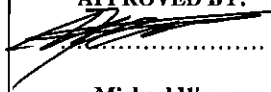
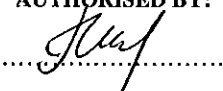


**KUSILE POWER STATION
SPECIFICATION FOR STRUCTURAL CONCRETE**

	ENTERPRISES DIVISION KUSILE POWER STATION PROJECT	DOCUMENT No: 203-770	REVISION No: 04
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COMMENTS:		REFERENCES:	

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1. CIVIL CONSTRUCTION REQUIREMENTS FOR THE CONCRETE WORKS

The civil construction requirements for the concrete works conform to the requirements of the following Codes of Practice, Standards and Regulations, Specifications, including their latest revision and amendments:

SANS 10100-1	<i>Structural use of concrete - Part 1: Design.</i>
SANS 10100-2	<i>The structural use of concrete - Part 2: Materials and execution of work.</i>
SABS 0109	<i>Floor finishes on concrete.</i>
SABS 0155	<i>Accuracy in buildings.</i>
SABS 0400	<i>The application of the National Building Regulations.</i>
SABS 1466	<i>Portland cement with 30 % fly ash</i>
SABS 1491-1	<i>Portland cement extenders - Part 1: Ground granulated blast furnace slag.</i>
SABS 1491-2	<i>Portland cement extenders - Part 2: Fly ash.</i>
SABS 1491-3	<i>Portland cement extenders - Part 3: Condensed silica fume.</i>
SABS 471	<i>Portland cement (ordinary rapid-hardening and sulphate-resisting).</i>
SABS 626	<i>Portland cement with 45 % to 55 % ground granulated blast furnace slag</i>
SABS 831	<i>Portland cement with not more than 15 % ground granulated blast furnace slag</i>
SABS 878	<i>Ready-mixed concrete.</i>
SABS method 1071	<i>Water - Magnesium content.</i>
SABS method 1085	<i>Initial drying shrinkage and wetting expansion of concrete.</i>
SABS method 11	<i>Water - pH value.</i>
SABS method 202	<i>Chloride content of water</i>
SABS method 212	<i>Sulphate content of water.</i>
SABS method 213	<i>Water - Dissolved solids content.</i>
SABS method 216	<i>Water - Calcium content.</i>
SABS method 217	<i>Water - Free and saline ammonia content.</i>
SABS method 218	<i>Albuminoid ammonia content of water.</i>
SABS method 828	<i>Preparation of test samples for aggregates</i>
SABS method 856	<i>Bulking of fine aggregates.</i>
SABS method 861	<i>Sampling of freshly mixed concrete.</i>
SABS method 862	<i>Slump of freshly mixed concrete.</i>
SABS method 863	<i>Compressive strength of concrete (including making and curing of the test cubes).</i>
SABS method 865	<i>The drilling preparation and testing of concrete cores.</i>
SANS 1083	<i>Aggregates from natural sources – Aggregates for concrete</i>
SANS 201	<i>Sieve analysis, fines content and dust content of aggregates.</i>
SANS 197	<i>Preparation of test samples of aggregates</i>
SANS 202	<i>Chloride content of aggregates.</i>
SANS 3310-1	<i>Test sieves – Technical requirements and testing – Part 1: Test sieves of metal wire cloth.</i>
SANS 3310-2	<i>Test sieves – Technical requirements and testing – Part 2: Test sieves of perforated metal plate.</i>
SANS 50197-1/2	<i>Cement</i>
SANS 5832	<i>Organic impurities in fine aggregates (limit test).</i>
SANS 5833	<i>Detection of sugar in fine aggregates.</i>
SANS 5834	<i>Soluble deleterious impurities in fine aggregates (limit test).</i>
SANS 5841	<i>Aggregate crushing value of coarse aggregates.</i>
SANS 5842	<i>FACT value (10 % fines aggregate crushing value) of coarse aggregates.</i>
SANS 5847	<i>Flakiness index of coarse aggregates.</i>
SANS 6243	<i>Deleterious clay content of the fines in aggregate (methylene blue adsorption indicator test).</i>
SANS 6244	<i>Particles of diameter not exceeding 20 µm and not exceeding 5 µm and smaller, respectively, in fine aggregate (pipette method).</i>

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SABS 1200 Standardized Specifications

SABS 1200 F	<i>Piling</i>
SABS 1200 G	<i>Concrete (Structural)</i>
SABS 1200 GE	<i>Precast Concrete (Structural)</i>
SABS 1200 GF	<i>Prestressed Concrete</i>

America Concrete Institute Codes

ACI 207.4R-05	<i>Cooling and insulating systems for mass concrete</i>
ACI 207.1R-05	<i>Guide to mass concrete</i>
ACI 546R-04	<i>Concrete repair guide</i>
ACI 224R-01	<i>Control of cracking in concrete structures</i>
ACI 209R-92	<i>Prediction of creep, shrinkage and temperature effects in concrete structures</i>
ACI 308R-01	<i>Guide to curing concrete</i>
ACI 306R-88	<i>Cold weather concreting</i>
ACI 306.1R-90	<i>Standard specification for cold weather concreting</i>
ACI 305R-99	<i>Hot weather concreting</i>
ACI 305.1R-06	<i>Specification for hot weather concreting</i>
ACI SP-139	<i>Durable concrete in hot climates</i>
ACI SP-241	<i>Concrete heat development monitoring prediction and management</i>
ACI SCM-24(05)	<i>Concrete repair basics</i>

British Institute Codes

BS 8007	<i>Design of concrete structures for retaining aqueous liquids.</i>
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The above must be complied to except where it is otherwise specified in a Particular specification.

