from the tender mix shall be recovered separately.

Where the *Contractor* must subsequently increase the cementitious materials content of the approved mixes to maintain the specified strength requirements, such variation shall be deemed to be a result of insufficient quality control and shall be for the *Contractor's* account.

Table 5 Allowable range of mixture proportions to be used in the dam

Material	Unit	Minimum	Maximum
CEM I / CEM II / CEM IV Cement.	kg/m ³ .	70	100
Water : Cement Ratio.		Within the approved diamond-shape acceptance envelope.	
Coarse/Fine Source Aggregate Ratio.	%	70/30	100/0

The types of cementitious materials and aggregates shall not be altered for the duration of the contract without prior testing and approval.

No more than 10% of the cube strength test results shall be less than the Specified Hardfill Strength (5 MPa characteristic strength at 60 days age).

The coefficient of variation (CV) % for an average level of control shall be assumed in the design of the mix, according to table 6.4 of ICOLD Bulletin N°177 for all properties of the finally placed Hardfill.

Table 6 Hardfill mix breakdown (used for pricing of the BOQ rates)

Material	Unit	Mixture proportions
Type II Portland Cement.	kg/m ³ .	80
Coarse Source Aggregate.	%	85
Fine Source Aggregate.	%	15

PPS10.6.3 Requirements for Hardfill

The *Contractor* shall be solely responsible for the provision of suitable materials and the manufacture of Hardfill of the required quality. The mixture proportions used in the dam shall be within the ranges specified in Table 5 and the mix design parameters shall be within the range of values specified in Table 1.

Aggregate grading and moisture control shall be regarded as the primary means of assuring Hardfill quality during production, and checking these parameters shall be of the utmost importance. Strength specimens, including cubes, cylinders and cores as applicable, shall provide the subsequent stage of quality control by confirming that material produced within the approved grading–moisture envelope satisfies the specified hardened-property requirements.

PPS10.6.4 Hardfill Mix Design Development Process

The mix design development process shall demonstrate that the proposed Hardfill mix satisfies the specified requirements for aggregate grading, cementitious materials, workability, compactability, density, segregation resistance, setting time, compressive strength development, durability, constructability and quality-control tolerances before approval for full-scale use.

As a minimum, the *Contractor* shall undertake the staged Hardfill mix design development process described below. Each stage shall have a defined objective, test programme, acceptance basis and reporting deliverable. The process shall be progressively expanded into the Hardfill Mix Design Method Statement, Form N9, and submitted to the *Engineer* for approval within three weeks of Commencement.

a) Stage 1: Establish the Properties of the Materials

The first step in the Hardfill mix development process shall be to design the quarrying, crushing and sieving process, identify, test and report the characteristics of the proposed aggregates and cementitious materials, and to confirm that each material complies with all applicable requirements of this Specification.

At least two cement types shall be proposed.

This stage shall be undertaken in parallel with the quarrying (PPS6), crushing and sieving processes, and a search for sands in the surrounding rivers, so that controls applied during aggregate manufacture can assist in developing aggregate materials that meet the specified characteristics.



The trials and testing shall establish the variability, limits and suitability of each material source before laboratory trial mixes are prepared, and shall provide the basis for confirming that the selected materials are capable of satisfying the specified grading, quality, performance and construction requirements. Particularly important aggregate characteristics that influence fresh Hardfill behaviour include the flakiness and elongation indices of the coarse aggregates, the fines content of the sand and the compacted void ratio of the sand.

A range of grading curves from different combinations of stockpiled materials shall be evaluated to develop an optimum blend. The likely variation in grading within each stockpile shall also be evaluated, and sufficient representative samples shall be tested to assess its effect on the blended grading. The trials shall:

- Identify and document the proposed aggregate and sand sources, including the intended stockpile combinations or single aggregate source, as applicable.
- Determine the relevant material characteristics, including grading, fines content, flakiness and elongation indices, compacted void ratio and any other properties required by this Specification.
- Confirm that each proposed material complies with the applicable quality, grading and acceptance requirements specified in this Specification, including the prescribed minimum and maximum grading envelopes shown in Table 4.
- Establish the likely production variability for each stockpile or material source, based on sufficient representative sampling and testing.
- Demonstrate that the selected gradation limits represent credible field production extremes and provide a suitable basis for subsequent laboratory trial mixes.

b) Stage 2: Establish the Diamond Shape Acceptance Envelope – Laboratory Hardfill Trial Mixes

Stage 2 shall establish the relationships between aggregate grading, total water content, cement content, fresh Hardfill behaviour, compacted density and compressive strength. The testing shall define the range within which the Hardfill can be mixed, handled and compacted satisfactorily while achieving the specified density, strength and construction requirements.

This stage shall include screening and recombining the source aggregates to compare grading variances and Hardfill properties obtained with the selected source aggregate combinations. Mixes shall be optimised for cohesiveness, low segregation tendency and conformance with Table 1 properties.

Separate diamond-shape acceptance envelopes shall be investigated for nominal cement contents of:

- 1) 70 kg/m³ cement .
- 2) 80 kg/m³ cement;
- 3) 90 kg/m³ cement;
- 4) 100 kg/m³ cement;
- 5) As required to define the strength–cementitious content relationship and satisfy the specified performance requirements.

Where multiple cement types are proposed, each type shall be tested at the various contents.

During this stage of the mix development programme, accelerated curing tests shall be used to estimate the Hardfill strength at the nominated design age of 60 days, and shall be supported by conventionally cured specimens to establish and confirm an acceptable correlation between accelerated and conventional curing results, as per PPS10.6.4 g). Accelerated-curing results shall remain indicative until the correlation has been accepted by the Engineer.

The objective of this testing shall be to define the diamond shape acceptance envelope for the selected materials in the strength-gradation-moisture content space illustrated in Figure 2 below. The acceptance envelope is the region within which all tested mixes achieve or exceed the design compressive strength while maintaining acceptable fresh density, compactability, workability and segregation resistance.

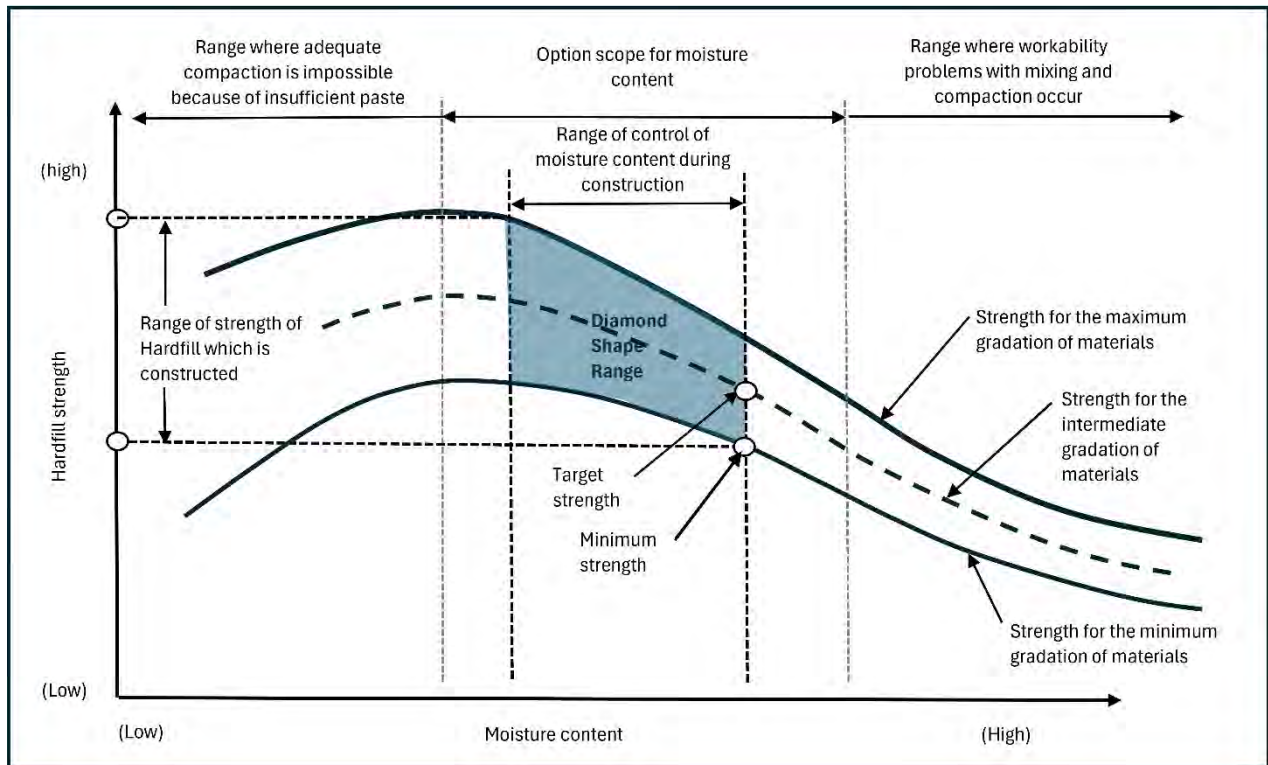


Figure 2 Mixing lanes and individual recycler pulls

Aggregates shall be blended in the laboratory to replicate the prescribed minimum and maximum grading envelopes as per Table 4, and an intermediate mid-point target grading. A matrix of laboratory trials shall be undertaken combining:

- At least three gradations (minimum, maximum and target (midway value)).
- At least five water contents spanning the full practical range from dry-side compaction failure through optimum moisture to wet-side workability failure.

This matrix shall produce a minimum of fifteen mix conditions and shall be sufficient to define the outer practical limits of the diamond-shape acceptance envelope in terms of aggregate gradation and moisture content.

For each cement content, the diamond-shape acceptance envelope shall comprise the tested combinations of grading and total water content that meet all the following requirements:

- Can be mixed, handled and compacted satisfactorily.
- Does not exhibit unacceptable segregation, ravelling, bleeding, paste migration or accumulation of coarse aggregate.
- Can be compacted without abnormal or excessive compaction effort.
- Achieve the specified fresh and compacted densities.
- Exhibit acceptable cohesiveness and segregation resistance.
- Satisfy the applicable Fresh and compacted Hardfill density requirements.
- Achieve the specified design-age compressive strength.
- Remain suitable for the proposed production and construction methods.
- Meet all other applicable fresh-Hardfill requirements in Table 1.

The Stage 2 testing report shall include:

- Mix proportions and Parameters (Table 1)
- Actual constituent-material and grading information.
- Complete mix proportions and actual water contents.
- Modified VeBe Time
- Fresh and compacted Hardfill density results.
- Accelerated and conventional compressive-strength results.
- Plots defining each diamond-shape acceptance envelope.
- The basis adopted for each envelope boundary.
- Sensitivity to grading, water and cement-content variation.



- The candidate mixes recommended for Stages 3 and 4.

Candidate mixes selected for Stages 3 and 4 shall lie within a robust central region of the applicable envelope and provide adequate tolerance for expected variations in grading and moisture content. Selection shall consider economy, strength, density, workability, compactability, segregation resistance and production robustness, rather than cement content or strength alone.

The *Contractor* shall not proceed to Stage 3 until the Stage 2 trial mix results, proposed acceptance envelope and recommended candidate mixes have been submitted to the *Engineer* and the *Engineer* has confirmed that the results provide a suitable basis for further optimisation.

c) Stage 3: Establish Hardfill Setting Times and Admixture Optimisation

Following selection of the best-performing candidate mixes from Stage 2, Stage 3 shall determine the setting characteristics of the Hardfill and confirm whether admixtures are required. Where admixtures are proposed or required, this stage shall establish the effective dosage range and demonstrate that the proposed admixture system is compatible with the selected cementitious materials, aggregate grading, water content and construction methodology. Particular attention shall be given to set retarders where required to satisfy the mixing, haulage, placing and compaction timing requirements of PPS10.6.7.3. Setting time tests shall be undertaken on the selected candidate mixes using a penetrometer in accordance with ASTM C403M, or another method accepted by the *Engineer*.

d) Stage 4: Final Laboratory Mix Optimisation and Hardened Property Verification

Stage 4 shall optimise the selected Hardfill mix and verify the hardened-material properties required for design and construction of the Works. Before commencing Stage 4, the proposed aggregate sources and target grading, cement type, admixture system, specimen-preparation method and accelerated-curing procedure shall have been established through Stages 1 to 3.

The Stage 4 laboratory programme shall be based on the best-performing candidate mix or mixes selected from the Stage 2 diamond-shape testing. Testing shall refine the cement and water contents around the selected operating point and shall identify the most economical mix that provides adequate performance margin and robustness against the anticipated variations in aggregate grading, aggregate moisture, batching, mixing and compaction.

The principal optimisation trials shall be undertaken using the proposed target production grading. The programme shall include not fewer than three closely spaced cement contents centred on the preferred Stage 2 cement content and, for each cement content, the target moisture content and representative dry-side and wet-side moisture variations. Confirmation trials shall be conducted using representative coarse-side and fine-side variations of the production grading. All trial conditions shall fall within, or assist in confirming, the diamond-shape acceptance envelope established under Stage 2.

Each trial mix shall be assessed for aggregate grading, total water content, cement content, water-cement ratio, fresh density, modified VeBe time, cohesiveness, compactability, segregation resistance, paste coating, adhesion to equipment, compacted density and compressive-strength development. Accelerated curing may be used for comparative screening and optimisation, provided that the accepted project-specific maturity-strength relationship is used. The selected candidate mixes shall also be tested using conventional curing through the nominated 60-day design age.

A separate enrichment trial programme shall be undertaken for GEVR, GE-Hardfill or combination thereof proposed at foundation contacts, against formwork or in other designated zones. The trials shall establish the enrichment materials and proportions, method and timing of enrichment, practical workability, grout penetration, vibration requirements, density, compressive strength, segregation resistance, interface behaviour and finished quality. Small-scale placement trials shall reproduce the relevant construction geometry and access constraints as closely as practicable.

On completion of Stage 4, the Contractor shall nominate two or three mixes for evaluation in the Full-Scale Trial. Unless otherwise accepted by the Engineer, these shall comprise the proposed production mix at target moisture content and representative dry-side and wet-side moisture conditions within the approved diamond-shape envelope. The nominated mixes shall be demonstrated to meet the specified fresh and hardened-material requirements before Stage 5 commences.

e) Stage 5: Full-Scale Trial and Production Control Confirmation

Stage 5 shall demonstrate and, where necessary, refine the selected Hardfill mix under full-scale construction conditions on the Full Scale Trial embankment. The Full Scale Trial shall confirm the suitability of batching, mixing, haulage, spreading, compaction, joint treatment, enrichment zones, GEVR or GE-



Hardfill interfaces, quality-control testing, construction tolerances and production control procedures. The Full Scale Trial shall also confirm that the approved laboratory mix design can be reproduced consistently using the proposed production equipment, personnel, procedures and field quality-control regime. See Clause PPS10.6.9.

f) Mix Design Reporting

Each stage of the mix design process shall be documented in a stage report and submitted to the *Engineer* for review and approval before the next dependent stage proceeds. The *Contractor* shall not proceed beyond a hold point until the relevant stage report, test results, proposed acceptance limits and recommended next-stage mix selections have been submitted and accepted by the *Engineer*.

Trial mix results shall be reported as they become available. Each trial mix report shall contain, as a minimum, the following information:

Each mix shall be recorded with, at minimum:

- Unique Trial mix number.
- Date cast.
- Aggregate gradation descriptor (minimum, maximum and target).
- Actual aggregate gradation and source (e.g. Stockpile No's)
- Total water content
- Cementitious materials content.
- Parameters as per Table 1.
- VeBe Density
- Absence or inclusion of admixtures, if used.
- 28 & 60 day accelerated compressive strength.
- 28 & 60 day conventional compressive strength.

Trial-mix reports shall state the actual accelerated-curing duration and temperature history, the calculated maturity or equivalent age, the estimated 28-day and 60-day strengths derived from the accepted correlation, and the corresponding conventionally cured compressive-strength results at 28 and 60 days.

The entire mix design process shall be summarised in a consolidated report describing the methodology, laboratory systems, equipment, personnel, procedures, source materials and mixes tested. The report shall collate the individual trial mix reports, present the approved mix proportions and allowable construction limits, and include conclusions and recommendations for production control during construction.

g) Accelerated Curing Testing

Accelerated curing testing shall be used during the laboratory mix development programme to provide early estimates of the compressive strength expected at the nominated design age. The accelerated curing procedure shall be based on maturity principles and shall be calibrated for the specific Hardfill materials, cementitious content, aggregate grading, moisture content and curing regime proposed for the Works.

The *Contractor* shall develop a maturity-strength relationship for each candidate mix, or group of mixes demonstrated to have equivalent maturity behaviour, by testing companion specimens cured under both conventional and accelerated curing conditions. The maturity index shall be calculated from the recorded time-temperature history of each specimen using an approved maturity method, such as the Nurse-Saul or Arrhenius equivalent-age approach. The datum temperature, activation energy or other maturity parameters adopted shall be justified by test data or relevant published guidance and shall be submitted to the *Engineer* for approval.

The accelerated curing regime shall not alter the moisture condition or cause drying, thermal damage, microcracking, delayed hydration effects or strength gain mechanisms that are not representative of the conventionally cured Hardfill. The curing temperature, duration, specimen size, insulation, demoulding time and storage conditions shall be controlled and recorded.

Accelerated curing results shall be correlated with conventionally cured compressive strength results at relevant ages, including the nominated design age of 60 days. The *Contractor* shall demonstrate that the correlation is sufficiently reliable for screening and mix optimisation purposes before accelerated results are used to infer design-age strength. Until the correlation has been accepted by the *Engineer*, accelerated curing results shall be treated as indicative only and shall not replace compliance testing of conventionally cured specimens.

The trial mix report shall include the accelerated curing procedure, time-temperature records, calculated maturity indices, compressive strength results, maturity-strength curves, correlation plots against



conventional curing results, proposed acceptance limits and any restrictions on the use of accelerated curing results for production control.

PPS10.6.5 Hardfill Mixing

PPS10.6.5.1 General

The method by which materials are batched into mixing trucks to effect mixing shall not be permitted for the production of Hardfill. Hardfill constituents shall be mixed by means of mechanical stabilisation techniques, utilising a Mechanical Stabiliser/Recycler.

The principle of the required Hardfill production is the combination of a coarse and fine aggregate (quarry, and crushed or natural river sand material respectively) utilising the principles of road construction in dedicated temporary mixing lanes on a prepared Hardfill Mixing Platform, separate from the dam body. The addition of cement and correction of water content, also using road construction techniques serves to produce a workable Hardfill material, which shall be trucked to the dam body and placed using conventional RCC placement techniques.

PPS10.6.5.2 Mixing Platform

Mixing shall be done on a prepared hardstand surface, constructed using the same aggregates as intended for the Hardfill. An area has previously been cleared for this purpose. However, the *Contractor* shall verify its extent, condition and suitability for the proposed plant, production methodology and access requirements. The *Contractor* shall modify, extend or improve the area and its surface as necessary to comply with the requirements of this specification.

The natural ground line under the Mixing Platform shall be levelled by cut-and fill operations (all fill compacted or excavated and re-compacted, to 95% Mod AASHTO at optimum moisture content) Suitable gradients and cross fall shall be provided to drain the surface, with gradients between 2% and 3%. Where necessary to drain away excess rainwater, drainage channels shall be cut between mixing lanes and suitably lined to prevent erosion.

The in-situ materials below the Mixing Platform (both final surface and fill portions) shall be suitably compacted to provide a stable base, which shall not settle with load or moisture ingress. The top 300 mm in-situ material shall be compacted to 95% Mod AASHTO at OMC, whereafter a 150 mm minimum thickness wearing course of Hardfill aggregates stabilised with a minimum of 3% CEM II Cement, compacted to 98% Mod AASHTO at OMC, shall be provided to cap the area.

The required surface tolerance of the Mixing Platform shall be:

- Level tolerance of ± 10 mm.
- When testing the base with a rolling straight-edge the average number of surface irregularities equal to or exceeding 5 mm when taken over 100 m sections shall not exceed 6.
- The maximum value of any individual irregularity measured with the rolling straight-edge or a 3 m straight-edge laid parallel to the road centre line shall not exceed 10 mm.

Mixing shall take place in separate parallel lanes, each wide enough for a minimum of three and a maximum of six pulls (2.4 m mixing width) of the Mechanical Stabiliser/Recycler, allowing for 200mm overlap (Figure 1) In addition to mixing lanes of minimum 80 m in length, sufficient space for turning of the Mechanical Stabiliser/Recycler and water truck shall be provided at either end. The spacing of the mixing lanes shall be such that excess un-compacted material (minimum 200mm) can be cut off the sides of the lane using grading equipment without disturbing operations at adjacent mixing lanes.

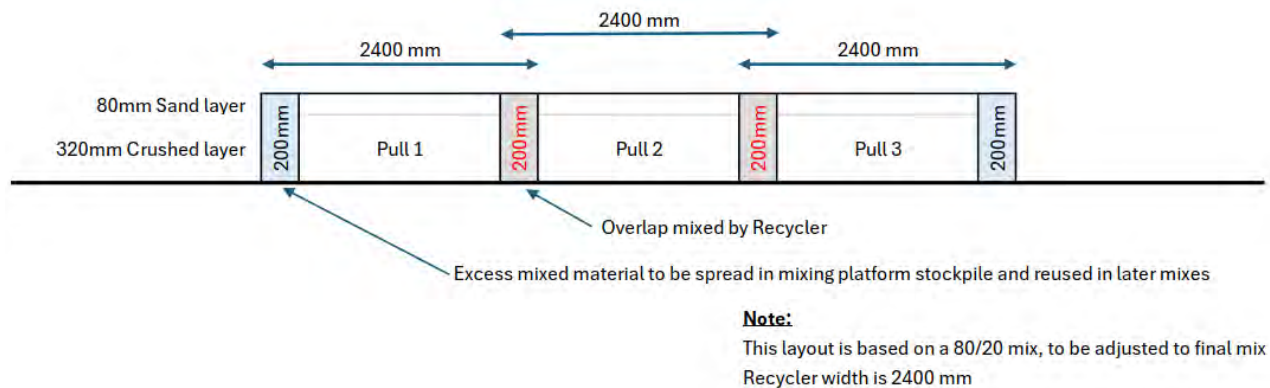


Figure 1 Mixing lanes and individual recycler pulls

Sufficient mixing lanes, including the programmed reuse of cleared lanes where applicable, shall be provided to produce at least one day's Hardfill production at the maximum placement tempo, approximately 1,860 m³/day. This shall be sufficient to complete a minimum of one full layer per day while also allowing preparation of the Mixing Platform for the following day's production.

All equipment operational on the Mixing Platform shall remain on the Mixing Platform for the duration of the Hardfill dam construction, and be fully dedicated to the production of Hardfill material. Each piece of equipment shall be checked daily for operational efficiency and cleanliness, and any defects immediately rectified.

The bodies and wheels of aggregate delivery trucks entering the Mixing Platform shall be fully cleaned before entering the platform area. No contamination of the surface of the Mixing Platform by extraneous materials, such as haul road mud, oil, or grease shall be permitted. Any areas so contaminated shall be immediately cleaned, and any Hardfill materials affected shall be disposed of immediately.

Preparation for the following day's Hardfill production is likely to take place during the night. Suitable lighting shall be provided to facilitate operations after dark. This shall be to the satisfaction of the *Engineer* in the interests of acceptable levels of quality control.

PPS10.6.5.3 Mixing Lanes

Except as approved by the *Engineer*, the expected Hardfill mixing process shall be as follows:

Mixing lanes shall be constructed by first spreading and levelling coarse aggregate with a motor grader to the necessary depth to provide its proportionate mass of material as designed in the approved mix proportions. The placed material shall be given one pass of a smooth drum vibratory roller in high frequency mode to seal the surface. Levels shall be recorded to the nearest millimetre at three positions at every 10m chainage (300mm from the left and right edges, and along the centreline of the lane.) Alternatively continuous laser level controls may be established on approval of the *Engineer* to control the thickness of the layer.

The fine aggregate shall then be spread and levelled on top of the coarse aggregate to the necessary depth to provide its proportionate mass of material. The placed material shall be given one pass of a smooth drum roller without vibration. Levels shall be recorded to the nearest millimetre at the same positions as on the underlying coarse aggregate.

The two layers shall then be fully mixed using the Mechanical Stabiliser/Recycler in three pulls across the width of the lane, allowing for a 100 mm overlap between each pull. Where the moisture content of the material is low, a maximum of 1% moisture may be dosed to facilitate lubrication of the mixing blades. The mixed material shall be given one pass of a smooth drum vibratory roller in high frequency mode to seal the surface.

Immediately prior to final mixing of cement, the required rate of application of cement and moisture to meet with the designated mix requirements for the combined thickness of the layer shall be determined through a regime of nuclear density gauge readings along the full length of the lane. The *Contractor* shall undertake sufficient testing of each mixing lane to establish its variation in moisture content for later water dosing in the mixing process.

The nuclear density gauge shall be calibrated each morning before production.

The cement shall then be spread uniformly over the full area of the lane by means of an approved type of mechanical spreader at the calculated rate of application in a continuous process, or it may be spread by



hand. In the latter case, pockets of cement shall be accurately spaced at equal intervals over the full surface of the lane so that the specified rate of application can be achieved. The cement shall be spread as evenly as possible and shall then be uniformly distributed over the entire surface to be treated.

The required water addition for each mixing lane shall be calculated immediately before cement mixing, based on measured moisture content and density of the premixed aggregate. The calculated water dose shall be applied through the Mechanical Stabiliser/Recycler water dosing system and shall be checked against the final moisture content determined from the diamond shape envelope and consistency requirements.

Immediately after the cement has been spread, it shall be mixed with the premixed aggregates for the full depth of the lane using the Mechanical Stabiliser/Recycler at the calculated moisture content. Care shall be taken neither to mix into the compacted layer underneath, nor to mix the cement in shallower than the lane depth, and in addition to continuous visual observations, checks to confirm this shall be undertaken at 5 m interval by means of steel rods inserted through the mixed material. Each mixing pull shall follow immediately upon the previous one to ensure continuous mixing of the whole mixing lane.

PPS10.6.5.4 Loading

Once the first pull of the mixing lane has been completed, its external side of unmixed material shall be trimmed off. On initiation of the second pull, material in the first pull bounded by the mixed second pull may be lifted by front-end loader to be deposited in the haulage trucks, taking care not to extract any material from the area of the second pull. Further loading of material from successive pulls shall follow the same principles.

PPS10.6.5.5 Transport

Fresh Hardfill shall be conveyed from the Mixing Platform to the dam site in articulated dump trucks utilising dedicated access roads.

Access onto and off the rising dam body shall be provided by means of similarly rising earthfill ramps. Where the ramp is placed against the inclined face of the dam, the face shall be protected by heavy geotextile and plastic sheeting. Additionally, the last section shall comprise a small steel bridge in order to minimise contact damage and to retain definition of the placement edge. Backfill against the upstream face shall be excavated, using small plant, and the affected area shall be inspected. Any observed damage shall be repaired with grouting and anchors, as considered necessary, before placement of upstream impermeable membrane/slab facilities.

A short distance before the dump trucks accesses the dam wall, a well-drained and appropriately orientated tyre washing area shall be provided. This facility shall be used for high-pressure water jetting of all truck tyres and chassis and the section of the access road between this point and the dam wall shall be surfaced with Hardfill. Surface water on this intervening connection shall be managed and they shall be kept clean of mud or any other any contaminants.

PPS10.6.6 Allowable Placing Conditions

If adverse weather such as heavy rain, occurs or is forecast to occur during placement, an interruption in placing operations may be approved or directed. A sample of available (summarised) climatological data for the applicable area based on historical information is provided in the Section C4 of the Contract Documents for general information only. However, it is the responsibility of the *Contractor* to satisfy itself concerning any construction schedule risk and added expense that could occur due to adverse weather.

a) Placing During Rain.

Hardfill shall not be placed during rainfall of more than 0.5 mm in 12 minutes. During periods of lesser rainfall, placement of Hardfill shall continue if the *Contractor* can meet the minimum requirements of a saturated surface onto which Hardfill is placed, free of ponds of water and clean. During periods of rain or when rain falls on the fresh Hardfill surface within 3 hours after placement, no heavy equipment or workers shall be allowed on, or be in direct contact with, freshly compacted Hardfill until the Hardfill has gained sufficient strength (no less than 3 hours after Hardfill placement) to prevent rutting, pumping, intermixing of rainwater with the Hardfill, or other damage to the Hardfill. Special precautions shall be taken to prevent contamination of the Hardfill by ponded water. After the Hardfill has hardened sufficiently to allow equipment and workers on the surface (as determined by the *Engineer*, but no sooner than 3 hours after Hardfill compaction), the Hardfill surface shall be cleaned of all loose material and water ponds, and if required and as directed by the *Engineer* shall be washed to break up laitance and/or mud like coatings on the surface. The washing shall not undercut any coarse size aggregate.



Pickup of the wash debris shall be accomplished with a truck mounted vacuum or other approved system. The washing action is critical in order to remove coatings formed during light rains that, if left in place, would act as bond breakers between each lift. Sufficient pieces of equipment of adequate size shall be provided so as not to slow the regular placement and compaction of Hardfill.

When rainfall is forecast, or imminent, the un-compacted placement area should be kept as small as practically possible and plastic sheeting should be stored close at hand so that it can be deployed to cover the uncompacted Hardfill without delay as soon as rainfall exceeding the allowable rate is measured.

b) Cold Weather.

Hardfill shall not be placed when ambient air temperatures drop below 0°C, except that if the surface of the compacted Hard fill and the mix itself stays above 0°C, placement of the Hardfill will be allowed to continue. If the ambient air temperature drops to below -1°C and the surface of any Hardfill less than 21 days old drops to below 0°C, the surface shall be covered with heavy tarpaulins, blankets, insulation, or other approved temporary protection to maintain concrete temperature above 1°C until after the ambient air temperature rises above 5°C.

c) Hot Weather.

The *Contractor* shall take the necessary measures to ensure that the Hardfill temperature at point of placement does not exceed 30°C.

Typical measures that may be necessary to restrict the temperature of the Hardfill as finally "built-in" include:

- Cold water fog spray of coarse aggregate stockpiles.
- Chilled water fog spray of aggregate
- Chilled mixing water.
- The use of flake ice in the Hardfill mix as partial replacement of the mixing water.
- Hardfill placement in the cooler seasons of the year.
- Hardfill placement during night-time.
- Hardfill placement on cloudy days.
- Shading of aggregates from solar radiation.

Should placement be attempted during the warmer seasons of the year, it may be necessary to apply a combination of the above measures to achieve the allowable placement temperature.

PPS10.6.7 Placing Hardfill, GEVR and GE-Hardfill

PPS10.6.7.1 Layout of Placement Area

The design layout for the dam construction is defined in the Project Specification and on the drawings.

The *Contractor* shall construct the dam in a continuous, horizontal manner from one abutment to the other, with minimal surface treatment between the placement layers, as prescribed in Clause PPS10.6.12.

As placement of each layer progresses across the dam, the exposed edge shall be kept "live" in the process of progressive placement. Whenever a cold joint at any edge of any layer does occur, it shall be located at least 3 m from the location of other cold joints that may have previously occurred in the same direction along previous layers. The cold joint shall be prepared as specified prior to resumption of Hardfill placement as follows:

- (a) Remove the surface mortar, laitance and contaminants by high pressure washing up to 400 bars and until the surface has achieved the exposed aggregate condition. If the treatment is made while the surface is still green, medium pressure washing might be enough to achieve the same surface finish;
- (c) Clean the surface, to remove all loose material, dust and dirt using an approved method, such as labour or high pressure water and air washing and vacuum debris removal. This green-cutting procedure shall expose but not undercut any coarse aggregate; and
- (d) On resumption of Hardfill placement, ensure that the surface is free from debris and contaminants and cover the specified surface area of the "cold" joint with a thin paint of grout or a 20 mm thick layer of bedding mortar, as directed by the *Engineer*. The bedding mix shall not be exposed for a period of longer than 15 minutes (or other period directed by the Engineer) before being covered by the next layer of Hardfill.

No cold joint shall be allowed along the edge of a layer in the upstream-downstream direction for more than one third of the upstream-downstream dimension of the dam at that elevation.



PPS10.6.7.2 Layer Placement

The placement and compaction methods applied shall ensure that the Hardfill is well compacted, that segregation is eliminated and that a seamless bond exists between the main Hardfill body and the Hardfill facing. Method statements for the layer methods to be applied shall be supplied to the *Engineer* for approval and methods shall be proved by the *Contractor* to the satisfaction of the *Engineer* during the construction of the Full-Scale Trial. If, at any stage during the construction, the methods of placement or compaction are considered by the *Engineer* not to be achieving the optimal results, the *Engineer* may instruct appropriate changes, for which the *Contractor* shall not be entitled to any additional compensation.

Placement shall follow the Continuous Layer Placement method in which Hardfill is placed continuously in horizontal layers across the full surface area of the dam at the level in question, from one abutment to the other.

PPS10.6.7.3 Depositing, Spreading and Re-Mixing

The *Contractor* shall ensure that the receiving surface is not contaminated by dust, dirt, sand, grease, oil or any other substance that may fall from the trucks during transportation and dumping of the Hardfill. Under no circumstances shall dump trucks, whose tyres have become contaminated with adhering material through travel on unsurfaced roads, be permitted to travel on the dam wall without cleaning.

The interval between mixing and final compaction of Hardfill shall be no greater than 2 hours. This time limit may be relaxed if the ambient temperature drops below 15°C, as long as the *Contractor* can demonstrate to the satisfaction of the *Engineer* that complete Hardfill freshness can be maintained for a longer period.

A record of each lane of material mixed shall be kept reflecting the time when mixing commenced, and this shall be correlated with the placing operations. Any Hardfill material older than 2 hours shall not be used on the dam, and shall be discarded.

The mix shall be spread into layers that shall, after compaction, be 300 mm thick. All Hardfill shall be deposited and spread in a manner that results in no segregation when compaction occurs. Initial deposition of Hardfill shall be by end dump truck and the Hardfill shall be deposited on previously placed and spread uncompacted fresh Hardfill.

A small dozer or a front end loader shall assist with deposition and spreading of materials as needed in confined areas, at the abutments and at other locations as approved or directed. No Hardfill or other concrete shall be placed on a previous layer that has been found to be suspect and is being prepared for testing.

Hardfill placement shall be defined by the *Contractor* on a schematic drawing after the optimal procedures have been established during construction of the Full-Scale Trial. In general, however, the following provisions and procedures shall apply to the placing of Hardfill:

- a) The subsequent load of mixed Hardfill shall be dumped approximately 2.5 m behind the advancing face of Hardfill placement, dozed over the edge and evenly spread out in a horizontal layer of approximately 360 mm uncompacted thickness, or of other approved thickness as determined during testing on the Full-Scale Trial. The objective of pushing the load over the advancing face is to promote the remixing of the Hardfill and thereby to minimize segregation and the spreading equipment shall be used in the most appropriate manner to achieve this objective.
- b) When segregation occurs during spreading, the segregated material shall be redistributed over the Hardfill surface prior to compaction. When general segregation takes place through a lack of mortar, the procedure described in (a) above shall be repeated.
- c) Where GEVR is to be applied, grout with a w/c ratio of 0.60 shall be poured onto the surface of the previous Hardfill layer to a depth of between 20 and 30 mm, or at a dosage of 20 to 30 litres/m², immediately prior to the spreading of the new Hardfill layer. It is usual practice to retain the grout in discrete ponds formed with a windrow of uncompacted Hardfill, spread by hand approximately 500 mm from the applicable face. The grout dosage and the methods to be applied to ensure the correct dosage for GEVR shall be demonstrated to the satisfaction of the *Engineer* at the Full-Scale Trial.
- d) Where GE-Hardfill is to be applied, grout with a w/c ratio of 0.60 shall be poured onto the surface of the current Hardfill layer to a depth of between 20 and 30 mm, or at a dosage of 20 to 30 litres/m², immediately after the spreading of the new Hardfill layer. The grout dosage and the methods to be applied to ensure the correct dosage for GEVR shall be demonstrated to the satisfaction of the *Engineer* at the Full-Scale Trial.



PPS10.6.8 Compaction of Hardfill, GEVR and GE-Hardfill

PPS10.6.8.1 Hardfill

After spreading, all surfaces of each layer of Hardfill shall be compacted with a self-propelled vibratory compaction roller. The number of passes to be completed to achieve the target density shall be determined during Hardfill mix trials and finally proved during construction of the Full-Scale Trial.

The target density shall be a percentage of the theoretical-air-free-density (t.a.f.d.). This density may vary from time to time as the mixture proportions (water content) and materials change throughout the placement. The density at each location shall be recorded as the average of the density at three different depths at the same point (50 mm, 150 mm and 250 mm). Control of the compacted Hardfill shall be such that the density of the compacted Hardfill, as measured by the nuclear density gauge, shall conform to the following limits:

- a) The average of all the measurements in-place of the wet density of each layer shall be higher than 97.5% of the t.a.f.d.; and
- b) The average density at a single location shall not be less than 95% of the t.a.f.d.

Should it not be possible to achieve adequate compaction to the satisfaction of the *Engineer* with 10 passes, the *Contractor* may be requested to review his mix designs, compaction procedures and compaction plant. After such a review, the *Contractor* shall be required to prove adequate compaction on a test strip before resuming Hardfill placement on the dam wall.

A round trip over the same material shall count as two passes. In general, a large width-self-propelled vibratory roller shall be used in open areas and small vibratory rollers shall be used adjacent to faces, the abutments, galleries and other concrete structures, etc. A hand-guided vibrating plate shall be used for compaction in any areas that cannot be reached with the drum of a vibratory roller. Rollers shall not be operated in the vibratory mode until they are moving. No edge of Hardfill shall be compacted, except where Hardfill is spread adjacent to conventional concrete.

Compaction of Hardfill shall follow the procedure set out below:

- a) During the first pass, which is to consolidate the layer, no vibration shall be used. The whole surface to be compacted at any one time is to be treated in this manner before the second pass commences.
- b) The first pass shall be followed by subsequent passes using vibration until the specified compaction, as determined by tests, has been achieved. The number of passes shall be established during the trials on the Full-Scale Trial. A total number of passes of less than 10 is envisaged.
- c) Compaction of any section of a layer is to commence immediately after the spreading of that section has been achieved and shall be continued to completion within 15 minutes of the Hardfill having been deposited in the working area, or a maximum of 120 minutes after mixing. These periods may be relaxed when ambient temperature is below 15°C and if the *Contractor* can demonstrate to the satisfaction of the *Engineer* that the Hardfill remains fresh for the applicable extended period.
- d) The addition of water to the mix shall not be allowed during any stage between the time of completion of mixing and the time of full compaction of the Hardfill.