The use of any codes not specifically defined in above or are discontinued, is left to the discretion of the *Contractor*. Full details of such codes or replacements are submitted to the *Engineer* for acceptance.

Any ambiguities that arise between the above codes, specifications and variations and additions are for the discretion of the *Engineer* and for his approval.

1.1 VARIATIONS AND ADDITIONS TO CODES AND STANDARD SPECIFICATIONS

1.1.1 General

Whilst the full responsibility rests with the *Contractor*, it is essential that there is full agreement between the *Contractor* and the *Engineer* on all matters in regard to construction methods to be employed by the *Contractor* and before commencement of any work of.

After construction operations have started it is possible that modifications to the construction methods originally agreed upon will be found desirable, and such modifications are made from time to time by agreement in writing between the *Contractor* and the *Engineer*.

The *Contractor* is fully responsible for ensuring that the founding material and level thereof for piles fully meets all the requirements of the accepted design. Under no circumstances is the *Engineer* to be called upon to provide the final assessment of the founding suitability.

The following variations and additions are applicable to this contract. Any other variation and/or addition to these required by the *Contractor* or his designer and accepted by the *Engineer*, form also part of this specification.

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Variations and additions to the following specifications and codes have been implemented:

- SANS 10100-2 Structural use of concrete: Part 2: Materials and execution of work
- SABS 1200G Concrete (Structural)
- SABS 1200GE Precast concrete (Structural)

1.1.2 Notes on the Variations and additions

- (1) Variations and additions are given hereafter and the clauses are numbered to correspond with the standardized codes or specification clause number to which each variation and/or addition applies.
- (2) Reference to the "Factories, Machinery and Building Work Act, 1941 (Act 22 of 1941)" means to be the "Occupational Health and Safety Act, 1993 (Act 6 of 1993)".
- (3) In clause 2.2 of SABS 1200 series - Application

The words "in Portion 2 of the Project Specification" means to read "in the Scope of Work".
- (4) In all other clauses, wherever the term "Project Specification" is used, means to read "Scope of Work".
- (5) Wherever the term "approved" is used, means to read "accepted".
- (6) The cost of all tests specified is included in the tender price.
- (7) The measurement and payment for all work will be made according to the items as specified in the Contract in addition to the 1200 series Standardized specifications.

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SABS 1200 G VARIATIONS AND ADDITIONS TO SABS 1200G CONCRETE (STRUCTURAL)

VA-G 2 INTERPRETATIONS

VA-G 2.3 DEFINITIONS

a) General

Adverse weather

Delete and replace with:

The ambient temperature is above 25°C

Normal weather is defined as weather conditions in which the ambient temperature is higher than 15°C but not higher than 36°C

Add:

Cast in item. Any item which is secured in its final position prior to casting of the concrete. This does not include items which are fixed in position by bolting or grouting after the concrete has been cast.

Add a new clause:

VA-G 2.3 d) ABBREVIATIONS

See SANS 50197-1 for the available cements

VA-G 3.2.1 Applicable Specifications

Add:

PFA is obtained from a source approved by the *Engineer*. Should the *Contractor* wish to change the source of the PFA during the construction period, he advises the *Engineer* accordingly in advance and submits the results of test on the PFA from the proposed new source, including relevant concrete trial mixes and obtain the *Engineer's* approval for same. If approval has been received from the *Engineer*, the *Contractor* informs the *Engineer* of the date when PFA from the new source is to be used.

The loss on ignition is not to exceed 7% and the percentage mass retained on a 45 micron screen is not to exceed 12.5%.

The *Contractor* submits, to the *Engineer*, for PFA used on the works:

- a.) the producer's test certificate for the loss on ignition,
- b.) test results from an approved laboratory, giving the percentage mass retained on a 45 micron screen by wet sieving,
- c.) and test results from an approval laboratory, indicating chloride content and sulphate (SO₃) content of the PFA

every three months.

VA-G 3.2.2 Alternative Types of Cement

Delete and replace with:

Concrete is manufactured using only the cements, or blends of cements, as specified in SANS 50197-1 as constituting the cementitious portion of the concrete mix. Note that low alkali cement, or blended cement, may be mandatory if the aggregates show potential alkali silica reactivity.

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Cementitious binders shall be common cements that comply with SANS 50197-1 or blends of certain common cements and extenders that comply with SANS 1491-1, SANS 1491-2 or SANS 1491-3.