Trucks and/or other vehicular traffic not related to the Hardfill placing process shall be minimized on compacted Hardfill surfaces. Exceptions to this are the following situations:

- a) Trucks shall back up on just placed, uncompacted Hardfill for actual dumping of Hardfill; and
- b) After the completion of Hardfill for each lift, the end dump trucks are permitted (one time only and without making sudden turns or stops) to drive across freshly compacted Hardfill to the location necessary to the start of hauling for the next lift.

PPS10.6.8.2 Additional Compaction Passes

If optimum compaction density has not been achieved after 10 passes, additional passes shall be made until density is achieved, or until otherwise directed.

PPS10.6.8.3 Other Concretes

The compaction of facing concrete or other mass or structural concrete shall be carried out in accordance with the requirements of the Project Specification (and the Concrete Specification).

PPS10.6.8.4 GEVR and GE-Hardfill

The placement and compaction of GEVR and/or GE-Hardfill shall be subject to testing in the Full-Scale



Trial. The method employed shall ensure that complete mixing of the enriched grout through the Hardfill with full compaction though the layer can consistently be achieved. Where honeycomb areas are encountered at any stage, methods and/or grout contents shall be adjusted to ensure a dense homogeneous matrix with no voids. On stripping of formwork, the surface shall exhibit a clean, uniform appearance without any voids.

Priority shall be given to the use of GEVR, then GEVR and GE-Hardfill, and GE-Hardfill as a last option.

a) GEVR

Once the Hardfill has been spread to cover the grout, the GEVR shall immediately be compacted using immersion vibrators until the concrete is fully consolidated, air bubbles are no longer present and grout is uniformly distributed on the top of the layer surface. Subsequently the interface between the Hardfill and GEVR shall be compacted using a small a self-propelled smooth, twin-drum vibratory roller. Areas not accessible to the vibratory roller shall be compacted with a reversible plate compactor. The GEVR shall be fully compacted within 30 minutes of grout mixing, unless a set retarder is used. The methods to be applied to ensure the effective compaction of the GEVR shall be demonstrated to the satisfaction of the *Engineer* at the Full-Scale Trial.

b) GE-Hardfill.

Once the grout has been placed on the Hardfill, the GE-Hardfill shall immediately be compacted using immersion vibrators, following which the interface between Hardfill and GE-Hardfill shall be compacted using a small vibratory roller that is able to pass close to the formwork.

c) GEVR and GE-Hardfill.

A combination of GEVR and GE-Hardfill may be used. The trial shall be conducted to select the relative effort and grout proportions to be applied to each method. This combination may be supplemented with grout enrichment made though grout introduced though holes vibrated in the Hardfill surface using immersion vibrators or hand tools.

PPS10.6.8.5 Facing Concrete

Immediately following placement, facing concrete shall be compacted against the formwork using immersion vibrators and the Hardfill placement must follow within such time that the contact surface of the facing concrete is still sufficiently fresh to allow vibration. Should a break in Hardfill placement occur, the surface of the facing concrete shall be broken back to where a fresh fully compacted and an exposed aggregate surface shall be created. Additional fresh facing concrete shall then be placed against the old concrete immediately before the resumption of Hardfill placement. No facing concrete must be placed at an unsupported slope steeper than 45 degrees.

Once the fresh Hardfill has been placed against the facing concrete, the facing concrete at the interface with the Hardfill shall be compacted using immersion vibrators. On completion of compaction of the adjacent Hardfill, the interface between the Hardfill and the facing concrete shall be compacted using a small vibratory roller, traveling as close as possible to the formwork. All concrete shall be fully compacted before the occurrence of first set, or within 40 minutes of mixing.

Should the *Contractor* wish to offer an alternative of conventional facing concrete, he shall be required to prove by means of the Full-Scale Trial that full compaction of the facing concrete, the Hardfill and the interface is effectively achieved to the satisfaction of the *Engineer*.

PPS10.6.9 Full-Scale Trial

At least 90 days before commencing with the Hardfill placement operation for the dam, the *Contractor* shall be required to construct at least one Full-Scale Trial, in the presence of the *Engineer*. The Hardfill Full-Scale Trial shall be at least 40 m long x 12 layers of Hardfill, with both upstream and downstream stepped formwork, minimum 6m wide at the top. It shall serve to prove the Hardfill mix, the *Contractor's* plant and placement capabilities, the layer treatment processes and the various proposed placement and compaction methods. The Full-Scale Trial shall be constructed using the same techniques, materials and attention to detail as specified for the main dam. This includes the same foundation clean-up and protection, the same lift joint treatment and protection, the same construction of the upstream face, the same details for installation of waterstops and contraction joints, etc.

a) Trial construction

The Full-Scale Trial shall be used to evaluate and optimise various issues related to the Hardfill, including:

- a) All manufacture, mixing, conveyance, placement and compaction plant and operators;



- b) The proposed Hardfill mixes under construction conditions;
- c) Variations of the Hardfill mix and GEVR/GE-Hardfill;
- d) Joint / crack inducing and directing systems;
- e) The requirements for inter-layer and lift surface treatment, etc;
- f) Joint sealing systems;
- g) Various conveyance, placement and compaction methods and procedures;
- h) The quality assurance and control systems to be implemented.

The placement of the Full-Scale Trial shall continue until the *Engineer* is satisfied that the *Contractor* has demonstrated his ability to maintain effective methods and procedures and that his installations are acceptable and consistently correct.

The *Contractor* shall give the *Engineer* at least four weeks' notice of his intention to proceed with the Full-Scale Trial so that the *Engineer's* staff may make the necessary arrangement to be present. As experience is gained with Hardfill, or circumstances change, it may be necessary to undertake further trials to test different methods or mixes.

The *Contractor* shall keep complete, contemporaneous records of all activities undertaken during construction of the Full-Scale Trial. Records shall include, as a minimum:

- a) Dates and times of operations and any stoppages.
- b) Weather conditions and ambient and material temperatures.
- c) Material sources/stockpile identifications, moisture contents and all mix proportions and adjustments.
- d) Plant utilised, settings and calibrations and the names of operators.
- e) Production, haulage, placing, spreading and compaction sequences, including layer thicknesses and number of passes.
- f) In-situ test results (including density, moisture and VeBe where applicable) and locations of tests.
- g) Details of joint/crack inducer installations and any lift surface treatment.
- h) Details of different GEVR/GE-Hardfill process and materials trialled.
- i) Nonconformances, corrective actions and approvals by the *Engineer*.

Within 14 days of completion of Full-Scale Trial construction (excluding subsequent core drilling and long-term testing), the *Contractor* shall submit a Full-Scale Trial Construction Record Report collating these records, supported by photographs, sketches and production and quality control logs, and identifying the adopted procedures and any recommended changes for the Works. The report shall be updated upon completion to include core drilling and long-term testing immediately at various stages as information comes to hand.

Only operators and supervisors who have worked on, and been approved at, the Full Scale Trial will be allowed to work on the dam during the initial placement.

b) Drilling programme

50 days after completion of the Full-Scale Trial, a drilling programme shall be initiated to recover a sufficient number of 150 mm cores to enable the qualitative evaluation of all aspects tested. In order to obtain the *Engineer's* approval of the *Contractor's* plans for the Full-Scale Trial, a report must be submitted two weeks before the proposed date of construction, detailing the intended objectives, method statements, layout and programme. On completion of the *Contractor's* core drilling and testing programme, a comprehensive report must be submitted to the *Engineer* detailing all findings during construction and testing. This report shall contain detailed photographs and be accompanied by a video record of the Full-Scale Trial construction.

c) Shear strength testing

50 days after completion of the Full-Scale Trial, in-situ direct shear strength testing preparations shall be made to test the interlayer shear strength of the Hardfill in the Full-Scale Trial. At the direction of the *Engineer*, surficial layers of placed Hardfill shall be removed with a minimum 25 tonne excavator to expose the testing locations.

Testing shall be undertaken in accordance with IS-7746. Blocks 700 mm x 700 mm x layer thickness shall be cut using concrete saw in the surface of the exposed layer where the tests are designated, allowing for the moving of the test block and testing equipment. A minimum of ten valid test results will be required.

The *Engineer* shall nominate the normal and shear forces to be used at the time of testing and shall witness all tests. All results shall be reported as directed in IS-7746 under a cover including comprehensive photographs of the process and samples, calibration certificates of testing equipment and summary of results.



PPS10.6.10 Treatment of Hardfill Surfaces

PPS10.6.10.1 General

All joint surfaces under all ambient conditions shall be kept clean, uncontaminated, free from ponded water, and continuously moist until placement of the subsequent Hardfill or other concrete. Treatment of exposed horizontal Hardfill surfaces during rain shall comply with the requirements of PPS10.6.6.

PPS10.6.10.2 Previous Hardfill Layer Surfaces

The surface of previous Hardfill layers shall be thoroughly cleaned of all loose and contaminating material prior to placement the following layer. Both brushing and water jetting shall be used.

In the case of water jetting, its use shall be delayed until the Hardfill is sufficiently hard so that there is no undercutting of coarse aggregate particles.

PPS10.6.10.3 Treatment for Vertical Joints

Cold vertical joints at the leading edge of a Hardfill placement shall be treated in accordance with this specification and/or the project drawings. When it becomes apparent that placement of Hardfill shall be terminated before the entire lift has been completed across the full placement surface area, the following actions shall be taken:

- a) After full compaction, the leading edge of the Hardfill placement shall be trimmed to a slope of 1V : 4H and the bottom 60 mm shall be trimmed vertically. All waste material shall be removed from the dam.
- b) The joint preparation procedures specified in PPS10.6.10.2 then shall be applied.

Placement interruptions necessitating vertical joints in the Hardfill layers may occur when a breakdown of equipment takes place or when a shutdown is necessary due to climatic factors. A vertical joint not treated in the manner described above shall be subject to drilling and/or jack hammering to remove any non-consolidated Hardfill.

PPS10.6.11 Facing Systems for Hardfill Construction

PPS10.6.11.1 Kerbing Facing Systems

The upstream and downstream faces of the Hardfill dam may be specified to be formed by using an extruded in-situ placed concrete kerb. The kerb system shall be implemented to enable compaction of Hardfill against and creating a face onto which the impermeable membrane can be fastened on the upstream side.

The concrete for the extruded kerb shall comply with the requirements of SANS 1200 G Concrete (Structural) and the plant and processes shall conform to the requirement of SANS 1200 MK Kerbing and Channelling.

The following mix proportions are provided as a *guide* for the design of the dry mix necessary for extrusion of the kerb by an extruding machine:

Cement:	50 – 70 kg/m ³
Aggregate:	1 050 kg/m ³
Sand:	1 050 kg/m ³
Water:	130 l/m ³

While an ultimate characteristic 28 day strength of a 25 MPa is required, the above proportions shall be subject to final design by the *Contractor* and adjustment on the completion of trial mixes and extrusion trials. The dimensions of the concrete kerb shall be, at minimum, as shown on Drawings, to ensure stability in relation to the mix and placement methodology of the kerb and Hardfill proposed by the *Contractor*. Tolerances for curb construction shall be in accordance with Clause PPS10.9. The mix design of the kerbs shall provide for the placed concrete to develop sufficient strength between the time of extrusion and the placement of the containing Hardfill layer such that the kerb maintains its form and does not slip when Hardfill is placed and compacted against it, and shall retain the overall specified lines and shape of the Hardfill profile. Where necessary to achieve the required workability, strength and durability, the *Contractor* shall utilise admixtures to the requirement of PPS10.3.6.4 in the design of the kerb concrete mix.

It is the *Contractor's* responsibility to ensure that the kerbing system used is stable, both from a strength and dimensional perspective. The *Contractor* shall consequently propose suitable dimensions which will retain 300mm Hardfill layers which will be compatible with his construction methodology and mix design for



approval by the *Engineer*, shall be proved to the satisfaction of the *Engineer* during tests on the Full-Scale Trial. No system shall be used without the approval of the *Engineer*.

The kerb extruding machine shall be operated in a horizontal plane such that the finished concrete sloping surface of the curb shall coincide with the upstream slope as per the setting out drawings. The machine shall be aligned with the aid of suitable laser equipment or survey control. Unless otherwise approved, the kerb shall be constructed in a continuous operation from abutment to abutment. The rate of placement of the kerb shall be such that the concrete emerging from the machine shall not slump. 5-10mm gaps as specified in SANS 1200 MK shall be formed at the line of each induced joint in the dam.

Care shall be taken to avoid damage to the concrete kerb by the Hardfill placing and compacting equipment. Any damage shall be made good prior to the next lift of the kerb being placed on top of the previously placed kerb.

PPS10.6.11.2 Formwork Facing Systems

The upstream and downstream faces of the Hardfill dam may be specified to form the external face of the body of Hardfill using formwork. Formwork systems shall be used for surfaces stepped at any angle, vertical or inclined.

The face forming systems for the project shall be as conceptually shown on the drawings comprising standard 600mm and 1200mm steel "Econoform" formwork panels and walers. The formwork facing systems proposed by the *Contractor* shall be proved to the satisfaction of the *Engineer* during tests on the Full-Scale Trial. No system shall be used without the approval of the *Engineer*.

All such facings covered by this specification shall use purpose-designed temporary formwork based on standard formwork systems, which shall be designed by the *Contractor* and the form anchor capability of the system used shall be demonstrated by to the satisfaction of the *Engineer* by approved means before commencing work. Formwork shall have sufficient strength to withstand the pressure resulting from placement and vibration of the Hardfill/CVC/ GE-Hardfill/GEVR and shall have sufficient rigidity to maintain the specified tolerances. Extreme care shall be taken to prevent the occurrence of any permanent openwork, honeycombing or voids at the face, or GE-Hardfill/GEVR/Hardfill interface. The formwork and the formwork joints shall be sufficiently tight to prevent any loss of mortar.

The types of ties used and their spacing shall be such that the required finish is achieved and will not be marred by the subsequent corrosion of ties through the use of removable cones against the formwork face. Recesses resulting from removal of the cones shall be patched using a method and materials to be approved by the *Engineer*.

Formwork shall not be stripped until the supported concrete has attained sufficient strength to safely support itself, any loads imposed during construction, and any subsequent layers to be placed. The formwork system shall be sufficiently robust and reusable to permit stripping, relocation and re-erection from lower completed steps in a manner that maintains the specified placement tempo. The *Contractor* shall provide a leap-form arrangement comprising one active formwork facing and at least one lower formwork facing system over the full length of the dam.

Hardfill shall not be placed directly against formwork without enhanced durability and strength systems such as GE-Hardfill, GEVR or conventional concrete, which shall comprise the surface zone of the Hardfill face, at least 400mm wide.

PPS10.6.12 Preparation of Receiving Surfaces

PPS10.6.12.1 Foundation Preparation

Prior to placing any concrete, (including any Hardfill, filler concrete, bedding mix, or other conventional concrete placed adjacent to and at the same time as the Hardfill) all surfaces shall be cleaned and free of loose, un-keyed, and deteriorated rock, all mud and silt accumulations, vegetation, loose fragmented rock pieces, laitance, puddles or ponds of free surface water, mortar coatings and other detrimental materials. High pressure water jetting, followed by an approved clean up procedure, shall be applied on all concrete surfaces for the removal of laitance, mortar coatings, stains, or other difficult-to-remove surface contaminants. A bedding mortar shall be applied to the prepared surface immediate prior to the placement of the concrete.

It is anticipated that removal of loose materials in the foundation and on receiving surfaces can be achieved using high pressure water washing and/or air water jetting.



PPS10.6.12.2 Preparation of Receiving Hardfill Surfaces

The receiving surface for fresh Hardfill layers shall be clean and free from all dust, loose aggregate, organic material, oil or any other contaminant. Undulations in the layer surface within the tolerances shall be retained without any attempts to smooth these out.

Prior to placement of the subsequent Hardfill layer, the receiving surface shall be thoroughly cleaned using brooms, compressed air, water hoses, or a combination thereof, as required to remove all dust, loose aggregate, fines and other deleterious material. Cleaning methods shall be selected to suit the condition of the surface and shall not disturb the compacted Hardfill, cause segregation of the aggregate, or result in the accumulation of sediment.

Following cleaning, the surface shall be inspected and any remaining loose material removed. The use of water for cleaning shall be controlled to avoid softening the surface, washing out fines, or creating ponded water. Any standing water shall be removed prior to placement of the overlying Hardfill layer. The receiving surfaces shall, however, be moist at the time of receiving the Hardfill.

PPS10.6.13 Curing and Protection

PPS10.6.13.1 General

Aside from the Hardfill lift surfaces, all finished surfaces shall be kept continuously moist for a period of at least 28 days after the final set of the Hardfill, GEVR or concrete has taken place, or after formwork has been stripped, or until covered by the subsequent lift. Alternatively, finished surfaces may be treated with an approved curing agent.

PPS10.6.13.2 Hardfill Surfaces

All compacted Hardfill, GEVR and concrete surfaces shall be kept continuously moist until covered by the next layer of Hardfill, or for a period of 28 days, whichever is the shorter. Care shall be exercised during continuous Hardfill placement to ensure that mortar on the surface is not washed out by an excess application of water. On no account shall the *Contractor* be allowed to use curing compounds on surfaces that are to receive Hardfill. Measures to ensure that continuous curing operations are maintained during nights, week-ends and public holidays shall be implemented.

PPS10.6.13.3 Hot Weather Protection

When necessary or as directed, provisions for windbreaks, shading, fog spraying, ponding or wet covering with a light coloured material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations shall allow.

PPS10.7 INDUCED JOINTS

PPS10.7.1 General

Where facing concrete or GEVR/GE-Hardfill is specified in the upstream and downstream side of the dam, joints shall be formed in the relevant surface zone to ensure that cracking occurs at designated locations and is provided with isolation waterstops and chamfers. These joints shall be created utilising crack inducing and debonding plate, fitted with waterstops as detailed on the drawings. Suitable plant, equipment and facilities shall be provided for the manufacture, alignment, installation, joining, testing, protection and repair of the joint inducing system. The crack inducer system proposed by the *Contractor* shall be proved to the satisfaction of the *Engineer* during trials on the Full-Scale Trial. The *Contractor* shall design a support system for waterstops at the faces where installation of these systems is indicated on the drawings. The system shall be applied to ensure the accurate fixing and alignment of the inducing system and waterstops and shall be capable of keeping all items taut in their correct locations above the Hardfill layer in such a manner that they shall not be disturbed during the placement or compaction of the surrounding concrete. The design of the system shall be submitted to the *Engineer* for acceptance.

PPS10.7.2 Crack Directors

Contraction joints through the body of the Hardfill shall be formed at locations and on alignments indicated on the drawings. They shall be induced by inserting a debonding HDPE, or other approved sheet into the green Hardfill immediately after compaction has been completed (including density test). The HDPE sheets shall be 1.5 mm thick, 250 mm high (in the case of a 300 mm layer) and up to 2000 mm in length, unless



otherwise indicated on the drawings, or other approved. The gap between successive individual sheets placed along the length of the induced joint shall not exceed 25 mm.

Where the joints are crossed by waterstops, the *Contractor* shall take care when inducing the joints that the waterstops are not damaged, or misaligned in any way during formation of the joint.

Crack Directors shall be in accordance with the details indicated on the drawings. The methods and systems for this installation shall be optimised during construction of the Full-Scale Trial and shall be subject to the approval of the *Engineer*.

PPS10.7.3 Crack Inducers in Facing Concrete and/or GEVR/GE-Hardfill

Joints or cracks in formed Hardfill facing shall be placed at pre-determined positions as shown in the drawings. They shall be induced by installing de-bonding plates into the GE-Hardfill, GEVR or concrete at placement.

The crack inducing system shall be manufactured in suitable material, in accordance with the details indicated on the drawings and installed in such a manner that ensures that the inducing plates are firmly in contact with the waterstops and aligned such that the plate is exactly on the line of the centre bulb of the waterstop and on the alignment of the chamfer on the dam face (if one is present), to an accuracy of ± 3 mm. The accurate installation of this system must be rigorously enforced and the *Contractor's* quality control system must allow the *Engineer* to be completely certain that the crack inducer system is accurately and correctly installed, without any incidence of failure.

A suitably robust framework shall be manufactured and used to hold the waterstop and the joint-inducer plates firmly in their vertical position during the placement and compaction of GE-Hardfill, GEVR, concrete and Hardfill around and in the vicinity of the induced joint.

Should the alignment of the components within an installed crack inducer system, or the alignment of the crack inducer system itself ever be found to fall outside the indicated tolerances, corrective action should be immediately taken.

PPS10.7.4 Joints in Facing Kerbs

In the case of the extruded in-situ kerb surfacing applicable to the rest of the dam, joints shall be cut in the green concrete of the kerb in line with the requirements of SANS 1200 MK. The alignment of the cut joint shall correspond within 10mm of the alignment of the crack directors.

PPS10.8 WATERSTOPS

Waterstops shall be of approved manufacture in flexible PVC to the pattern specified or shown on the drawings. They shall conform to the ASTM and USACE CRD-C572 and the specification requirements set out in Table 7.

Table 7 Requirements for PVC Waterstops

Property	Test Method	Required Limit
Water absorption.	ASTM D570.	0.15% max.
Tear resistance.	ASTM D624.	35 KN/m min.
Ultimate elongation.	ASTM D638.	350% min.
Tensile strength.	ASTM D638.	13.8 MPa min.
Low temperature brittleness.	ASTM D746.	No failure @ -37°C.
Stiffness in flexure.	ASTM D747.	4.13 MPa min.
Specific gravity.	ASTM D792.	1.45 max.
Hardness, Shore A.	ASTM D2240.	79 $\pm$ 3
Tensile strength after accelerated extraction.	CRD-C572.	11.0 MPa min.
Elongation after accelerated extraction.	CRD-C572.	300%
Effect of Alkalis after 7 days: Weight change. Hardness change.	CRD-C572.	-0.10% < +0.25% $\pm$ 5 points.

The waterstops shall have integral continuous side-fins with eyelets that are punched in on the outside edges to enable them to be attached firmly in position. Waterstops shall be supplied in lengths as long as possible consistent with means of transport and efficiency of handling so as to minimise jointing.

Prior to the waterstop being used in the works, a certificate of compliance, indicating that the product that the *Contractor* proposes to use, has been tested and conforms to the above-mentioned requirements shall



be submitted to the *Engineer*. The test certificate shall not be more than 3 months old. Furthermore, adequate samples of each batch of waterstops shall be submitted to an approved laboratory for testing in accordance with the specifications.

The PVC waterstop shall be easily joined on site by using a temperature controlled electric heater blade, in accordance with the manufacturer's instructions and to the approval of the *Engineer*. The resulting joint shall have a minimum strength of 11 MPa in tension at 23°C and shall be impervious. The waterstop shall also be capable of being easily joined on site to form right angled Tee junctions. All intersections between waterstops shall be prepared by mitring and welding intersection pieces in the factory according to the manufacturer's instructions and to the approval of the *Engineer*. Straight lengths of waterstops only may be field welded in accordance with the manufacturer's instructions.

Waterstops shall be securely and accurately located in positions so as not to displace or deform during construction. Special precautions shall be taken for the placement and consolidation of concrete around waterstops to ensure fully effective contact and void free concrete.

Waterstops forming a seal with the foundation rock, shall be anchored into pre-formed pockets excavated into competent rock. The pockets shall have dimensions of 500 x 300 x 750 mm deep, with sides inclined by no more than 20° to the vertical. The pockets shall be thoroughly cleaned and backfilled by tremie with a non-shrink cementitious grout immediately before the waterstop is inserted.

Water swellable 'Basic Polymer' hydrophilic waterstops shall be made from a preformed elastomeric strip free from rubber, bentonite or other inclusions. The waterstop shall have an unrestrained volumetric expansion of not less than 170%. It must not deteriorate under prolonged wet/dry cycling. It must be able to withstand a hydrostatic head of 50 metres.

PPS10.9 TOLERANCES

The provisions and requirements of the Project Specification and the Concrete Specification in relation to tolerances shall generally be applied to Hardfill construction, except as modified below.

- a) The thickness of compacted layers of Hardfill shall be within 30 mm of that stipulated;
- b) The elevation of the surfaces of Hardfill layers upon which subsequent concrete is placed shall not vary by more than 50 mm from the design elevation, except that the elevation of the top three lifts of the dam shall be within 25 mm of that shown on the drawings.
- c) The alignment of all waterstops shall not deviate more than ± 50 mm from the line specified on the drawings.
- d) Gradation and moisture content of the placed material shall fall fully within the diamond shape acceptance envelope.

PPS10.10 QUALITY ASSURANCE, CONTROL, TESTING AND RECORDS

PPS10.10.1 General

Hardfill Quality Assurance and Control shall focus on the implementation of appropriate measures, procedures, systems and checks with the objective of eliminating the occurrence of strength and other test failures. The primary means of achieving quality assurance in Hardfill construction is through rigorous control of the constituent materials and production process, with particular emphasis on aggregate grading and moisture content within the diamond shape acceptance envelope. Aggregate grading directly influences density, paste distribution, workability and strength, while moisture control governs compaction efficiency and the consistency of the placed material. Accordingly, the monitoring and verification of aggregate gradation and moisture content shall be regarded as matters of the highest importance and shall form the foundation of the Quality Assurance Programme.

Hardfill cube crushing tests shall be used as part of the next step in the quality assurance and confirmation programme. The testing of cubes, cylinders and other production samples represents the next level of quality control, providing confirmation that the materials and construction processes are performing as intended and that the specified material properties are being achieved.

The process of sampling and testing Hardfill cores reflects the actual characteristics of the material incorporated into the dam, and core tests are accordingly regarded as the final measure of the quality control achieved in the completed Hardfill construction, as well as providing a definitive record of the important in-situ properties of the concrete within the dam. Despite this fact, the sampling and testing of Hardfill cubes and other production specimens shall remain governing, as these tests provide important early warning of changes in material quality and construction performance, allowing corrective action to be



implemented before any deficiencies become incorporated into the Works. The provisions of the following specifications shall apply:

- (a) SANS Method 5865 - The drilling, preparation and testing for compressive strength of cores taken from hardened Concrete
- (b) SANS Method 5863 - Compressive strength of hardened concrete, which shall apply to the test methods adopted for the determination of the compressive strength of concrete cubes and cores.
- (c) SANS Method 5863 and SANS 10100-2 (Part 2 – Concrete building material and the execution of work), which shall apply to the acceptance criteria for Strength Concrete and shall be applied from first placement on all parts of the works.

All cube test results shall be statistically assessed.

Accelerated curing of Hardfill cubes shall be used both for the Hardfill mix design development programme and for quality control of Hardfill placement on the dam. Both 7 and 14 day accelerated curing programmes shall be developed by the *Contractor* in consultation with the *Engineer* and for the *Engineer's* approval in the quality assurance and control process.

Where tests are specified per mixing lane, and more than three pulls are to be used per mixing lane, the frequency of testing shall be pro-rated (rounding up) to a base of 3 pulls, and the lateral spacing varied across all pull lines.

PPS10.10.1.1 Quality Assurance and Control

Effective programmes for quality assurance and control shall be established and maintained for all Hardfill construction and these shall be the means by which compliance with the contract requirements is assured and control records are maintained. The Quality Assurance Programme of the *Contractor* shall serve to ensure that all controls are effective and are effectively enforced and observed. The programme shall further ensure that problems and/or quality variations are identified and rectified before these might affect the works. The Quality Assurance Programme shall include, inter alia, the following aspects: monitoring aggregate manufacture and gradations, moisture, gradation requirements and mix proportions at the Mixing Platform, ensuring adequate materials availability, that embedded items are properly installed, that surface preparation and curing is correctly carried out and that all other tests and inspections required by this specification are correctly completed. The *Contractor* shall plan and document his Quality Assurance and Quality Control Programmes and these shall be approved by the *Engineer* before the main construction activities are initiated and shall be maintained as a "live" document for the duration of construction.

The specified strength and material parameters for testing of compacted samples and drilled cores shall be established on the basis of the results derived through trials on the Full-Scale Trial construction. These figures shall be incorporated into the final Hardfill Project Specification along with a related series of acceptance criteria for placed Hardfill. The final acceptance procedure shall take into account the reliability and variability of Hardfill sample testing, as compared to typical equivalent core results, and shall develop secondary checks to estimate the relevance of test criteria failures.

Qualified personnel, equipment and supplies that are necessary to ensure the effective testing and fulfilment of the quality control programme shall be provided by the *Contractor*. No concrete placement or aggregate production shall be allowed until the *Engineer's* approval of the quality control programme has been granted. The tests described in Clause PPS10.10.2 shall be performed and, based upon the results of these inspections and tests, the action required in Clause PPS10.10.3 shall be taken. Reports shall be submitted as required in Clause PPS10.10.4. The required corrective measures listed in the sub-clauses under Clause PPS10.10.3 refer to the testing item with the same sub-clause reference under Clause PPS10.10.2.

The *Engineer* may maintain his own independent Quality Assurance programme, as a means to oversee and confirm the effectiveness of the quality programmes followed by the *Contractor*. The *Contractor* shall submit his quality assurance and control programmes to the *Engineer* for scrutiny on request and the *Engineer* shall retain the right to redirect any activities considered to be inadequate or ineffective. All quality control and assurance personnel shall be available on a continuous basis 15 days prior to the start of placement of the Full-Scale Trial until 15 days after completion of all Hardfill and concrete placement for the main dam.

PPS10.10.1.2 Hardfill Core Programme

The records of greatest value that define the actual quality achieved in the dam construction, are those derived as part of the Hardfill core recovery and testing programme.



Fifty-six days after first Hardfill placement, a core drilling programme shall be initiated (so that cores can be tested at 60 days), and 150 mm diameter diamond core drills shall be active from the downstream face on virtually a continuous basis until 3 months after completion of Hardfill placement, or from the various crests of the dam when Hardfill has reached that level, or as directed by the Engineer.

Cores shall generally be drilled from a platform attached to the steps of the downstream face of the dam, except during extended breaks in Hardfill placement when drills shall be set up on the Hardfill surface. Cores shall generally be drilled vertically, but a number of cores shall be drilled at specific angles intercepting the horizontal lift joints. For every five vertical cores, there shall be one inclined core as directed by the Engineer.

Accurate records and logs of the recovered cores shall be maintained, including position of extraction, angle of drilling and depth of each section of the core. Only drilled Hardfill older than 56 days shall be taken for testing. Cores shall be tested for compressive strength and density (SANS 5863 and 5865) and joint shear strength (ASTM D 5607) at age of 60 and 120 days. A minimum of one set of each test per 8 m of drill hole shall be taken.

In total at least 10 cores shall be extracted from the dam for inspection and testing. Each core shall extend from the designated drill level to 0.2 m below the foundation level. The location of each core shall be selected by the *Engineer* to provide a representative view of the in-situ properties of the Hardfill placed in the dam and to investigate specific areas as indicated by the *Engineer*.

In addition, a comprehensive testing programme shall be previously undertaken on cores recovered from the Full-Scale Trial and this shall form the basis for finalisation of a number of aspects, including the mix designs, the bedding mix type, facing systems, etc. The recovery and testing of cores from the Full-Scale Trial shall occur in parallel with a programme of cube manufacture (including accelerated curing) and testing, as well as in situ density measurements, etc. On completion of this work, the development of a coordinated system of quality control shall be possible, whereby early test results and the equivalence of 7 and 14 day accelerated cube curing can be related to final in-situ Hardfill material properties. The related quality assurance and control programme shall be compiled by the *Contractor* and approved by the *Engineer*, for execution during the construction of the main dam.

PPS10.10.2 Inspection Details and Frequency of Testing

Fresh concrete shall be sampled and tested for compliance with the specifications and for additional information as required. Samples for testing shall be taken at the placing location at the time of placement, but may also be taken at the Mixing Platform as directed by the *Engineer*.

PPS10.10.2.1 Aggregate Properties

The Contractor shall undertake testing as listed below on representative samples at appropriate intervals during aggregate production, so that variations from the gradation envelopes confirmed during the mix design process and forming the upper and lower boundary of diamond shape acceptance envelope are identified and corrected before the material is incorporated into the stockpiles. The sampling and testing regime shall demonstrate that each stockpile is representative of, and consistently complies with, the approved aggregate requirements, with sampling representing at least one test per 300 m³ of aggregate or one test/week during aggregate production whichever is the greater.

- (a) Gradation of the coarse and fine aggregate, including establishment of the projected combined grading as established from the mix design development process.
- (b) Elongation and flakiness indices of coarse aggregates (BS BS812 Part 105),
- (c) Fineness modulus of the fine aggregate.
- (d) Compacted (rodded) void ratio of the fine aggregate.
- (e) Specific gravity and absorption of all aggregate sizes,
- (f) Abrasion test (Los Angeles) for the coarse aggregate sizes,
- (g) Loss by washing (particles <0.075 mm) of the coarse aggregate sizes,
- (h) Organic Impurities in accordance with SANS 5847.
- (i) If required by the Engineer, plasticity index of the sands (sample passing 0.420mm sieve) and determination of deleterious clay content of the fines in aggregate (methylene blue).

Further, during Hardfill production, tests (a) to (d) shall be performed at least once each day on a sample from every mixing lane, in which case the combined properties of the mixed material shall be sampled. In addition, at least one set of tests (e) to (i) shall be performed each day on a randomly sampled specimen selected from one of the mixing lanes.



When, in the opinion of the *Engineer*, a problem exists in connection with the cleanliness of aggregate, specific tests shall be made in accordance with SANS 5847.

PPS10.10.2.2 Hardfill Mixing and Moisture Control.

Layer thicknesses shall be controlled by laser guided systems. Control levels shall be extracted and recorded for quality control purposes on every layer (sand and aggregate) at minimum 5 m intervals, at three spots (LHS, CL, RHS), or using other suitable three dimensional system to the approval of the *Engineer*. The aggregate and sand shall be separately checked for compliance with the designed mixture ratio. The difference in layer thickness shall be calculated to check the thickness of the sand laid on top of the aggregate. Variation of no more than 5 mm on average and 10 mm at specific locations shall be permitted. In an instance where two measurements at one chainage are in excess of the latter limitations, the placement shall be re-graded.

Once the sand and aggregates have been mixed and immediately prior to cement placement and mixing, density and moisture of the mix shall be measured by means of a calibrated nuclear density gauge. Readings shall be taken at 10 m chainages (alternating LHS, CL, RHS) at 300 mm and 100 mm depths, and an average density and moisture of the pre-mixed lane calculated, for use in recycling operation.

Prior to the commencement of each day's production, daily moisture corrections for the nuclear density gauge shall be determined at the designated 10 m chainages from the first mixing lane processed that day. These corrections shall be verified using a minimum of eight (8) moisture content correlation tests, conducted in accordance with SANS 3001-GR20 by the oven-drying method. The applicable moisture correction shall be recorded in a register and evaluated for variances with time.

The total number of bags required to cover the entire mixing lane to be mixed shall be calculated and checked. A record of this number shall be included on the daily report forms, together with the required spacing distances. Checks on the spacing shall be made by means of average spacing over 11 bags, to correlate to 10 times the required spacing. Once cement bags have been opened and the cement has been spread, a minimum of six mass samples per mixing lane, on a pre-placed 500mm x 500mm placed sheet shall weighed and compared to the required dosage of cement.

Before the Hardfill is removed from the mixing lanes for placement, the moisture of the mix shall be measured by means of the calibrated nuclear density gauge. Testing shall be made at 10 m chainages along each mixing lane (alternating LHS, CL, RHS), with a minimum of 8 No per lane. The VeBe density shall be measured at three of these locations, with a minimum of one test for every 250 m³ of material in the mixing lanes.

PPS10.10.2.3 Temperatures

Hardfill temperatures (for each mix placed) shall be determined every hour on the hour during the placing of Hardfill by means of a digital type immersion thermometer. Hardfill temperatures shall be measured at the Mixing Platform at the same locations at the moisture testing, when heaped for spreading and in the spread state immediately prior to compaction. The temperature of a heap of discharged Hardfill at the site of placing shall be measured at a penetration depth of not less than 250 mm from the surface of the heap.

At the same time as the placement temperature is recorded, the ambient air temperature shall also be recorded by means of the mercury thermometer. The reading shall be taken in the shade as close as possible to the position of the Hardfill placement.

Additional tests shall be made when rapid set time or workability loss is reported by the placing foreman or *Engineer*.

The *Contractor* shall record the following information:

- 1) The temperatures of the Hardfill at the Mixing Platform, in the heap before spreading and in the spread layer;
- 2) The ambient air temperature;
- 3) The time of day (hour); and
- 4) The position in the works, i.e. the reference level of the Hardfill layer and the chainage value.

The method of measuring the temperatures shall be to the approval of the *Engineer*. The readings shall be taken by a suitably trained person.

PPS10.10.2.4 Placed Moisture Content.

At least once every hour at the placement site (immediately after compaction) the moisture content shall be determined on the Hardfill mix at placement using a nuclear gauge in the direct transmission mode. The



probe shall be driven to a depth of 250 mm for each reading. The gauge shall be calibrated against oven-dry samples tested to SANS 3001-GR20 of each mix design used on a daily basis. After consistent moisture control is achieved, the rate of testing may be decreased to one test per 2 hours at the placement. At least three tests shall be made in different areas of each layer of Hardfill placed.

PPS10.10.2.5 Preparation for Concrete Placement.

Foundations, lift surfaces, construction joints, formwork, and embedded items shall be inspected in sufficient time prior to each concrete placement in order to certify that the area is ready to receive concrete. Formwork shall be checked closely for condition, support, alignment, and dimensions. The results of inspections shall be reported in writing as a part of the quality control reports. The placing foreman shall supervise all placing operations, shall determine that the correct mix design of concrete is placed in each location as directed by the *Engineer* and shall be responsible for measuring and recording concrete temperatures, ambient air temperature, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit placing to begin until they have verified that an adequate number of vibratory rollers and spreading equipment of the correct size, in working order, and with competent operators is available. He shall further ensure that all required joint treatments have been effectively accomplished.

PPS10.10.2.6 Dumping and Spreading.

The placing foreman or other designated representative shall continually observe and monitor dumping and spreading operations to ensure that operations are appropriate to minimise segregation and to avoid excessive spreading after dumping. Each layer of Hardfill shall be routinely checked in its spread uncompacted condition for evenness and correct thickness that shall result in a smooth, even, compacted layer within the thickness tolerances specified and having an average thickness as required. A laser shall be used in conjunction with hand-carried vertical rods to determine the elevation (and subsequently the thickness) of each layer. The laser shall be of the type that emits a rotating or constant light beam in a fixed plane.