VA-G 3.2.3 Storage of Cement

Add:

All cement is delivered in bulk, or in sealed containers, and is stored near to the mixing plant, in compliance with SABS 973, in silos of a type approved by the *Engineer*.

Cement (as listed in Clauses SABS 1200-G 3.2.1 and 3.2.2 and amendments above) may not be stored longer than 8 weeks after the date of manufacture.

Should storage of cement be longer than 8 weeks through reasons beyond the control of the *Contractor* he may have the material tested by an approved laboratory for compliance with SABS 471 and apply to the *Engineer* for a concession.

The cement store is run on a first in, first out basis. Cement is not to be stored more than 8 weeks from the date of manufacture before it is used.

Add a new clause

VA-G 3.2.4 Testing of Cement

The *Contractor* receives, and keeps a record, for the *Engineer's* inspection, of the Manufacturer's test certificates for each assignment of cement, covering all the requirements of SANS 50197. Assignment is defined as cement delivered per week.

All testing of the cement shall be according to SANS 50197.

VA-G 3.3 Water

VA-G 3.3.1 Add:

Water for concrete is obtained only from the potable water supply, and conforms to the requirements of SABS 0100-2 and SANS 51008. Any failure of the water to comply is immediately reported to the *Engineer*. If non compliant water is used without informing the *Engineer* of the non compliance of the water and the concrete is rejected, the Contractor shall remove and replace the concrete at own cost.

VA-G 3.4 AGGREGATES

VA-G 3.4.1 Applicable Specification

Add:

The *Contractor* demonstrates, by means of a report from an approved laboratory, that the aggregates do not exhibit excessive shrinking properties in accordance with SABS 1083. He also demonstrates that the aggregates do not have a potential alkali silica reaction. In this regard, a petrographic examination of the aggregate, and a report from a specialist geologist or petrologist, shall accompany the laboratory report. The examination and report is in accordance with the latest recommendations of the National Building Research Institute.

The maximum size of coarse aggregate for structural concrete, unless stated on the relevant drawing, is not to exceed the lesser of:

- One fifth of the thickness of the concrete element;
- 5 mm less than the clear distance between reinforcing bars;
- 40 mm

Coarse aggregate for use in mass concrete may be larger than 40 mm, if shown on the drawing or approved by the *Engineer*.

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Pea gravel shall have 100 % of particles passing a test sieve of nominal aperture 9,5 mm, between 95% and 100 % passing 4,74 mm and between 0 % and 5 % passing 2,35 mm.

The drying shrinkage of concrete shall not exceed 0,040 %, when tested in accordance with the requirements of SANS 6085

All aggregates used is of equivalent standard to the original samples and further samples is supplied as required. Once an aggregate has been approved by the *Engineer* for use in the *works* the *Contractor* is not to, except with consent of the *Engineer*, change the source of supply of aggregates for the *works*.

VA-G 3.4.2 Use of Plums

Delete and replace with:

Plums are not to be used.

Add the following new clauses:

VA-G 3.4.4 Fineness Modulus

The fineness modulus of the fine aggregate is not to vary by more than 0.2 from the fineness modulus of the sand used in the trail mix. Where the variation in fineness modulus exceeds this limit, the mix is adjusted to suit.

If the fineness modulus of the fine aggregate varies by more than 0.5 from the sand used in the trail mix, the *Engineer* may call for a new trail mix to be made for re-approval.

The fineness modulus of the fine aggregate is determined each day on which concreting takes place.

VA-G 3.4.5 Chemical Properties

When tested in accordance with SANS 202 and 212, as appropriate, the total acid-soluble chloride content and acid-soluble sulphate of the aggregates shall not exceed the following limits:

a) Chloride Content (expressed as percentage of chloride-ion by weight of aggregate)

- Fine Aggregate 0.03% by weight of fine aggregate.
- Coarse Aggregate 0.3% weight of coarse aggregate.

Provided always that, for the combined fine and coarse aggregates, the total acid-soluble chloride, expressed as percentage of chloride-ion by weight of fine and coarse aggregate combined, shall not exceed 0.03, and that for the hardened concrete, the total acid-soluble chloride, expressed as the percentage of chloride-ion by weight of cement, shall not exceed 0.15

b) Sulphate content (expressed as percentage of sulphuric anhydride (SO₃) by weight of aggregate).

- Course and fine aggregate 0.4% weight of aggregate.

Provided always that, for the hardened concrete, the total acid-soluble sulphates, except that present in the cement, expressed as the percentage of SO₃ by weight of cement shall not exceed 2.5

c) Alkali Reactivity

When tested in accordance with SABS 1245 all aggregates for use in the *works* shall have negligible alkali reactivity.

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VA-G 3.4.6 Routine Testing of Aggregates

a) Testing for Contamination

Results obtained from tests for chloride and sulphate content and alkali reactivity, is submitted to the *Engineer* prior to any concreting taking place. Thereafter, aggregates shall be sampled weekly and tested for chloride and sulphate content. Aggregates which are found to have a chloride or sulphate content in excess of the limits given in Clause VA-G 3.4.5, shall not be used as aggregates for concrete.