PPS10.10.2.7 Compaction Equipment.

Before any compactor is used in Hardfill construction, it shall be checked for correct dimensions, weight, and vibratory capacity. At least once per 12 shifts of use, a recheck of frequency shall be made. At least once per placement shift for the first 5 days of operation by any new operator, performance shall be checked for the correct number of passes, correct spread, coverage of the area being rolled, and good rolling practice. Thereafter spot checks shall be made on each operator at least weekly.

PPS10.10.2.8 Hardfill Consistency and fresh density (VeBe density)

Consistency of Hardfill shall be measured using the VeBe apparatus as described in BS 1881 (Part 104). The procedure for the test shall be as follows:

- (i) The mass (P) shall be located centrally above the transparent disc such that the moving assembly comprising rod, disc and surcharge mass shall weigh $12.5 \text{ kg} \pm 100 \text{ g}$. The weight of the surcharge alone is 10 kg.
- (ii) Only aggregate passing a 37.5 mm screen shall be used for the test (refer to paragraph 5 of BS 1881).
- (iii) The internal surfaces of the container shall be thoroughly clean and free from superfluous moisture and any set concrete before commencing the test,
- (iv) The apparatus shall be placed on a rigid surface free from external vibration and the surface of the table shall be level,
- (v) The container shall be firmly secured to the table by means of the two wing nuts,
- (vi) The container shall be filled with the concrete in the manner of a loose bulk density test for aggregate,
- (vii) The top surface of the concrete shall be struck off level with a trowel or slump tamping rod so that the container is exactly filled,
- (viii) The transparent disc, which shall have a surcharge of 10 kg, shall be swung into position over the concrete,
- (ix) Vibration shall be started immediately and the stop-watch started simultaneously,
- (x) The remoulding of the concrete in the container shall be observed through the transparent disc. At the moment when all the concrete has been fully compacted the stop-watch shall be stopped and the vibration simultaneously switched off. The moment of full compaction shall be taken as the moment when the whole surface of the transparent disc is covered with concrete and the



- paste completely fills the ring between the disk and the mould,
- (xi) The following information shall be included in the report:
- Date of test,
 - Identification of sample i.e. point of sampling and approximate location when placed in terms of chainage and offset,
 - Loaded VeBe time (in seconds), and,
 - Time of concrete mixing and time of the test.

An additional test of fresh Hardfill density (VeBe density) may follow using the same sample. The procedure is as follows:

- (i) Continue vibration so that the total vibration time is two minutes,
- (ii) Clean off the transparent disc so that all the ingredients of the concrete are in the container,
- (iii) Weigh the container and concrete,
- (iv) Fill the container, still containing concrete, with water until it is completely full,
- (v) Weigh the container, concrete and water,
- (vi) Calculate the fresh compacted density by:

$$\text{density} = \frac{W_C - W_0}{V_0 - (W_W - W_C)} \times 10^3 \text{ (kg/m}^3\text{)}$$

where:-

- V_0 = volume of container (litres)
- W_0 = weight of container (kg)
- W_C = weight of container and concrete (kg)
- W_W = weight of container, concrete and water (kg)

PPS10.10.2.9 Concrete Specimens for Compressive Tests.

Hardfill shall be sampled at position of placement and cubes shall be manufactured, cured and tested for compressive strength. All sampling, preparation and testing shall be in accordance with the provisions set out in SANS 5863. Each set shall comprise 9 cubes, unless otherwise indicated; with 3 cubes each tested at 7, 28 and 60 days, except in the case of the Full-Scale Trial and in the process of establishing control for the main dam construction. For every 15 sets of cubes made, an additional set of 3 shall be made for testing at 365 days age.

Test specimens shall be compacted to the same density as applicable for the wet density of the compacted Hardfill on the dam wall close to the point of sampling. At least 98% of the cubes shall indicate densities of within 50 kg/m³ of the measured wet density of the Hardfill close to the point of sampling.

All cubes shall be clearly marked with adequate information to allow precise identification, accurate tracing and full correlation and evaluation of the results at any stage.

The following regularity of cube sampling shall apply:

- (i) Full-Scale Trial.

A minimum of one set of 150 mm cubes shall be made for every half layer (approximately 90 m³) of Hardfill mixed, and a set of cubes shall be made for each mixing lane used in the trial, whichever is the greater.

- (ii) During Hardfill Placement.

A minimum of one set of cubes of 150 mm dimension shall be manufactured every shift during Hardfill placement, or one for every 250 m³ if more than this production was achieved in a single shift. The cubes shall be tested in compression at the ages specified above.

PPS10.10.2.10 Density.

The density of Hardfill after compaction shall be determined as indicated in Clause PPS10.6.8.1 with nuclear density gauges, which shall be regularly calibrated.

During the course of all Hardfill placement, a running cumulative average of Hardfill densities shall be maintained on a bar graph (or other acceptable form) and shall consist of all valid readings, starting after all major mix design field adjustments have been completed for the Full-Scale Trial. In addition, at the end



of each day of Hardfill placement, a running cumulative average shall be provided to the *Engineer* in bar graph form (or other acceptable form) consisting of all valid readings for each mix design for:

- 1) Density readings made on that day.
- 2) Density readings made during the previous seven (7) days of Hardfill placement,
- 3) Density readings made during the previous 28 days of Hardfill placement.

a) Density Tests During Compaction.

Quality control density tests are to be used to determine whether the optimum compaction density has been achieved and to determine when additional Hardfill compaction or other actions are necessary. Density readings at different locations and depths shall be made during compaction as requested by the *Engineer*.

b) Density Tests Following Compaction.

Density readings shall be made on a regular basis after compaction with the vibratory roller has been fully completed. At least six readings shall be taken for every layer or every 250 m² of Hardfill placed, whatever is more frequent. As specified the density at each location shall be calculated as the average of the readings taken at 50, 150 and 250 mm depths. Locations of density readings shall be determined and shall be subject to the approval of the *Engineer*. Readings shall be scheduled so as not to disrupt or delay any of the other ongoing Hardfill operations. In addition, the percentage of compacted surface that is fully covered with paste shall be recorded every 500 m². This percentage should be above 90% in all inspections.

PPS10.10.2.11 Curing Protection and Joint Surfaces.

Moist Curing. At least once every 2 hours around the clock, 7 days per week, an inspection shall be made of all areas subject to moist curing and joint protection. However, the surface moisture condition shall be inspected as often as necessary to assure that 100 % of each lift surface is kept moist at all times. The surface moisture condition shall be noted and recorded. If an isolated area has been allowed to dry, that area shall be considered as improperly cured.

PPS10.10.3 Corrective Action

Clause PPS10.10.3 applies the same sub-clause references as applied under Clause PPS10.10.2.

On the occurrence of a failure of any test to demonstrate compliance with the specification, the *Contractor* shall report the event to the *Engineer*, together with his evaluation of the cause and his intended remedial measures. Any further action shall be at the discretion of the *Engineer*.

PPS10.10.3.1 Aggregate Properties

Whenever a test result is outside of the specification limits, the *Engineer* shall be immediately notified and a recheck sample taken. If the recheck sample is outside of the specification limits, the *Engineer* shall again be immediately notified, and positive steps shall be taken to rectify the situation. The *Engineer* shall advise the *Contractor* if production and placement of concrete shall be stopped at that time.

When testing for particle shape is required, two consecutive failures in the same sieve size shall be immediately reported and immediate action shall be taken to correct the deficiency.

PPS10.10.3.2 Hardfill Mixing and Moisture Control..

Where layer thicknesses in mixing lanes exceed the agreed thicknesses, the layers shall be re-graded before mixing in cement.

Where the initial moisture content along the mixing lane before final mixing varies by more than 30% of the range of moisture contents of the diamond shape acceptance envelope established during the Hardfill Mix Design Development Process, the mixing lane shall be re-graded and mixed to achieve this maximum range. Only one secondary re-mix shall be permitted, failing which the entire mixing lane shall be removed.

Where the final moisture content of the mixing lane after final mixing falls outside the range of moisture contents of the diamond shape acceptance envelope, the material in the lane shall be removed and not used in the dam. In this case, the cause of the variance shall be established and appropriate remedial measure, to the approval of the *Engineer*, made.

Where cement dosage is more than 5% less for the required application rate per square metre, the entire mixing lane area shall be re-checked for application rate and additional cement added. Where cement dosage exceeds 10% of the required rate per square metre, cement shall be selectively removed to



conform. A further six measurement areas shall be taken at random areas, to be determined by the *Engineer*, removing the cement and replacing it on the plastic sheeting to the same level as the surrounding area.

In each case the *Engineer* shall be informed of the corrective action to be applied before execution.

PPS10.10.3.3 Temperature.

Whenever the mix temperature approaches or falls above 30 °C or below 2 °C, the *Engineer* shall be notified immediately. Placement shall not proceed unless the *Engineer* is satisfied that the specified temperature requirements will be achieved. All other temperatures shall be included as standard data in the quality control reports.

PPS10.10.3.4 Mixing Platform and Placed Moisture Content.

Where the moisture content at the placement site falls outside the range of moisture contents of the diamond shape acceptance envelope, the material shall be uplifted and removed from the dam.

PPS10.10.3.5 Preparation for Hardfill placement.

Should unsatisfactory preparation of any type be observed, etc., the *Engineer* shall order that this be rectified before Hardfill placement is resumed.

PPS10.10.3.6 Dumping and Spreading.

Whenever thickness checks on uncompacted Hardfill indicate an excess or shortage of material, the layer shall be immediately bladed off or supplemented to establish the correct thickness before compaction. The *Engineer* shall be immediately notified to determine the necessary corrective action.

Any segregation of the fresh Hardfill observed during dumping and spreading shall be re-mixed with fresh Hardfill of the previous and/or next load using both the dozer and shovels. If segregation remains, the cause shall be investigated and remedial actions shall follow immediately. If the cause of the segregation is not found or the remedial actions do not bring any benefit after 1 hour, the Hardfill placement shall be stopped until the *Contractor* can demonstrate that the segregation of the fresh Hardfill has been fully controlled, and that the re-mixing effort can be minimized or is no longer required.

PPS10.10.3.7 Compaction Equipment.

Compaction equipment not meeting the physical dimensions and weights required shall be removed from the project. Any roller having improper frequency shall be corrected before being used for Hardfill compaction. Roller operators running at speeds in excess of specification requirements shall be immediately notified and shall correct any noted improper practices or be replaced by another operator.

Any dirty equipment (mud, grease, loose Hardfill, etc.) or equipment leaking oil shall immediately be removed from the working face. Any areas of the Hardfill contaminated under such circumstances shall be removed to the satisfaction of the *Engineer*.

PPS10.10.3.8 Hardfill Consistency.

Should consistency testing indicate VeBe values outside the allowable range, the mix shall be immediately analysed and the mixing or mixing proportions adjusted accordingly. Should a repeated pattern of unacceptable values be observed, the *Engineer* shall halt Hardfill placement until appropriate remedial measures are adopted.

PPS10.10.3.9 Concrete Compressive Strengths.

The *Contractor* shall prepare a detailed report on all compressive strength testing, presenting his proposed remedial measures in the case of problems, or downward trends in strength, etc. The *Engineer* retains the right to order the *Contractor* to remove any Hardfill that fails to meet the Project Specification.

PPS10.10.3.10 Compacted Density.

Whenever the average of all density readings from within a grid section falls below the target optimum compaction density value, the entire lift surface shall be immediately compacted within the grid section by making additional roller passes. A determination shall also be made as to why the optimum compaction density value has not been achieved and immediate steps taken to increase density to the required value. The process of taking density readings followed by additional roller passes shall be repeated until the



optimum compaction density value has been achieved. However, if after a reasonable number of additional passes the Hardfill still does not meet the optimum compaction density value, the Hardfill for that lift within the grid section shall be removed, or at the discretion of the *Engineer* the Hardfill may be permitted to remain. Actions to be taken to increase density values for future placements include but are not limited to making mix property adjustments, decreasing the interval between mixing and compaction, or temporarily stopping all operations until placement can be achieved during cool or cloudy days or at night time.

PPS10.10.3.11 Curing Protection and Joint Surfaces.

Any failure to observe this Specification shall be immediately rectified.

PPS10.10.4 Reports.

Mixing platform and placement control reports and results (both passing and failing) of all tests conducted at the project site, shall be reported daily and summary reports shall be delivered to the *Engineer* within two days after the end of each monthly reporting period. These requirements do not relieve the *Contractor* of the obligation to report certain failures immediately as required in preceding clauses. Such reports of failures and the action taken shall remain available for examination and the *Engineer* shall have access to all of the *Contractor's* quality control records at any time.

PPS10.11 MEASUREMENT AND PAYMENT

Items shall be measured as described below under the respective sub-clauses of this specification, as applicable. The tendered rate for each item shall include for all the activities described under the sub-clause and under the various clauses of this Specification, as applicable.

The following items shall be measured and paid for under the relevant clauses of the Project or Standard Specification:

- (a) Formwork to steps.
- (b) Surface finish to steps and final horizontal surfaces.
- (c) Reinforcement.
- (d) Joints (not induced joints).
- (e) Preparation of receiving foundation and other concrete surfaces, which shall include for the provisions of this specification.

PPS10.11.1 Hardfill Concrete (State Grade and Type).....Unit: m³

The unit of measurement shall be the cubic metre of compacted Hardfill placed within the theoretical lines, as specified on the drawings, less the volume of facing concrete if applicable.

The tendered rate shall cover all costs in relation to materials directed under Table 6, plant and labour for the following:

- (a) The design of the Hardfill mix and mix design programme to the Engineer's approval.
- (b) Supply of all materials required for the Hardfill, including, but not limited to cement, water, quarrying and processing.
- (c) Quality assurance and control.
- (d) Manufacture, transport, temperature control, placed in accordance with the method specified and compact Hardfill to the satisfaction of the Engineer and to complete lift joint preparation.
- (e) All vertical joint treatment.
- (f) All bedding mixes, except those paid for under items **PPS10.11.5**.
- (g) Curing required.
- (h) Preparing of all receiving surfaces of previously placed Hardfill layers and foundation or as directed by the Engineer.
- (i) Testing of the Hardfill as specified, including water pressure testing and the drilling and testing of all cores as specified in PPS10.10.1.2.
- (j) The provision of thermometers and the recording of mixing and placement temperatures as specified in PPS10.5.11.
- (k) Any necessary cooling of materials, as required.
- (l) All other actions and provisions required to provide the Hardfill to meet the requirements of the



specification not measured elsewhere.

No separate payment shall be made for any grouting, as ordered by the *Engineer*, of the dam body Hardfill in the zones indicated on the drawings to be impermeable.

For tender purposes the Hardfill mix provided in Table 6 shall be priced. Irrespective of the admixture, aggregate and water composition, only adjustment to the cement content established through the approved trial programme shall be made. This will be done through **PPS10.11.3**.

PPS10.11.2 Hardfill Mixing Platform Unit: Lump Sum

The unit of measurement shall be a Lump Sum for the construction and maintenance of the Hardfill Mixing Platform required to mix the Hardfill as specified. It shall also cover the cost of the removal and rehabilitation of the area taken up by the Mixing Platform on completion of Hardfill manufacture.

It shall cover the provision of all labour, plant, materials, etc to carry out these operations.

Payment of the items of PPS10.11.2 shall be made as follows:

- 75% when all facilities as proposed by the *Contractor* in his Hardfill method statement and approved by the *Engineer* have been constructed such that Hardfill mixing can commence.
- The remainder to be paid on completion of the Hardfill manufacture when the area has been rehabilitated to the satisfaction of the *Engineer* and Environmental Officer.

PPS10.11.3 Variation in Cementitious Content (State type of cementitious material) ..Unit: tonne (t)

This unit of measurement shall be the quantity of deviation (increase or decrease) in cementitious material from the quantities indicated in the Hardfill tender mix proportions Table 6.

PPS10.11.4 Extra over PPS10.11.3 for GEVR and/or GE-Hardfill Unit: m³

The unit of measurement shall be the cubic metre of compacted Hardfill that is grout-enriched as GEVR and/or GE-Hardfill by immersion vibrator. The only GEVR/GE-Hardfill for which payment shall be made, shall be that and those areas indicated on the drawings, or as ordered by the *Engineer*. Any GEVR/GE-Hardfill that is made necessary by any activities, or for any purposes elected by the *Contractor* shall be for his account and no payment shall be made.

The rate shall cover all costs for the mix design, materials, plant and labour required for the mixing, transporting, preparation, dispensing grout and compacting, testing and curing the GEVR/GE-Hardfill, as well as achieving the specified finish on all surfaces.

PPS10.11.5 Bedding Mortar Unit: m²

The unit of measurement shall be the square metre of bedding mortar specified and placed. The minimum thickness of the layer shall be 20 mm. The only mortar bedding layers for which payment shall be made shall be the layers and layer areas indicated on the drawings, or as ordered by the *Engineer*. Any bedding mortar that is made necessary by stoppages by the *Contractor*, shall be for his account and no payment shall be made.

The rate shall cover all costs for the mix design (if required), materials, plant and labour required for the mixing, transporting, placement and spreading of the bedding mortar.

PPS10.11.6 Filler Concrete (Grade 20/40) Unit: m³

The unit of measurement shall be the cubic metre of filler (levelling or dental) concrete placed where specified on the drawings or in the Project Specification, or as ordered by the *Engineer*.

The rate shall cover all costs for the preparation of surfaces or trenches, together with the placing of any



items to be embedded, the mix design, materials, plant and labour required for the mixing, placing and compaction of the filler concrete.

PPS10.11.7 Full-Scale Trial Unit: No

The unit of measurement shall be the number of Full-Scale Trials constructed. The rate shall include for clearing and excavating the surface to rock, cleaning of the rock surface, placing blinding where necessary, placing a bedding layer prior to placing the first layer of Hardfill, placing of subsequent layers until the *Engineer* is satisfied with the *Contractor's* operation, and all plant, labour and materials required for the operation, including quality control, recording and reporting. Payment for additional Full-Scale Trials shall only be made if necessary due to changed circumstances beyond the control of the *Contractor*.

PPS10.11.8 In-situ Shear Testing of Hardfill layers Unit: No

The unit of measurement shall be the number of In-situ shear tests as described in PPS10.6.9. The rate shall include for all plant, equipment, personnel and resources to undertake the tests, including the exposure of the test surface, preparation of the test samples, testing and reporting.

PPS10.11.9 PVC Waterstops (State type and width)..... Unit: m

The unit of measurement shall be the metre of waterstop installed in the dam. The tendered rate shall include full compensation for this item and all materials, plant and labour required to manufacture, transport, locate and install PVC waterstops as specified.

PPS10.11.10 Crack Inducers in the U/S Face Unit: m

The unit of measurement shall be the linear metre of joint or crack inducer complete as scheduled or ordered. The rate shall cover all costs for materials, plant and labour (excluding waterstops) required for each joint, inclusive of temporary supports and raising activities as the Hardfill level rises.

PPS10.11.11 Crack Inducers in the D/S Face Unit: m

The unit of measurement shall be the linear metre of joint or crack inducer complete as scheduled or ordered. The rate shall cover all costs for materials, plant and labour (excluding waterstops) required for each joint, inclusive of temporary supports and raising activities as the Hardfill level rises.