	PROPERTY	TEST METHOD	FINES (Limits)		COARSE (Limits)	TEST
			Natural	Mechanical	Mechanical	Frequencies
1	Grading, mass percentage that passes sieves ¹⁾ that have square apertures of nominal size 4 750 µm 150 µm	SANS 201	90 – 100 5 – 25		See SANS 1083 Table 2	Daily
2	Dust content, material that passing a 75 µm sieve ¹⁾ , mass percentage, max.	SANS 201	5 ²⁾	10 ²⁾	2	Daily
3	Methylene blue adsorption value ³⁾ , max.	SANS 6243	0.7		-	Daily
4	Clay content ⁴⁾ , material of particle size smaller than 5 µm, mass percentage, max.	SANS 6244	2.0		-	Daily
5	Fineness modulus	SANS 201	1.2 – 3.5		-	Daily
6	Chloride content ⁶⁾ , expressed as Cl, mass percentage, max.	SANS 202	concrete for prestressing : 0.01 normal reinforced concrete : 0.03 non-reinforced concrete : 0.03		0.1 0.3 0.3	3 months or when change of source or plant
7	Sulphate content, expressed as SO ₃ , mass percentage, max.	SANS 212	concrete for prestressing : 0.2 normal reinforced concrete : 0.4 non-reinforced concrete : 0.4		0.2 0.4 0.4	3 months or when change of source or plant
8	Organic impurities	SANS 5832	The colour of the liquid above the fine aggregate shall not be darker than the colour of the reference solution, except that this requirement shall not be applicable if the fine aggregate complies with the requirement for soluble deleterious impurities.		-	Daily
9	Presence of sugar	SANS 5833	Free from sugar unless the fine aggregate complies with the requirement for soluble deleterious impurities.		-	Initial test only or when change of source or plant
10	Soluble deleterious impurities	SANS 5834	The strength of specimens made with the fine aggregate shall be at least 85 % of that of the specimens made with the same fine aggregate after it has been washed, except that this requirement shall not be applicable if the fine aggregate complies with the requirements both for organic impurities and for the presence of sugar.		-	3 months or when change of source or plant
11	Aggregate crushing value (ACV) ⁵⁾ , of less than 13.2 mm and more than 9.5 mm fraction (dry), mass percentage, max.	SANS 5841	-	-	29	3 months or when change of source or plant
12	10 % FACT value, of less than 13.2 mm and more than 9.5 mm fraction (dry), kN, min.	SANS 5842	-	-	Coarse aggregate for use in concrete subject to surface abrasion, structural elements of	3 months or when change of source or plant

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	PROPERTY	TEST METHOD	FINES (Limits)		COARSE (Limits)	TEST
			Natural	Mechanical	Mechanical	Frequencies
					reinforced or prestressed concrete (or both): 110 Coarse aggregate for use in concrete not subject to surface abrasion: 70	
13	Flakiness index, max.	SANS 5847	-	-	35	Daily
14	Alkali reactivity	ASTM C295 ASTM C289	See ASTM C295/C289		See ASTM C295/C289	3 months or when change of source or plant
15	Magnesium ion content	SABS 1071	MgSO ₄ < 15% Na ₂ SO ₄ < 10%		MgSO ₄ < 15% Na ₂ SO ₄ < 10%	3 months or when change of source or plant

NOTES:

- 1) Complying with SANS 3310-1 or SANS 3310-2.
- 2) These limits may be exceeded under certain circumstances (see 4.2.3).
- 3) Applicable only if dust content exceeds limit given in the table (see 4.2.3).
- 4) Applicable only if dust content and methylene blue adsorption values exceed the relevant limits given in the table (see 4.2.3). For the purpose of this requirement, the clay content is defined as -5 µm material which might not all be clay minerals. The clay content of this -5 µm fraction is likely to be appreciable if the methylene blue adsorption value exceeds the relevant limit given in the table.
- 5) Caution must be exercised on sites where fine aggregate is prepared (or delivered) for the making of prestressed and other concrete for which the chloride content is specifically restricted (see the table). Stockpiles of such fine aggregate should be kept well apart from other fine aggregate and should properly marked. Suppliers of fine aggregate derived from the crushing or milling of rock are cautioned that, whereas the parent rock could be relatively free from chlorides, washing of such aggregate with water that contains an excessive amount of chlorides could cause the chloride content of the resulting fine aggregate to exceed the specified limits.
- 6) Optional alternative to the 10 % FACT value.

VA-G 3.5 ADMIXTURES

VA-G 3.5.1 Approval of admixtures required

Add:

No admixtures containing chlorides are to be used.

Add new clause:

VA-G 3.5.3 Tests

The *Contractor* stipulates the technical reasons for the use of admixtures in the mix. Adequate trial mixes and test samples to the satisfaction of the *Engineer* is prepared to demonstrate that the presence of the admixture has no detrimental effect on any of the characteristics of the fresh or hardened concrete.

VA-G 3.6 REINFORCEMENT

Add:

All reinforcement and cast in items is tagged and stored in such a way that it can easily be identified by bar-mark code.

The *Contractor* registers the delivery to site, movements, locations on site and usage of all reinforcement and cast in items in order to ensure that no interruption to the progress of the works is occasioned by the lack, or misplacement, of any reinforcement or cast in items.

Dowel bars are Type A mild steel, of plain, round cross-section, and is chamfered 3mm at both ends.

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VA-G 3.8 DETERIORATED MATERIAL

Add:

Such material is removed and replaced at the *Contractor's* expense.

Add new clauses:

VA-G 3.10 HOLDING DOWN BOLTS

Holding down bolts are of the type, and length, detailed on the Drawings. If HD bolts are galvanized they must comply to SABS 763 over the full exposed length and to at least 75 mm below the concrete surface. Galvanized nuts and washers must also comply to SABS 763.

VA-G 3.11 GROUT

Grout is approved non-shrink non-metallic proprietary grout with a 28 day compressive strength of at least 50 MPa.

VA-G 4 PLANT

VA-G 4.2 BATCHING PLANT

Add

Mix references must at all times be clearly displayed at the batching plant and the mechanical scales marked with the correct weights. If digital scales are used no marking is needed.

Any change in mix proportions caused by changes in aggregate grading, or in the required proportions, is to be accompanied by a change in the mix reference.

The batching plant area is to be provided with adequate lighting to allow safe working conditions during night shift operations.

VA-G 4.5 FORMWORK

VA-G 4.5.1 Design

Add new clause:

VA-G 4.5.1.1 Design of sliding formwork

a) Sliding formwork shall be designed so that:

- 1) the formwork panels are inclined to give a small taper, the forms being slightly wider at the bottom than at the top,
- 2) the taper produces the specified concrete thickness at the mid-lift level of the form, and
- 3) the spacing of the jacks with their jack rods shall be such that the dead load of the sliding-formwork assembly, the frictional load, and the mass of materials, personnel and equipment shall be evenly distributed and within the design capacity of the jacks used.

b) Drawings of the complete sliding-formwork assembly shall be submitted for review before the fabrication of sliding formwork or bringing the sliding formwork and any additional equipment to the site. The drawings shall show full details of the forms, jacking frames, access ladders, hanging platforms, safety rails and curing skirts as well as details of the jacks and jack layouts. An instruction manual in which the sliding techniques, jacking procedure, methods of keeping the formwork level, the procedure to be adopted to prevent bonding of the concrete to the forms and a method for releasing the forms in the event of bonding, the instrumentation and monitoring of the

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slide casting and correcting for verticality, twisting and levelness are described in detail, shall be submitted together with the drawings.

- c) Hoisting equipment for sliding formwork shall operate stepwise with upward movements of 25 mm. The use of linked hydraulic jacks or pneumatic jacks is preferred, since these are driven by an electrically operated pump, and can hoist at a steady rate. The jacks shall have independent controls for regulating verticality and levelness. The jacking system shall ensure that the sliding-formwork assembly can be hoisted evenly.
- d) All equipment shall be thoroughly tested and inspected before installation and shall be maintained in a good working order throughout the entire sliding operation. Sufficient back-up plant, equipment and quantities of materials shall be kept on site to ensure that the slide casting can proceed without interruption.
- e) Suitable instrumentation shall be installed on the sliding platform and foundations and against the sides of the structure for monitoring the height, verticality, levelness and twisting at regular distances.
- f) The verticality of the structure shall be controlled with laser alignment apparatus or optical plummets, and the levelness of the sliding forms shall be controlled with a water-level system with reference control points placed at strategic locations.
- g) Height and verticality shall be monitored at intervals that do not exceed 4 h or 500mm. The readings shall be plotted immediately on graphs. When the structure is more than 10 mm from the vertical datum, action shall be taken to correct the deviation.
- h) Records of all readings and measurements taken shall be filed systematically and made available at all times to the persons overseeing or in control of the sliding operation.
- i) During the entire period of the sliding operation, a person who is fully acquainted with the sliding technique and the methods of construction, shall be in attendance on the sliding platform and in control of the sliding operations.

VA-G 4.5.3 Ties

Add the following:

The water tightness requirement of the structure, when applicable, is taken into account when deciding upon the type of tie to be used. The cover requirement applies to ties left permanently in place.

VA-G 5 CONSTRUCTION

VA-G 5.1 REINFORCEMENT

VA-G 5.1.1 Bending

Add new clause:

VA-G 5.1.1.5 Reinforcement is cut with cropping or shearing equipment only. If cutting torches are to be used approval must be given by the *Engineer* on each specific item or element where this will be used.

VA-G 5.1.2 Fixing

Add:

All welding must be approved by the *Engineer* including the type of welding.

VA-G 5.1.3 Cover

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Delete and replace with:

The cover of concrete over the reinforcement shall be as shown on the working drawings and shall be maintained by the use of mortar blocks or plastic spacers.