PPS10.11.12 Crack Directors (state material & installation Unit: m

The unit of measurement shall be the linear metre of crack director complete as scheduled or ordered. The rate shall cover all costs for materials, plant and labour (excluding waterstops) required to manufacture, transport, locate, install and protect the crack director.

PPS10.11.13 Set-ups for 150 mm Core Drilling in Hardfill Unit: No

The unit of measurement shall be the number of set-ups for the drilling of 150 mm quality assurance cores in Hardfill, as directed by the *Engineer* (over and above specified for which payment must be allowed for under **PPS10.11.1**). A set-up shall be measured once only for each hole regardless of the number of times that the plant is moved during the drilling operation. Adjustment of the drilling equipment to deal with a number of angled holes at one station shall not be measured as separate set-ups. The rate shall cover all costs of moving, transporting and handling, establishment, temporary works and preparation of the drill rig for drilling, as well as removal of the rig and clearing.

PPS10.11.14 Standby for 150 mm Core Drilling Rig Unit: h

The unit of measurement shall be the time in hours that the 150 mm drill rig is on standby awaiting the



Engineer's instruction to complete drilling, or to be moved (over and above specified for which payment must be allowed for under **PPS10.11.1**). The rate shall cover all costs of keeping the drill rig, all drilling personnel and other equipment and materials on standby. It shall not cover time during which plant and labour are standing-by while tests and other operations necessary for the completion of the work are being carried out.

PPS10.11.15 Drilling and Recovery of 150 mm core in Hardfill Unit: m

The unit of measurement shall be the length of undamaged 150 mm Hardfill core recovered, as ordered by the *Engineer* (over and above specified for which payment must be allowed for under item **PPS10.11.1**). The rate shall cover all costs of drilling core, at any angle, in Hardfill, recovery of the core, provision of core boxes, storage of the core in core boxes protected in plastic film, transportation of the core to the *Engineer's* site laboratory, recording comprehensive information on core origin and grouting of the drilled hole, as accepted by the *Engineer*. The rates shall include for one set of compressive strength and density (SANS 5863 and 5865) and joint shear strength (ASTM D 5607) for every 10m of core extracted. The rate shall also cover all costs of complying with the *Drilling and Grouting Specification*.

PPS10.11.16 Water pressure testing in 150 mm core holes in Hardfill.....Unit: No

The unit of measurement shall be the number of separate water pressure tests, which are satisfactorily performed, as ordered by the *Engineer* (over and above specified for which payment must be allowed for under **15.001**). The rate shall cover all costs of establishing and conducting a water pressure test in a 150 mm or 75 mm core hole, using packers, as directed by the *Engineer* and in compliance with the requirements of the *Drilling and Grouting Specification*.

PPS10.11.17 Grouting of 150 mm core holes in Hardfill Unit: No

The unit of measurement shall be the number of core holes satisfactorily grouted, as ordered by the *Engineer* (over and above specified for which payment must be allowed for under **PPS 10.11.1**). The tendered rate shall cover all costs of grouting the hole with a 1:1 mixture of cement and water, as directed by the *Engineer*, in accordance with the *Drilling and Grouting Specification*.



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PARTICULAR SPECIFICATION
DAM MONITORING INSTRUMENTATION

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PPS-29

PARTICULAR SPECIFICATION

DAM MONITORING INSTRUMENTATION

PPS29.1 SCOPE

This section deals with the supply, storage, installation and commissioning of instruments to be installed in and around the dam, and the readings to be taken during the construction period for the monitoring of the structural behaviour of the dam during construction and operation.

PPS29.2 INTERPRETATION

PPS29.2.1 Work Included

The *Contractor* shall be responsible for the timeous procurement of all instrumentation components, allowing all instruments at least 2 months on site to acclimatise to local conditions. Before placing any purchase orders, the *Contractor* shall request the *Engineer's* approval of his proposed instrumentation selection as well as a written Notice to Proceed.

The *Contractor* shall store, test and calibrate as required, transport, install, commissioning and maintain all the procured instrumentation (incl. all cabling, power supplies, auxiliaries, readout units, etc.). The Contractor shall furnish and install cabling conduits, necessary supports for the cable leads, the basic reading station facilities, cabinets, panel boards, power and lighting protection facilities.

All electronic instrumentation installed shall be integrated into an Automated Data Acquisition Systems (ADAS). The *Contractor* shall be responsible for the design, configuration and commissioning of the ADAS system.

He shall further construct defined instrumentation shafts in the Conventional Vibrated Concrete (CVC) or Hardfill and provide the necessary cable racks for power supply and connection of instrumentation to the designated monitoring stations.

Installation procedures shall be planned well in advance of scheduled installation dates. The *Contractor* shall issue method statements (step-by-step procedures) to the *Engineer* for the drilling methodologies, installation of the individual instruments, cabling and protection, making use of the instrumentation manufacturers' instruction manuals and state-of-the-art knowledge. This shall include a detailed cabling routing plan and instrumentation numbering system.

Installation of all instrumentation shall only be undertaken by experienced *Contractor's* personnel, whose qualifications shall be proven to the *Engineer*. The personnel involved in the testing, calibration, installation, commissioning, monitoring and maintenance of the instrumentation system shall be suitably qualified and experienced in this field. Specialists from the relevant instrumentation suppliers shall visit the site to train the *Contractor's* personnel as required.

Factory calibration shall be undertaken by the relevant manufacturers and individual calibration certificates for each instrument shall be submitted to the *Engineer* prior to installation.

Pre-installation acceptance tests (and calibration as required) shall be performed by the *Contractor*, in the presence of the *Engineer*, immediately prior to installation of the instruments. The *Contractor* shall provide detailed records of the pre-installation acceptance tests and calibration as well as of the installation of the instruments.

Initial readings, including calibration and commissioning of the installed instruments, shall be carried out in the presence of the *Engineer* to prove the proper installation and function of the instruments.



The *Contractor* shall submit an instrumentation installation schedule for each instrument and location for approval by the *Engineer*. The instrumentation schedule shall be consistent with the issued construction schedule and shall be submitted to the *Engineer* prior to installation of the first instruments.

All instruments in the CVC, Hardfill and earth/rockfill dam shall be installed in sequence with the progress of the Works, and in particular with the progress of the Hardfill and the construction of the galleries. The *Contractor* shall be responsible for the protection of the instruments, cables and readout units at all times during construction.

It is a requirement of this contract that all the instrumentation, inclusive of the ADAS shall be fully operational and approved by the *Engineer* before reservoir impoundment commences.

The *Contractor* shall be prepared to accept changes in the instrumentation layout or additional installations of instruments, if required by the *Engineer*, and shall also be prepared to receive installation instructions for changed site conditions. The *Contractor* shall provide access to all instrumentation locations at all times during construction.

PPS29.2.2 Definitions and Abbreviations

The following abbreviations will apply:

ADAS	Automated Data Acquisition Systems
CVC	Conventional Vibrated Concrete
FS	Full Scale

PPS29.2.3 Codes and Standards

All instrumentation shall operate on 230V single phase 50Hz power supply. The *Contractor* shall be responsible for all transformers and associated cabling to instruments operated on low voltage systems (e.g. 12V).

PPS29.2.4 Instrumentation Monitoring

The *Contractor* shall be responsible for all instrumentation readings for the durations of the Construction and Defects Notification Periods, and for the sensible and sustainable recording of all instrumentation data and its management.

Accordingly, it will be in the interest of the *Contractor* to have the ADAS system operational as soon as practically possible. Until such time that the ADAS is operational, the *Contractor* shall download all data to the designated laptop computer. The intervals for recording data for each instrument and the requirements in respect of reporting instrument data to the *Engineer* are defined in Section PPS29.5 of this Specification.

Measurement reports including graphic presentation of the readings shall be prepared by the *Contractor* and submitted to the *Engineer* on a weekly basis for the readings to be taken as indicated in Sub-Clause 0 below.

The interpretation of the measurements will be undertaken by the *Engineer*.

PPS29.2.5 Submittals and Approvals

The following is applicable:

1. Within ninety (90) days of Notice to Commence, the *Contractor* shall submit for *Engineer's* approval the schedule of delivery and installation for all instrument types in relation with the Construction programme;
2. At least two (2) months before ordering the supply of any instrument, data loggers and/or acquisition systems, the *Contractor* shall submit for *Engineer's* approval:



- Each instrument's supplier details.
 - The installation subcontractor details and Curricula Vitae (CV) of the personnel in charge of the supervision.
 - The proposed instrument referencing system (See Sub-Clause PPS29.8).
 - The specifications, model and size of each instrument and associated readout devices, cables and accessories. The submittal shall include all details related to the proposed instruments and the manufacturer's installation specifications.
 - Detailed specifications and drawings defining the proposed cabling routing.
 - Details of the ADAS system, including, but not limited to the database and presentation software to be used, the planned customisation and graphical presentation configurations, the groups of instruments to be graphed, etc.
3. At least twenty eight (28) days prior to the scheduled date of installation, the *Contractor* shall submit for *Engineer's* approval:
- Proposed procedures for installation, backfilling and testing, if different from those specified.
 - Proposed methods of access to instrumentation and temporary readout panels, and protection during construction.
4. No later than fifty six (56) days prior to the commencement of classroom training, the Curricula Vitae (CV) of the personnel proposed for operational and maintenance training shall be submitted to the *Engineer* for approval.
5. After the installation of the first instruments, the *Contractor* shall submit an updated instrument reading listing of all installed instruments to the *Engineer* in electronic format on a weekly basis. These submittals shall continue until the expiry of the Defect Notification Period.
6. No later than two (2) months after initiation of impoundment, as-built drawings of the installed instrumentation and associated readout devices, cables and accessories.
7. No later than two (2) months after initiation of impoundment, the operational manuals for the ADAS system.

PPS29.3 MATERIALS

PPS29.1.1 General

Instruments for dam monitoring shall include:

- Survey prism targets and survey monuments;
- Geodetic survey instruments;
- Electrical piezometers;
- Air temperature meters;
- Thermistors
- Thermocouples;
- Strain gauges;
- Flow measuring weirs;
- Water level staff gauges;
- Data loggers, etc; and
- ADAS system.

The *Contractor* shall procure, install and commission the different instruments suitable for the site conditions, complete with accessories, installation devices and manuals after the approval of the proposed instrumentation details by the *Engineer*.

All instruments and their associated cabling, read-out units, installation consumables, appurtenances, etc. shall be procured from manufacturers having a worldwide reputation and proven track-record in the field of geotechnical or seismic instrumentation. Specifications and technical data of the instruments proposed by the *Contractor* shall be submitted to the *Engineer* for approval before placing the purchasing orders.



Installation shall be carried out where shown in the drawings and/or instructed by the *Engineer*, as soon as the progress of the construction allows. Reading of the instruments shall commence as soon as the progress of the construction allows.

The *Contractor* shall submit detailed step-by-step procedures (method statements) on the complete installation procedures for each instrumentation type to the *Engineer* for approval. Drilling of boreholes, logging of cores, flushing of holes and checking that holes are entirely free of any debris and drill mud will fall under the responsibility of the *Contractor*.

It is the *Contractor's* responsibility to procure the different instruments and set up the instrumentation installation works in accordance with the dam construction schedule. The installation of dam instruments shall not interfere with the continuous process of earthfill, rockfill, CVC or Hardfill placement.

PPS29.3.2 Cabling and Transient Protection

All cabling shall be multi-cored, purpose designed instrumentation cable of a type approved by the manufacturer of the instrument whose signal is to be carried. Individual insulated conductors shall be twisted into pairs inside a conductive insulating material in the cables. The cables shall be of the heavy duty insulated type of robust construction and suitably durable and reliable for dam construction. All cable must include all requirements for waterproof splicing, waterproof connection to instruments and appropriate end connections and identification markings at readout points. All related and necessary sundry and miscellaneous items shall be deemed to be included with the supply of the cables.

All instruments shall require earthing and lightning protection of adequate capacity to eliminate related damage to the instrument, or cabling during a lightning strike.

Cables shall be suitably protected against possible damage during Hardfill, concrete and fill material placement and general construction activity. Any installation damaged during Hardfill, concrete or fill material placement shall be replaced by the *Contractor* at his own cost. This may include full replacement of the installation in higher Hardfill layers.

PPS29.3.3 Installation in the Hardfill

The drawings indicate the general locations of the instrumentation and anticipated cable routes. Generally, cabling shall be directed horizontally in the Hardfill towards the galleries or instrumentation shafts/pendulum shafts.

The *Contractor* shall plan his operations around the locations of the instruments and cable routes.

Instruments designated to be embedded in Hardfill shall be installed within the monolithic body of the Hardfill and within the uninterrupted course of Hardfill placement. It is more important to install instruments in the ongoing placement than to place all instruments in the same Hardfill layer. It is considered significantly preferable to install all instruments required at one "elevation" over a maximum of three progressive placement layers, than to install all instruments in the same layer with the consequence that a warm, or even, a cold joint is required between the applicable and the successive layers.

The *Contractor* shall design and arrange all of his activities and procedures to minimize the risk of damage to installed instruments and instrumentation cables. Until second set of the Hardfill, all instruments shall be read hourly to ensure correct function. Should any malfunction be detected, the instrument will be excavated and replaced. During the first two days after instrument installation, the alignment of the cabling and the instrument locations will be marked with flags in the surface of the Hardfill placement area and the passage of any heavy traffic over these areas shall be kept to a minimum.

PPS29.3.4 Operational Conditions

Unless otherwise stated, all instrumentation installed in/on the dam shall be suitable for use under the



following conditions:

- Operation temperature range -15°C to +70°C
- Operation humidity range 5% to 100%.

PPS29.4 INSTRUMENTATION

PPS29.4.1 Survey Prism Targets, Survey Monuments and Settlement Beacons

The *Contractor* shall procure and install built-in Survey Targets Receptacles and removable Survey Prism Targets (stationary geodetic light reflectors) on the downstream crest of the dam for monitoring the displacements of the dam by geodetic precision survey.

The receptacles shall be grouted into the concrete of the dam wall crest, approximately 100 mm from the downstream edge, to form a permanent reference point. Each receptacle shall be provided with an alignment and mounting frame and a lockable, hinged protection cover. The protection cover shall be of a strong and durable construction to allow the protection of the survey target receptacle from all potential vehicle and other hazards on the crest of the wall and will seal against the mounting frame to ensure weather-proofing when the cover is closed. The alignment frame must be adequate to ensure the absolute vertical alignment and strong anchorage of the receptacle. All components shall be manufactured in heavily proportioned brass. The receptacles shall have a 5/8 inch Wild bayonet fit to receive and ensure the accurate location of the prism target. The prism target receptacle shall allow the repeated absolute accurate location of the prism to within 0.1 mm.

The prism targets shall allow accurate targeting from a distance of 2 500 m, be visible by at least three survey targets on the abutments and have a vertical target range of 45°. The Installation location of the reflectors shall be such that a clear sight is provided between the relevant survey monuments and the reflectors. The targets shall be of a robust, high quality construction, shall be individually numbered for identification and shall be provided with a robust, weather-proof case for protection during storage. A very high level of machining accuracy must be applied for the prism manufacture (< 1 mm accuracy), and a positioning tolerance of 0.1 mm shall be maintained at all targets.

Survey monuments shall be as per the details on the Drawings. These shall be constructed at suitable locations on sound, stable rock, approved by the *Engineer*. The mounting brackets shall be manufactured of brass and compatible with the Geodetic Survey Instruments as per Sub-Clause 0 below.

The locations of the prism targets and monuments shall be as provisionally shown in the tender drawings. The final layout will be confirmed by the *Engineer* once the survey triangulation system is finally set up.

Settlement beacons shall be constructed as per the details on the Drawings. These shall be constructed at suitable intervals on both the upstream and downstream of the embankment crest. The settlement beacons shall consist of a concrete pillar (concrete class 25/19) excavated into the completed embankment earthfill or rockfill material. A brass levelling stud shall be provided at the top. The settlement beacon shall protrude a minimum of 100 mm from the crest or roadway.

The *Contractor* shall be responsible for protecting the survey monuments, settlement beacons and the instruments from any damage or displacement and for the maintenance of the same at his own cost during the execution of the works.

PPS29.4.2 Geodetic Survey Instruments

The *Contractor* shall procure a tachymeter (laser total station) and an electro-optical level including a 2 m and 5 m levelling staff gauge for alignment, levelling and triangulation as indicated below. The *Contractor* shall furnish a high quality tripod with each instrument.

Tachymeter specification:

- Measurement distances 1.5 m to 2.5 km (Strong haze, 5 km visibility, or strong



- Precision of distances sunlight, severe heat shimmer)
 $< 1 \text{ mm} \pm 1 \text{ ppm}$ (Strong haze, 5 km visibility, or strong
sunlight, severe heat shimmer)
- Precision of angles $< \pm 0.5''$ (0.15 mgon) (ISO 17123)
- Distance resolution $\pm 0.01 \text{ mm}$
- Angle resolution $\pm 0.1''$
- Magnification 30x
- Shortest focussing distance 1.7 m
- Automatic target recognition for standard reflector prisms

Levelling specification:

- Measurement distances 1.5 m to 2.5 km (Strong haze, 5 km visibility, or strong
sunlight, severe heat shimmer)
- Accuracy $< 0.1 \text{ mm/km}$ (Strong haze, 5 km visibility, or strong
sunlight, severe heat shimmer)
- Resolution $< \pm 0.1''$
- Magnification 32x
- Shortest focussing distance $< 1.6 \text{ m}$
- Insensitive to direct solar radiation

All necessary accessories for the operation of the instruments shall be included, including accessories required such as, but not limited to, a device for data transfer to a PC, software for data transfer and evaluation on a PC, operation manuals, batteries, spare batteries and battery chargers, etc.

PPS29.4.3 Electrical Piezometers

The *Contractor* shall procure, install and commission electrical vibrating wire piezometers for the monitoring of the temperature and uplift pressure in the rock of the dam foundation where shown in the Drawings or instructed by the *Engineer*.

The electrical piezometers shall essentially consist of a diaphragm and vibrating wire pressure sensor, housed in a stainless steel sealed body with a porous filter tip, the connecting cables and the read out unit, suitable both for local reading and for automatic remote reading.

In accordance with the cable layouts (See Sub-Clause PPS29.3), suitable numbers of automatic readout units, data loggers (multi-channel for connection of more sensors on one logger) and backup power supplies, all of a type recommended by the instrument manufacturer shall be provided with these instruments.

A compatible portable read-out unit shall be supplied with the instruments for the interim period until the ADAS is up and running. Where the latter unit can be used on more than one vibrating wire type instrument, only suitable numbers to meet with the monitoring requirements need be procured.

Electrical piezometers shall comply with the following requirements:

- Measuring range up to 3.0 MPa
- Accuracy $< 0.1\% \text{ F.S.}$
- Resolution $< 0.025\% \text{ F.S.}$
- Thermal sensitivity shift $< 0.05\% \text{ F.S.} / ^\circ\text{C}$

Vertical boreholes shall be drilled by percussion or rotary equipment at *Contractor's* convenience to reach at a depth of -4 m below the monolith base. The final depth of installation will be dependent on the geological conditions identified when the foundations are fully opened and will be instructed by the *Engineer* at the time. The specified piezometers shall be installed near the bottom of the boreholes as shown on the related Drawings. The diameter of the boreholes and the instrumentation installation procedures shall be as recommended by the manufacturer of the instrument.

The piezometer unit shall contain a built-in thermistor, conforming requirements of the thermistor type instruments described in Sub-Clause 0 herein.