The minimum thickness of concrete cover over reinforcement, measured from the outside of the reinforcement, shall not be less than:

Environment or Type of structure	Cover (mm)	
	Inside	Outside
1 Internal dry environment	-	40
2 Internal wet environment	-	40
3 External environment away from wind borne aggressive agents	-	40
4 External environment exposed to wind borne aggressive agents	-	50
5 External environment in or adjacent to the material handling plant	-	50
6 Below ground, above the capillary rise zone and water table	-	60
7 Below ground, in the capillary rise zone or below the water table	-	70
8 Below ground in or adjacent to the material handling plant	-	80
9 Surfaces exposed to aggressive discharges	-	80
10 Chimney windshields	40	40
11 Bulk storage bunkers containing Coal and Ash.	60	60
12 Piles	-	60
13 Blow down sumps	80	50
14 Water containing tanks above ground level	50	40
15 Water containing tanks/sumps below ground level	50	50
16 Slipform structures	40	40
17 Demin water structures, i.e. tanks, channels, etc.	60	50
18 Chemical containment and dosing areas	60	50

VA-G 5.1.4 Splicing

Add:

Screw type or swage type connectors, or additional splice lengths from those indicated on the Drawings, is subject to the approval of the *Engineer*.

VA-G 5.2 FORMWORK

VA-G5.2.1 Classification of finishes

b) Smooth

Delete and replace with:

This finish is obtained by the use of steel faced forms or high quality timber faced propriety formwork such as Peri or Doka Systems arranged in a regular pattern to fit the appearance of the structure. After stripping, all small fins, bulges and other projections is removed, surface honeycombing with the approval of the *Engineer*, surface discolorations and other irregularities repaired and all surface irregularities rubbed to form a smooth finish of uniform texture and colour. The finish is to the degree of accuracy defined in Clause VA-G 6.

c) Special

Delete and replace with:

This finish is obtained by the use of steel faced forms or high quality timber faced propriety formwork such as Peri or Doka Systems arranged in a regular pattern to fit the appearance of the structure. After stripping, all small fins, bulges and other projections is removed, surface honeycombing with the approval of the *Engineer*, surface discolorations and other irregularities

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repaired and all surface irregularities surface rubbed to form a smooth finish of uniform texture and colour. The finish is to the Degree of Accuracy I.

VA-G 5.2.5 Removal of Formwork

VA-G 5.2.5.2 Add the following to table 2:

50/50 OPC/MGBS concrete is as listed for PC 15.

Add a new clause:

VA-G 5.2.6 Chamfers

Unless otherwise noted on the Drawings, all exposed corners and arrisses is chamfered 25 x 25mm.

VA-G 5.2.7 The use of sliding formwork

VA-G 5.2.7.1 General

- a) The jacking frame shall be constructed with sufficient clearance between the underside of the cross members and the top of the formwork to allow the horizontal reinforcement and embedded items to be correctly installed. A control procedure shall be put in place to ensure that all the reinforcement is placed. There shall be horizontal reinforcement above the level of the top of the formwork panel at all times.
- b) Guides shall be provided to ensure that the vertical reinforcement can be correctly placed and the specified concrete cover over the reinforcement can be maintained.
- c) Where the jack rods are to be recovered, suitable precautions shall be taken in respect of their removal, so that the concrete is not damaged.
- d) Where jack rods occur at openings or wall chases, suitable lateral support shall be provided to prevent their buckling.
- e) Equipment and material shall be so distributed on the working platforms that the load will be evenly distributed over the jacks.
- f) Guard plates or other means shall be provided at the tops of the forms to the outside walls to prevent the concrete from falling down the outside.
- g) The framework, forms and platforms shall be regularly cleared and the accumulation thereon of redundant concrete shall be prevented.
- h) All precautions shall be taken to prevent contamination of the concrete by leaking oil or other causes.

VA-G 5.2.7.2 The sliding process

- a) Sliding shall not commence before the sliding-formwork assembly is fully operative and the sufficient stock of all materials required for the slide casting, as well as back-up plant and equipment, are on site.
- b) The rate of sliding shall be such that the concrete at the bottom of the formwork has obtained sufficient strength to support itself and all loads which might be placed on the concrete at the time, and does not adhere to the sides of the forms.
- c) The slide-casting operation shall be continuous, without any interruptions, until the full height of the structure has been reached. In the case of high slides or for any other justifiable reasons, controlled stops will be permitted but with the approval of the *Engineer*.

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VA-G 5.2.7.3 Interruptions

When the sliding operations are delayed for more than 45 min or the time as per approved concrete mix design, the adhesion of the setting concrete to the formwork panels shall be prevented by easing the forms or moving them slightly every 10 min, or alternatively, where reversible jacks are used, by lowering the forms by 10 mm to 25 mm. Wherever interruptions occur, emergency construction joints shall be formed and treated in accordance with G 5.5.7. Before concreting is restarted, the form shall be adjusted to fit snugly onto the hardened concrete so as to prevent steps from being formed on the exposed concrete surface. When slide casting is recommenced, care shall be taken to prevent the fresh concrete from being lifted off from the old concrete.