The transducer shall be manufactured entirely in stainless steel components and hermetically sealed, forming a vacuum chamber for the vibrating wire element. The ends of the vibrating wire shall be clamped, using a swaging technique that ensures high stability, while allowing miniaturization of the components. The piezometer shall use electromagnetic coils to both pluck the wire and to convert the vibration generated into an electrical output current, whose frequency is identical to the natural resonant frequency of the wire, across the full range of applicable wire tensions. The piezometers shall be fitted with 59 micron sintered stainless steel filters (suitable for low air entry).

The stability of the vibrating wire output shall be unaffected by changes in cable resistance caused by water penetration, temperature variations and contact resistance.

The piezometers shall be inserted into the completed and stable borehole at the required depths. The piezometers shall be surrounded by a sand filter 300 mm either side of the transducer which shall be completely sealed by bentonite plugs at its bottom and top part. The borehole shall be filled with grout between two piezometer locations.

Instrumentation cables shall lead to the data logger/ADAS system.

The head of the installation shall be protected with a strong steel cap suitable to preserve the head from any damage that can occur during construction.

PPS29.4.4 Air Temperature Meters

The *Contractor* shall procure, install and commission electrical resistance type temperature meters for the short and long term monitoring of the air temperature at the downstream side of the dam, where shown in the Drawings or instructed by the *Engineer*.

Each thermometer installation shall essentially consist of an electrical resistance type thermometer housed in a shock resistant robust stainless steel body, of the required cabling, routed in the CVC/Hardfill to the nearest dam gallery, and of the read out unit.

The temperature sensors are to be housed in concrete box-outs on the steps on the downstream face of the dam, the external faces of which will be protected with stainless steel gratings (to be supplied under this specification). In this environment, the temperature sensor shall be robust, weather-proof, durable and suitable for reliable operation over an extended period.

In accordance with the cable layouts (See Sub-Clause PPS29.3), suitable numbers of automatic readout units, data loggers (multi-channel for connection of more sensors on one logger) and backup power supplies, all of a type recommended by the instrument manufacturer shall be provided with these instruments.

A compatible portable read-out unit shall be supplied with the instruments for the interim period until the ADAS is up and running.

Electrical thermometers shall comply with the following requirements:

- Measuring range -20°C to 80°C
- Accuracy ±0.2 °C
- Resolution 0.1 °C
- Variation in resistance >110 ohm/ °C (including cable)

The *Contractor* shall install the temperature meters, cables, etc. in accordance with the recommendations of the manufacturer.



PPS29.4.5 Thermistors

The *Contractor* shall procure, install and commission thermistors with complete set of wires, junctions, connectors and readout units for the short and long term monitoring of the temperature of the dam Hardfill, where shown in the Drawings or instructed by the *Engineer*.

Thermistors shall be either be a single probe type or comprise of a thermistor string. A thermistor string comprises of a number of individual sensors encapsulated in a multi-conductor cable.

The thermistors shall comply with the following requirements:

- Measuring range -20°C to 80°C
- Accuracy ± 0.2 °C
- Resolution 0.1 °C
- Housing PVC
- Minimum spacing (string) 150 mm

In accordance with the cable layouts (See Sub-Clause PPS29.3), suitable numbers of automatic readout units, data loggers (multi-channel for connection of more sensors on one logger) and backup power supplies, all of a type recommended by the instrument manufacturer shall be provided with these instruments.

A compatible portable readout unit shall be supplied with the instruments for the interim period until the ADAS is up and running. Readout unit shall comply with the following requirements:

- Compatible with vibrating wire instruments;
- Applicable for ambient temperatures of -10 to 50°C;
- Timebase accuracy ± 50 ppm
- Sensor accuracy < 0.5 °C;
- Resolution 0.1 °C; and
- Operating time greater than 40 hours.

The *Contractor* shall install the thermistors, cables, etc. in accordance with the recommendations of the manufacturer.

PPS29.4.6 Thermocouples

The *Contractor* shall procure, install and commission thermocouples with complete set of wires, junctions, connectors and readout units for the monitoring of the temperature of the dam Hardfill during and after the construction period of dam, where shown in the Drawings or instructed by the *Engineer*.

Thermocouples shall comply with the following requirements:

- ANSI type Copper-Constantan (Type T) thermocouple wire;
- Accuracy < 0.5 °C; in according to ASTM-E230(1993) & ANSI MC96.1 (1998).
- Miniature type connector.
- Insulation resistance at room temperature shall be according to ASTM E-585 (table 2).
- The formability shall be according to ASTM E-585 (Can be formed around a mandrel equal twice the outside diameter without sheath rupture or loss of IR.)
- Twisted/shielded thermocouple wire to reduce electrical noise.
- The sheath outside diameter and wall thickness shall be according to ASTM E-585 and the sheath material shall be stainless steel grade 304SS.
- The wire type and diameter shall be sized for the lengths of installation anticipated.
- The cable shall be either welded, brazed or soldered without changing IR.

In accordance with the cable layouts (See Sub-Clause PPS29.3), suitable numbers of automatic readout units, data loggers (multi-channel for connection of more sensors on one logger) and backup power supplies, all of a type recommended by the instrument manufacturer shall be provided with these instruments. The Readout unit shall comply with the requirements of Sub-clause 0.



PPS29.4.7 Strain Gauges

The *Contractor* shall procure, install and commission strain gauges, with integral temperature meters, in the Hardfill of the dam wall to measure horizontal strains in both the upstream-downstream direction as well as parallel to the dam axis, where shown in the Drawings or instructed by the *Engineer*.

The strain gauges shall be of a strong and durable construction, suitable for installation in Hardfill, and the vibrating wire sensor shall be housed in a protective stainless steel pipe. The instruments shall have frequency output suitable for transmission over long cables.

The strain gauges shall comply with the following requirements:

- Strain range 3 000 $\mu\epsilon$
- Active gauge length 250 mm
- Accuracy $\pm 0.1\%$ F.S.
- Resolution 0.4 $\mu\epsilon$
- Nonlinearity $< 0.5\%$ F.S.
- Flange diameter > 50 mm, < 75 mm, stainless steel

The integral temperature sensor component of the gauge shall be a thermistor, conforming requirements of the thermistor type instruments described in Sub-Clause 2.17 herein above.

In accordance with the cable layouts (See Sub-Clause PPS29.3), suitable numbers of automatic readout units, data loggers (multi-channel for connection of more sensors on one logger) and backup power supplies, all of a type recommended by the instrument manufacturer shall be provided with these instruments.

A compatible portable read-out unit shall be supplied with the instruments for the interim period until the ADAS is up and running. Where the latter unit can be used on more than one vibrating wire type instrument, only suitable numbers to meet with the monitoring requirements need be procured.

PPS29.4.8 Flow Measuring Weirs

The *Contractor* shall construct flow measuring weirs in the dam galleries and elsewhere as shown in the Drawings or instructed by the *Engineer*. He shall procure, install and calibrate the necessary ancillary weir plates and measuring equipment to enable flow rates to be accurately measured and recorded.

The flow measuring weirs shall consist of a flume and stilling-well constructed in Hardfill as detailed on the drawings, of a stainless steel V-notch weir, of a water level recording instrument to be integrated into the Automated Data Acquisition system and of a staff gauge for manual water level reading. Generally two separate measuring weirs are provided at each measuring location, facilitating measurement of flow from both sides.

The water level recording instrument shall consist of a housed cylindrical weight suspended from a vibrating wire force transducer. The transducer shall be vented to the atmosphere to compensate for atmospheric variations. The instrument shall comply with the following requirements:

- Min Measuring range 350 mm
- Accuracy $\pm 0.1\%$ F.S.
- Resolution $\pm 0.025\%$ F.S.

The flow measuring weirs shall be calibrated by approved methods after installation. This shall include the controlled discharge of accurately known flow rates of water through the system.

In accordance with the cable layouts (See Sub-Clause PPS29.3), suitable numbers of automatic readout units, data loggers (multi-channel for connection of more sensors on one logger) and backup power supplies, all of a type recommended by the instrument manufacturer shall be provided with these instruments.



A compatible portable read-out unit shall be supplied with the instruments for the interim period until the ADAS is up and running. Where the latter unit can be used on more than one vibrating wire type instrument, only suitable numbers to meet with the monitoring requirements need be procured.

PPS29.4.9 Water Level Staff Gauges

The *Contractor* shall procure, install and commission calibrated metal staff gauges for the visual control of reservoir level during flood events and for the calibration of the automated water level pressure transducers.

The Staff Gauges shall be finished with a special porcelain enamel to ensure easy reading and to resist rust or discoloration. Each gauge or gauge section shall be 1 m in length and accurately graduated in into centimetres divisions, with each decimetre numbered using the International E-pattern available in white on black. Specific one metre elevation demarcation shall be indicated with separate compatible number plates securely attached to the gauge plates.

The gauge plates shall be 100 to 150 mm wide with a minimum of six grommets holes for fastening with stainless steel round-head bolts to mounting posts. The mounting posts shall consist of 100 x 100 x 10 mm stainless steel Gr 304 angles, of length between 1.6 m and 2.5 m. The lower 0.5 m of the post shall be vertically and securely concreted in 600 mm diameter holes in the abutment rock. Alternatively, at the discretion of the *Engineer*, 1 m long posts shall be mounted to the upstream face of the dam body or intake tower with suitable stainless steel Gr 304 adjustment adaptors. All bolts, nuts and washers shall be compatible stainless steel.

Successive staff gauge units should be correctly levelled to within 0.1 mm to allow accurate water level readings without gaps or overlaps.

PPS29.5 QUALITY ASSURANCE

PPS29.5.1 General

Instruments shall be installed only in the presence of the *Engineer*.

Instrumentation installation shall be supervised by personnel with a minimum of ten (10) years' experience in this specialised line of work.

The *Engineer* may direct that instruments be installed only during daylight hours. If installation needs to proceed at night, suitable lighting shall be supplied.

All instruments and cables are to be regularly checked and tested for functionality during installation.

The *Contractor* shall operate the relevant readout boxes for taking regular readings and to calculate the data and present the results to the *Engineer*.

PPS29.5.2 Approval Criteria

Approval of installations will be determined by the *Engineer*, based upon readings taken immediately after installation and readings taken during the on-going construction activities. Instruments which fail for whatever reason shall be replaced forthwith.

PPS29.5.3 Installation

Where possible and appropriate to the relevant installation, calibration shall be done by the manufacturer in his factory.

Where the site configuration requires on-site calibration, this shall be undertaken by suitably qualified personnel (See Sub-Clause PPS29.2.5) to fully compensate for the site installation's unique elevation, orientation, environmental conditions, etc.



PPS29.5.4 Tolerances

Instruments shall be installed within 100 mm of the locations shown in the Drawings or directed.

PPS29.5.5 Protection of Instruments during Construction

The *Contractor* shall be responsible for protection of all instruments against damage or displacement by construction plant, lightning and/or blast damage. Suitable construction procedures shall be developed, which will be for the cost of the *Contractor*, which neither compromise the effectiveness of the instrumentation, nor the integrity of the Hardfill. Any instrument damaged by the *Contractor's* plant shall be replaced at the *Contractor's* own expense.

PPS29.5.6 Sequencing and Scheduling

The scheduling of the procurement, supply and installation of all instrumentation shall be built into the general Construction Programme, with specific line items being provided for each instrument.

The *Contractor* shall make due allowance in his construction programme for any delays due to the installation of the instruments and associated readout devices, cables and accessories. Notwithstanding, the *Contractor* shall design his instrumentation installation to minimise, or eliminate any impact on the progress of CVC, Hardfill, earthfill or rockfill placement.

PPS29.5.7 Changes

Should any instruments or monitoring equipment become faulty or damaged, the *Contractor* shall immediately submit to the *Engineer* a detailed memorandum summarising the problems experienced. The faulty or damaged equipment shall then be replaced as soon as possible. The Supplier's instructions for replacement shall be followed to ensure best use of devices and equipment.

Monitoring equipment shall be re-calibrated at the intervals as defined by the supplier, at the expense of the *Contractor*, during his period of responsibility.

PPS29.5.8 Monitoring

The *Contractor* shall take readings from the instruments during execution of the Works. The *Engineer* will confirm the initial readings immediately following approval of their installation.

The *Contractor* may be required to delay placement of fill or concrete over any instrument, ducts, cables or leads, and splices or couplings, until after the initial readings of the instrument have been taken. The *Contractor* shall maintain access and lighting to all instrument/readout locations for the taking readings for the full contract period.

All instrumentation read-out data shall be backed up to a separate off-site location.

Any monitoring undertaken by the *Engineer* shall not relieve the *Contractor* of his responsibility for the proper execution of the Works as regards his own monitoring obligations.

As part of the monitoring regime, any other observations made which may relate to accuracy of readings shall be noted and reported to the *Engineer*.

Only monitoring equipment with valid calibration certification shall be used, including levelling equipment for precise levelling.

PPS29.6 DATA COLLECTION AND REPORTING

PPS 29.6.1 Principles

All instrumentation data will be interrogated, stored and processed using the automated data acquisition system (ADAS) and it is intended that this system be implemented as early as possible. Until the time that the ADAS system has been installed and its reliability proved to the satisfaction of the *Engineer*, all instrument data shall be measured and recorded manually by the *Contractor*, at the intervals stated below.



All instrument data will be collected and stored from the time of first installation. The readings at installation will be recorded, with the instrument installed in fresh CVC or Hardfill, together with an exact record of the progress of the successive layers above and the actual first and final set times for the CVC/Hardfill. The atmospheric conditions on installation shall be recorded and the data from the instrument shall be read hourly thereafter until final set of the CVC/Hardfill.

PPS29.6.2 Data Loggers

The *Contractor* shall procure, install and commission data loggers for all electronic instrumentation, including all necessary auxiliaries:

The data loggers shall be multi-channel devices to collect readings from multiple instruments where appropriate. Multiple vibrating wire instruments shall be linked through terminal/switching boxes to the data loggers to minimise the number of vibrating wire data loggers required. Each data logger shall be compatible with, and supplied by the same manufacturer as the instrument it receives data from.

Portable read-out units shall be supplied with each type of instrument (or sensor as the case may be) for the interim period until the ADAS is up and running.

The terminal/switching boxes and data loggers shall be installed and commissioned in time to start reading of the above instruments as soon as they are installed. Where instrumentation installation precedes the construction of the ADAS, the *Contractor* shall be responsible for the temporary arrangements to ensure that the instruments are read as required.

PPS29.6.3 Automated Data Acquisition System

The *Contractor* shall design, procure, install and commission a centralised Automated Data Acquisition System (ADAS) to interrogate, collect, store, manage and processed all instrumentation data. The main control computer for the ADAS shall be installed in the Instrumentation Readout Chamber adjacent to the Valve Chamber.

The Instrumentation Readout Chamber shall be provided with air conditioning to maintain a constant temperature of 22°C and ventilation to maintain humidity at below 25%. It shall be the *Contractor's* responsibility to make all necessary provisions to ensure the facility is dust and damp-free and adequately secured against theft and vandalism until the end of the Defects Liability Period.

The ADAS shall be capable of:

- Performing automatic remote reading at specified programmable time intervals for all electronic instruments.
- Manually downloading geodetic survey data from the designated instruments.
- Storing the data obtained from the data loggers; and manual input, and downloading from all instruments.
- Elaborating the data of individual instruments, or of instrument groups, in graphic and numeric form.
- Summarising data of individual instruments, or of instrument groups, in long-term graphs and numeric tables.
- Automatically displaying alarms when reading of selected instruments reaches specified values.
- Transmitting data and alarm signals via a modem link to the central control.
- Raising an alarm message at the scheme central control and at the central control should failure of the system, or a failure in its power supply, occur.

The *Contractor* shall provide licensed computer software for the required data recording, management and presentation. This shall include all database management tools required (Preferably SQL). The software shall be customised to suite the configuration of the instrumentation in the dam, facilitating rapid and easy interpretation of readings. The system shall be able to present data on each instrument, or any

group of instruments for any selected or pre-programmed time intervals. Presentation shall be clear, concise and easily referenced.

The *Contractor* shall also procure and install all required power cables, connection cables, communication cables, cable trays, auxiliaries, etc. needed to link the data loggers with the ADAS, as well as a modem link through the telecommunications systems of the colony.

The minimum hardware specification for the ADAS computer shall comply with the following requirements:

- Intel® Core™ i7-7700 Processor (8M Cache, 3.40 GHz);
- 8GB (1x8GB) DDR3-1333 nECC RAM;
- 2 x 3TB SATA 6Gb/s 7200RPM HDD;
- SuperMulti DVD;
- Windows 10 Professional 64-bit;
- Standard keyboard;
- Optical Mouse;
- 24 inch LED full HD monitor;
- 10/100/1000 NIC; and
- Modem link.

The minimum hardware specification for the laptop computer shall comply with the following requirements:

- Robust, dustproof construction suitable for a construction site;
- Intel® Core™ i7 7700 Processor;
- 8GB DDR3 1600 MHz SDRAM;
- 1TB 2.5" SATA 5400RPM HDD;
- SuperMulti DVD;
- Windows 10 Professional 64-bit;
- Standard keyboard;
- Optical Mouse;
- 15.6" Full HD Screen;
- 10/100/1000 NIC;
- 4 x USB 3.0 ports; and
- RS232 interface (USB adaptor).

The minimum hardware specification for the printer shall comply with the following requirements:

- A4 Colour laserjet;
- 600 x 600 dpi;
- 30 ppm print speed;
- Monthly print volume: 2 500 to 10 000 pages; and
- Input tray: 500 pages.

PPS29.6.4 Instrument Reading during Construction

The *Contractor* shall start reading of the different instruments as soon as they are installed, and shall continue reading during the construction period with the frequency indicated below, unless different instructions are given from time to time by the *Engineer*.

Table 1: Required Frequency of Reading for Instruments Installed in CVC/Hardfill

Frequency of Instrument Reading During Indicated Period				
Until Final Set	1 st Week	1 st Month	Months 2 - 6	After Month 6
Hourly	Twice Daily	Daily	Weekly	Monthly

*Note: Instruments in CVC/Hardfill includes strain gauges, thermistors, thermocouples and temperature

meters

Table 2: Required Frequency of Reading for Other Instruments

Instrument	Frequency of Reading During Indicated Period		
	Construction	First Filling	To End of Defects Liability
Piezometers	Monthly	Twice Weekly	Monthly
Leakage Weirs	-	Twice Weekly	Weekly
Surface Temperatures	Twice Daily	Twice Daily	Daily

Survey results and instrument readings shall be submitted to the *Engineer* in approved forms within 24 hours of the observation. Plotted results shall be submitted within 48 hours from the observation.

PPS29.7 MAINTENANCE AND OPERATION AND MAINTENANCE TRAINING

PPS29.7.1 Maintenance

The *Contractor* shall be fully responsible for the maintenance of all instruments installed until expiry of the Defects Liability Period. The operation after Taking Over shall be carried out by the *Employer*.

The Manufacturer's recommendations for all necessary transportation and storage care and protection, preparation, handling care, testing and maintenance shall be followed by the *Contractor* on all instruments and instrument cabling until the end of the Defects Liability Period.

Where physically possible, instruments damaged by the construction activities or malfunctioning for any reason before the expiry of the Defects Liability Period shall be replaced by the *Contractor* at his own cost.

In case the replacement of damaged or malfunctioning instruments is not physically possible, such damaged or malfunctioning instruments shall not be paid or their payment, if already made, shall be deducted from other payments due to the *Contractor*. Alternatively, if considered possible, the *Engineer* reserves the right to instruct the installation by the *Contractor* at his own cost of other monitoring instruments which could provide equivalent information.

PPS29.7.2 Operation and Maintenance Training

The *Contractor* shall provide complete operation and maintenance manuals and a comprehensive training to the *Employer's* personnel on the operation, maintenance and reading of all instruments installed, and on the operation and maintenance of data loggers and of the ADAS system.

Training shall be provided by suitably qualified specialists from the instrumentation manufacturers, whose curricula vitae shall be submitted to the *Engineer* for approval.

The *Employer* will nominate personnel for training in the operation of the instrumentation at the dam. They shall become available on a part time basis for training two months before the designated first impoundment date.

The *Contractor* shall propose a suitable training schedule for the approval of the *Employer*.

PPS29.8 INSTRUMENTATION REFERENCING AND AS-BUILT INFORMATION

It will be the responsibility of the *Contractor* to develop a meaningful and accurate reference system to plan the installation and record the exact location of each instrument and its associated cabling. The referencing system shall identify each instrument installed by:

- Instrument type;



- Elevation;
- Sectional location (e.g. chainage);
- Position (e.g. distance from the dam axis); and
- Placement layer No. and depth of instrument from surface at installation.

Each instrument shall be numbered with the appropriate identifier and all readings logged against this number.

At the time of installation, each instrument and its associated cabling shall be surveyed for its exact position in the structure to the nearest 50 mm. This shall be recorded on suitable as-built drawings and tabulated in an Excel spread sheet for submission to the *Engineer*. Photographic records of the installation (open and closed) and a detailed record of the ambient atmospheric conditions during installation shall be kept with the location reference information.

All instruments shall be interrogated immediately on installation and all instruments installed in fresh CVC/Hardfill shall be interrogated hourly thereafter until final CVC/Hardfill set. Data records for all instruments shall a history of placement of the successive 15 Hardfill layers above, accurate to the nearest hour.

As-built drawings shall be prepared in the latest version of AutoCAD in an approved layout system.

PPS29.9 MEASUREMENT AND PAYMENT

The rates tendered under this Section shall not include for the general obligations and work deemed to be covered by the items provided in Section 1 – General.

PPS29.9.1 Survey Prism Targets, Survey Monuments and Settlement Beacons

Unit : number (No)

a) Survey Prism Targets

The payment of Survey Prism Targets shall be made according to the number of Survey Targets Receptacles and removable Survey Prism Targets combinations completely installed.

The unit price shall include compensation for all costs associated with the installation, inclusive of a weatherproof storage case, maintenance, readings of the survey targets installed and connection to the permanent survey control point network.

Payment shall be made when each complete combination of Receptacle and Survey Prism Target is installed and approved by the *Engineer*.

b) Survey Monuments

The payment of survey monuments shall be made according to have a clear sight of the slopes and connection to the permanent survey control points network by triangulation and levelling and geodetic reading of the installed points according to Sub-Clause 0 herein above.

Payment shall be made when each survey monument and fix point is installed and approved by the *Engineer*.

PPS29.9.2 Geodetic Survey Instruments

Unit : number (No)

The unit price shall include compensation for all costs associated with the procurement, delivery, storage at site up to the handing over to the *Employer*, accessories mentioned in above and all other accessories required such as but not limited to a device for data transfer to a PC, a software for data evaluation on a PC, operation manuals, batteries, spare batteries and battery chargers.

Payment shall be made as follows:



- 50% when the instruments and all accessories are handed over to the Employer; and
- 50% when the training for the instruments is completed.

PPS29.9.3 Electrical Piezometers

Unit : number (No)

The payment of electrical piezometers shall be made based on the number of single piezometers installed.

The unit prices shall include compensation for all costs associated with the procurement, delivery, storage at site and installation including drilling, maintenance and readings of the piezometers installed.

Payment shall be made when each piezometer and its data logger is installed and fully operational.

PPS29.9.4 Direct Temperature Measurement Instruments

Unit : number (No)

The payment of Air Temperature Meters, Water Temperature Meters and Thermocouples shall be made based on the number of instruments installed.

The unit price shall include compensation for all costs associated with the procurement, delivery, storage at site, installation including cable protection and any hindrance to the concrete placement, surface housing boxes in the CVC or Hardfill as per the Drawings, maintenance and readings of the temperature meters installed.

Payment shall be made when each instrument and its data logger is installed and fully operational.

PPS29.9.5 Strain Gauges

Unit : number (No)

The payment of the Strain Gauges shall be made according to the stipulated unit prices based on the number of strain gauges installed.

The unit price shall include compensation for all costs associated with the procurement, delivery, storage at site, installation, including cable protection and any hindrance to the concrete placement, maintenance and readings of the strain gauges installed.

Payment shall be made when each strain gauge and its data logger is installed and fully operational.

PPS29.9.6 Supply and installation of instrument cabling

Unit : m

The payment for instrumentation cabling installed by the *Contractor* shall be per metre length for each type of cable.

The amount tendered shall include all costs of measuring required lengths, procuring suitable cables, junction boxes and all sundry items, excavation of cable trenches and pits, installing cables, backfilling trenches and pits, protecting cables, providing armouring and lighting protection and maintaining cables until the Take-Over Certificate is issued.

Payment shall be made as follows:

- 75% once the *Engineer* has certified the installation and testing; and
- 25% on the issue of the Take-Over Certificate.

PPS29.9.7 Flow Measuring Weirs

Unit : number (No)

The payment of flow meters shall be made according based on the number of complete flow meters installed.

The unit price shall include compensation for all costs associated with the procurement, construction in Hardfill and/or CVC of the appurtenant housings delivery, storage on site, installation, calibration, maintenance and readings of the complete flow meters installation as described in the specifications. The unit price shall include the Stainless steel V-Notch, water level recording instrument to be integrated into



the automated data acquisition system and of a staff gauge for manual water level reading as indicated on the Drawings.

Payment shall be made when each flow meter is installed and fully operational.

PPS29.9.8 Water Level Staff Gauges

Unit : number (No)

The payment of the water level staff gauges shall be made based on the number of 1 m long staff gauges units installed.

The unit price shall include compensation for all costs associated with the procurement, delivery, storage at site, installation, mounting, levelling and maintenance during construction of the combination of staff gauges, mounting posts, number plates, bolts, etc. as described in the specification.

Payment shall be made when each section of staff gauge installation is installed and levelled.

PPS29.9.9 Data Loggers

Unit : Sum

The payment of the data loggers shall be made according to the stipulated lump sum.

The lump sum price shall include compensation for all costs associated with the procurement, delivery, storage at site, installation, maintenance and use of the data loggers not included in other items of the Bill of Quantities.

Payment shall be made when all data loggers are installed and fully operational.

PPS29.9.10 Automated Data Acquisition System

Unit :Sum

The payment of the Automated Data Acquisition System (ADAS) shall be made according to the stipulated lump sum.

The lump sum price shall include compensation for all costs associated with the procurement, delivery, storage at site, installation and commissioning of the ADAS system, including all required cables and appurtenant works.

Payment shall be made as follows:

- 75 % when the ADAS system, and all accessories are installed, fully operational and reliably proved to the satisfaction of the *Engineer*; and
- 25% when the training for the ADAS system, and all accessories is completed.

PPS29.9.11 Instruments Reading During Construction

Unit : Sum

Separate payments will be made for the reading of the installed instruments during the construction period.

PPS29.9.12 Supervision of installation of instrumentation and equipment and testing **Unit : lump sum (Sum)**

The rates tendered against the items in the Bill of Quantities shall include for full compensation of all costs incurred in supervision and testing of the installations including the provision of all labour, equipment, transport, materials and temporary works necessary to perform on-site quality assurance and quality control, inspection and testing of the unit in accordance with the Specifications.

Payment will only be effected after full compliance of the items with the Specification has been certified by the *Engineer*.



PPS29.9.13 Operation and Maintenance Training

Unit : Sum

The payment for operational and maintenance training shall be made according to the stipulated lump sum price.

The lump sum price shall include compensation for all costs associated with the training of the *Employer's* personnel on the operation, maintenance and reading of the instruments installed, of the geodetic survey instruments, of the data loggers and of the ADAS system, etc.

Payment shall be made when all *Employer's* personnel are fully trained and capable of operating and maintain the system on their own.



PORTION 2: THE CONTRACT

PART C4: SITE INFORMATION

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PART C4.1: NTSONYINI DAM: GEOTECHNICAL INVESTIGATION REPORT

The Geotechnical Report will be issued electronically to all tenderer's who attend the compulsory site briefing and provide their details accordingly.



PART C4.2: HYDROLOGICAL DATA AND WEATHER DATA

NTSONYINI DAM FLOOD HYDROLOGY

The catchment

The Ntsonyini Dam catchment is located in the Quaternary Catchment T36A on the Kuzele River, at an elevation of approximately 600 m above sea level. The total area of the Ntsonyini Dam catchment is 27.1 km². The Ntsonyini catchment is a medium sized catchment (15 km² < A < 100 km²) with a fan-shaped catchment (Refer to Figure 1).

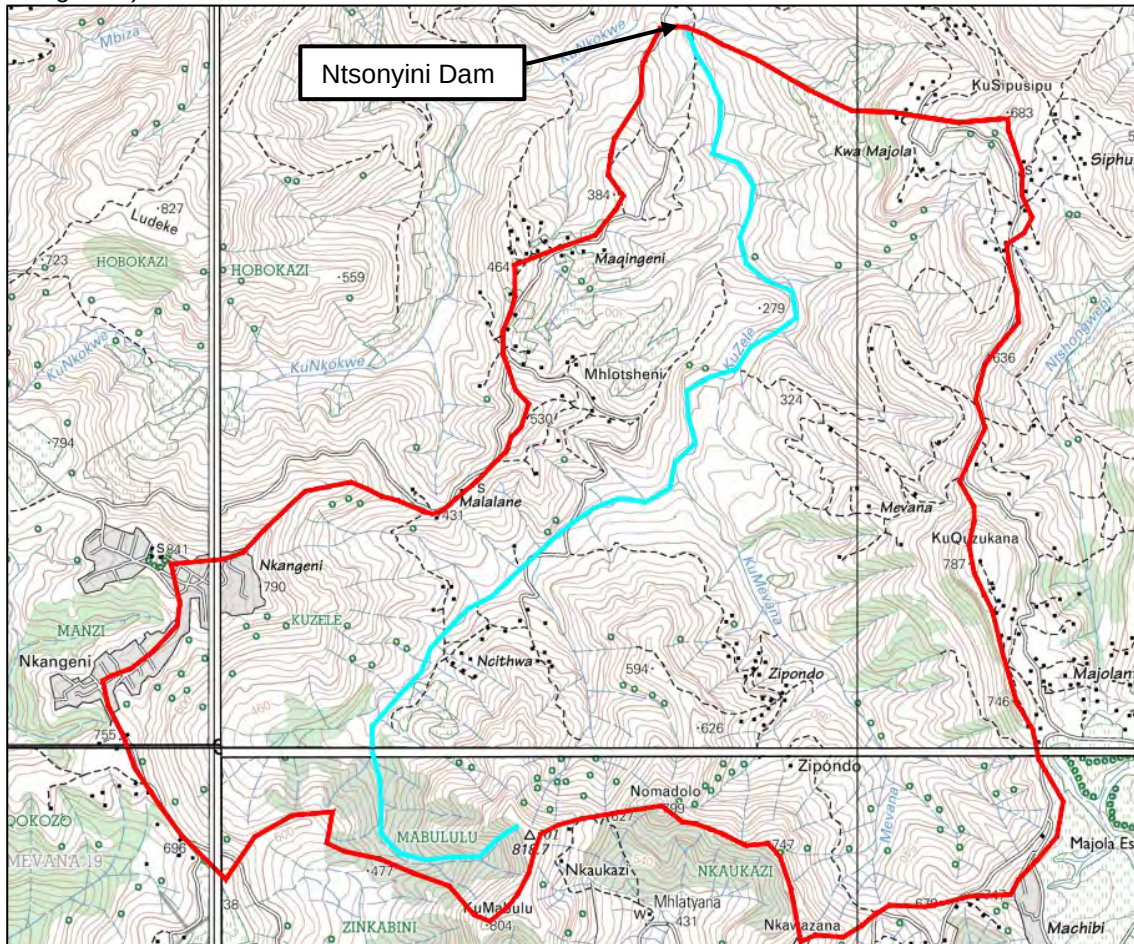


Figure 1: Ntsonyini Dam Catchment



Annual Flood Peaks

The calculated annual flood peaks are shown in Table 1.

Table 1: Ntsonyini Dam Annual Flood Peaks

Probability of exceedance (%)	Flood peaks (m ³ /s)
50 %	75
20 %	130
10 %	175
5 %	230
2 %	320
1 %	410
Recommended Design Flood at 0.5 %	500
Regional Maximum Flood (RMF)	700
Safety Evaluation Flood at RMF _{+Δ}	854

DAM WATER LEVELS

Ntsonyini Dam

The stage capacity curve of Ntsonyini Dam is shown in Figure 2.

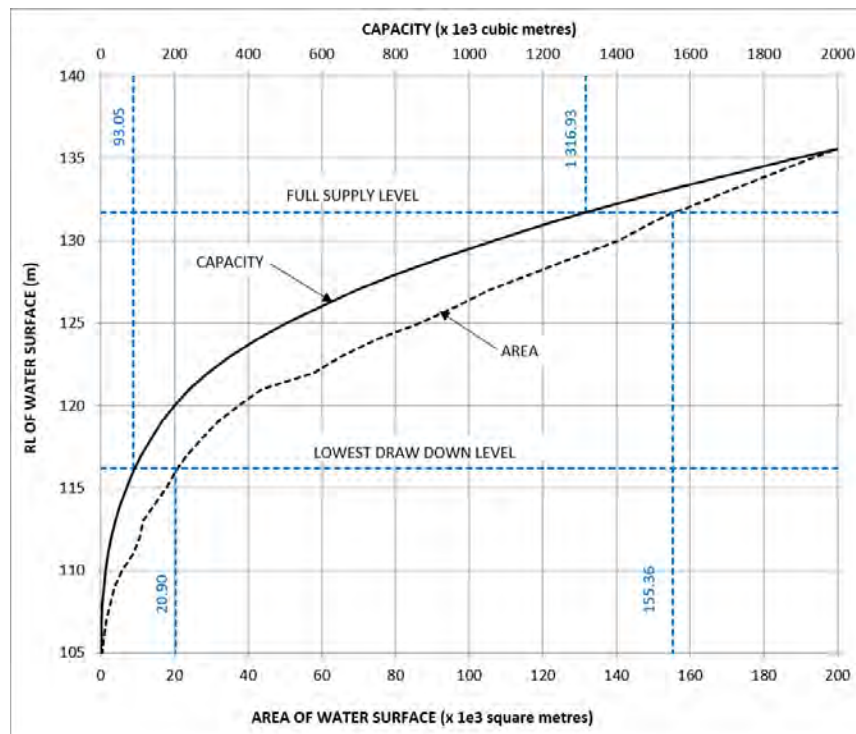


Figure 2 Stage Capacity Curve



Monthly incoming flood data for Ntsonyini Dam is not available. The monthly rainfall distribution data measured at Lusikisiki was used to assess and estimate the monthly risk levels during construction of Ntsonyini Dam based on the 2 year return period flood. This is shown in Table 2.

Table 2: Estimated Monthly River Flows

Month	Estimated Nominal river flow (m³/s)
Jan	5.95
Feb	4.72
Mar	5.30
Apr	4.00
May	1.80
Jun	1.71
Jul	1.47
Aug	2.61
Sep	4.65
Oct	7.25
Nov	7.5
Dec	6.77

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PART C5: DRAWINGS AND DETAILS

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PART C5.1: TENDER DRAWINGS REGISTER



PART C5.1: TENDER DRAWINGS REGISTER

Drawing Number	Description
General	
9919-001	Locality Plan
9919-002	Statistical Data of Dam
9919-003	Locality Layout of Dam
9919-004	Plan Layout of Dam Structure
9919-005	Dam Elevations
Geotechnical	
9919-010	Boreholes and Test Pit Investigations
9919-011	Soil/rock Profile obtained via boreholes
9919-012	Lugeon Test Results
9919-013	Foundation Excavation Plan
9919-014	Foundation Excavation Typical Sections
9919-015	Grouting Elevations and Details
9919-016	Drainage Elevations and Details
9919-017	Drainage Details
9919-018	Geotechnical Typical Details for Slope Protection
River Diversion	
9919-020	Plan Layout
9919-021	Sections and Details
9919-022	Diversion Inlet and Outlet Structure
Hardfill Dam	
9919-030	Typical Sections through Dam 1
7603-031	Typical Sections through Dam 2
9919-032	Typical Sections through Spillway
9919-033	Plinth Details and Sections
9919-034	Spillway Step Anchorage Details
9919-035	Stilling Basin Plan and Sections
9919-036	Detailed Stilling Basin Sections 1
9919-037	Detailed Stilling Basin Sections 2
9919-038	Details and Sections of Stilling Basin
9919-039	Stilling Basin Drainage System Plan and Sections
9919-040	Spillway Step Details
9919-041	Details and Sections of End Sil
9919-042	NOC: Parapet wall Sections and Details
9919-050	Hardfill Dam Joints Typical Sections and Details
Intake and Outlet Works	
9919-060	Intake and outlet works Plan Layout
9919-061	Intake Tower: Typical Section and Detail
9919-062	Intake Tower: Section A-A to G-G
9919-063	Intake Tower: Section H-H to J-J
9919-064	Outlet Works Valve Chamber Plan and Sections
9919-065	Outlet Works and Access Gallery Sections and Details
9919-066	Intake Tower Pipe and Grating Details
9919-067	Typical Louvre Details and Sections



Drawing Number	Description
9919-068	Intake Tower: Standard Ladders and Handrailing: Sections and Details 1
9919-069	Intake Tower: Standard Ladders and Handrailing: Sections and Details 2
9919-070	Intake Tower 1.0 ton Crane Details
Gallery	
9919-080	Gallery Plan View and Elevation
9919-081	Gallery Typical Sections
9919-082	Transition Gallery Sections and Details
9919-083	Gallery Roof Layout of Access and Longitudinal Gallery
9919-085	Gallery Drainage Pipe Details
Joints	
9919-100	Plan Layout and Upstream Elevation
9919-101	Typical US and DS Joint Details
9919-102	Induced Joints: Standard Details
9919-103	Spillway Joint Upstream Waterstop Fixing Detail
Instrumentation	
9919-120	General Layout and Details of Piezometers
9919-121	General Layout and Details of Instrumentation Read-Out box
9919-122	General Layout and Details of strain gauges and thermistors
9919-123	Construction and Deformation Beacons: Locations and Detail
9919-125	Galleries Weir Plan Layout
9919-126	Galleries Weir Plate Details
Miscellaneous	
9919-130	Signage Board
9919-135	Outlet Works: Security Door: Assembly
9919-136	Outlet Works: Security Door: Frame Details
9919-137	Outlet Works: Security Door: Details 1
9919-138	Outlet Works: Security Door: Details 2
9919-139	Outlet Works: Security Door: Details 3

PART C5.2: TENDER DRAWINGS

The Tender Drawings will be issued electronically to all tenderer's who attend the compulsory site briefing and provide their details accordingly.