VA-G 5.2.7.4 Surface treatment

Where the concrete surfaces formed by sliding formwork require treatment to achieve the surface finish specified for the member, the concrete shall, as soon as the surfaces under the formwork are exposed, be floated with rubber-lined floats or similar to the desired finish.

VA-G 5.3 HOLES, CHASES AND FIXING BLOCKS

Add:

Holes or chases are thoroughly cleaned, prepared and soaked with clean water prior to placing concrete or grout.

VA-G 5.5 CONCRETE

VA-G 5.5.1 Quality

VA-G 5.5.1.1 General

Delete and replace with:

Only strength concrete is used. The aggregates and the cement are not altered without approval.

VA-G 5.5.1.2 Consistency

Add:

The slump, as measured in accordance with SABS Method 862, is used as the means of controlling the consistency of every batch of concrete. The average slump for each mix is determined and fixed at the time the trial concrete mixes are made and approved. Batches of concrete of any particular mix are to have a slump within ± 25 mm of the slump determined from the trial mix. The consistency is such that the concrete can be compacted effectively with a minimum of bleeding and segregation.

VA-G 5.5.1.4 Chloride Content

Add:

In determining the amount of chloride-ion in concrete expressed as a percentage by mass of cement, the aggregate chloride content is measured as described in Clause VA-G 3.4.5

VA-G 5.5.1.5 Durability

Add:

The exposure conditions on site for all concrete work are considered as severe unless as specified otherwise. All concrete shall have a maximum water/cement ratio of 0.45 with a minimum cement content of 420 kg/m^3 or as specified otherwise.

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The concrete mixes shall be designed to comply with the requirements of both crushing strength and durability.

VA-G 5.5.1.7 Strength Concrete

Add:

The minimum concrete strength is 35 MPa for reinforced concrete and 15 MPa for unreinforced concrete.

The *Contractor* is required to design trial mixes in accordance with SABS 0100 - Part 2. The target strength of the trial mix is determined using K equal to 1.7 and a standard deviation of 5 MPa for a "good" degree of site control.

Target strength = Specified strength + (K x standard deviation).

The *Contractor* submits the trial mixes, together with 7 and 28 day test results to the *Engineer* for acceptance. The average 28 day test results equals, or exceeds, the target strength. No concreting may proceed until the trial mixes have been accepted.

VA-G 5.5.2 Batching

VA-G 5.5.2.3 Aggregates

Add:

Volume batching is permitted for concrete pours of up to 0.5 m³. All greater quantities are weigh-batched.

The mass of aggregates of each size required for each batch is determined and a correction made in each case for the moisture content of the aggregates.

VA-G 5.5.3 Mixing

VA-G 5.5.3.1 Mixing at construction site

b) Add:

Where a cement blend is used, CEM 1 is batched into the mixer before the addition of the other cementitious constituents.

g) Delete and replace with:

Concrete may only be retained in the mixer for a period of time such that the concrete is placed within two hours of the start of mixing. In such event, the mixer is not to turn continuously but is to run for only 2 minutes every 15 minutes.

The *Engineer* may order that the period of two hours be reduced if, in his opinion, the ambient temperature, or any other factor, will tend to produce early setting.

Concrete thus retained comply with all other requirements of the specification and failure to comply may result in the rejection of such concrete.

VA-G 5.5.3.3 No-fines concrete

No-fines concrete is composed of aggregate, cement and water. The aggregate consists of 4 parts 37 mm stone and 1 part 19 mm stone. The cement and aggregate is mixed with just enough water to form a smooth grout that will be fluid enough to flow together to form a fillet at each point of contact of aggregate particles. Not more than 21 liter of water per 50 kg cement is to be used. The proportion of aggregate to cement is: aggregate – 10 parts and cement – 1 part, all measured by mass.

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No-fines concrete is placed within 30 minutes after mixing. It is so worked that it fills the space to be concreted and that the adjacent aggregate particles are in contact with each other. No-fines concrete is not to be vibrated

VA-G 5.5.5 Placing

VA-G 5.5.5.1

Delete and replace with:

The *Contractor* gives the *Engineer* adequate notice of his intention to place concrete (in accordance with his approved test and inspection plan of the Quality Assurance Program.)

Concrete is placed within two hours of the start of mixing, and "within one hour of its discharge from the mixer. Concrete is not to be re-tempered in any way whatsoever. The forms to be filled are to be clean internally. All excavations, and other surfaces of an absorbent nature that are to come into contact with the concrete, is thoroughly dampened with water immediately prior to placing. There is to be no free water standing on the surfaces against which concrete is to be placed.

No "cold joints", resulting from any discontinuity of any pour, is permitted.

VA-G 5.5.6 Compaction

VA-G 5.5.6.3 Add:

Compaction of concrete by spading, rodding or forking is not permitted.

VA-G 5.5.6.4 Add:

The *Contractor* provides and has available at all times, sufficient backup compaction equipment to ensure that concreting operations are not delayed or interrupted in the event of a breakdown.

VA-G 5.5.7 Construction Joints

VA-G 5.5.7.1 Add:

The *Contractor* continues concreting through meal breaks, or after normal working hours, in order to complete work up to a construction joint. No extra payment is made to the *Contractor* for overtime working. Construction joints are to be not less than 5 meter centers in both directions,

VA-G 5.5.7.2 Add:

Unforeseen joints are joints which deviate from the design drawings as the need requires. The actual position and method of achieving any unforeseen joints is determined by the *Contractor* at least two weeks prior to the execution of said joint and the finishing-off of concrete to form unforeseen joints is to the approval of the *Engineer*. In the event that the position of such an unforeseen joint, in the opinion of the *Engineer*, jeopardizes the design of the *works*, he has the right to instruct the *Contractor* to break down and remove the concrete to a point to be determined by him. All costs relating to such a break down and removal of the defective work as well as those related to the reinstatement, are borne by the *Contractor*.

If an unplanned joint because of an emergency (such as a breakdown of the mixing plant or the occurrence of unsuitable weather), concreting has to be interrupted, concrete shall be finished off at the place of stoppage in the manner that will least impair the durability, appearance and proper functioning of the concrete and to the approval of the *Engineer*.

Add new clauses:

VA-G 5.5.7.4 Joint Filler

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Joint are formed in the manner and to the dimensions shown on the Drawings. Joints are prepared, primed and sealed, strictly in accordance with the sealant manufacturer's requirements.

Joint fillers are:

1. Bitumen impregnated compressible fibre board joint filler complying with AASHTO Specification M213 or US Federal Specification HH-G-341a (Type A, Class B)

or

2. Closed cell expanded polyethylene compressible joint filler complying with AASHTO Specification M153 and provided with a prepared pull-out strip designed to leave a recess of uniform depth equal to half the specified joint width (with a minimum depth of 12 mm) to receive the joint sealant.

Fibre board joint filler is reamed out to leave a recess of uniform depth, equal to half the specified joint width (with a minimum depth of 12 mm), to receive the joint sealant. A bond breaker of polyethylene tape is inserted between the joint filler and the sealant.

3. Soft board is not acceptable as joint filler material.

VA-G 5.5.7.5 Joint Sealant

Polysulphide joint sealants are to be either intumescent sealant or modified sealant to resist chemicals in coal dust, as indicated on the Drawings:

Polyurethane sealants are to be:

- a.) For Horizontal Joints either

1. Cold poured pitch extended polyurethane base joint sealant complying with SABS 1077

or

2. Gun grade polyurethane base joint sealant complying with SABS 1077.

- b.) For Vertical Joints either

Gun grade polyurethane base joint sealing complying with SABS 1077.

- c.) General

All joints sealants are formulated to be capable of accommodating cyclic movement of up to a minimum of 25% of the joint width, indicated on the Drawings.

All joint sealants (with the exception of cold poured pitch extended polyurethane based sealant), are coloured to match adjacent brickwork, concrete or colour scheme.

Joint sealants are applied not less than 28 days after the concrete has been cast in which the joints are formed.

Joints are prepared, primed, and sealed strictly in accordance with the sealant manufacturer's requirements.

The joints to be sealed are formed by the *Contractor* to the sizes shown on the Drawings.

The restoration of incorrectly constructed and/or damaged joints to the specified sizes is carried out by using epoxy mortar with minimum compressive strength of 50 MPa, designed for the repair of spalled and damaged concrete which is applied strictly accordance with the manufacturer's requirements.

VA-G 5.5.8 Curing and Protection

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Add:

A method statement for curing and protection for all structures must be submitted for approval by the *Engineer*.

Curing and protection shall also comply with ACI 308R-01, ACI 224R-01 and SABS 0100: Part 2 – Annexure B.

Whatever method of curing is used, precautions are to be taken to prevent cycles of wetting and drying.

The curing and protection of concrete is vital and the *Contractor* complies strictly with these requirements. Only blinding of thickness maximum 75 mm or less need not be cured.

VA-G 5.5.9 Adverse Weather Conditions

VA-G 5.5.9.1 Add:

Cold weather concreting shall comply with ACI 306R-88 and ACI 306.1R-90. A method statement for all relevant structures must be submitted for approval by the *Engineer*.

VA-G 5.5.9.2 Add:

Hot weather concreting shall comply with ACI 305R-99 and ACI 305.1R-06. A method statement for all relevant structures must be submitted for approval by the *Engineer*.

VA-G 5.5.10 Concrete Surfaces

VA-G 5.5.10.1 Add:

Exposed surfaces of concrete not finished against forms, is defined on the relevant Drawings.

VA-G 5.5.10.2 Delete and replace with:

The general concrete surfaces finishes required are indicated on the drawings and are classified as follows:

- a.) **Rough**
This comprises of a lightly ridged surface struck off and tamped with a tamping board. Degree of Accuracy III is required. This finish is to provide a good key for subsequent
- b.) **Wood float**
The surface is wood floated to a uniform surface free of trowel marks and finished to a Degree of Accuracy II
- c.) **Steel Float**
The surface is accurately struck off and floated and finished with a steel float to a smooth and uniform surface, free of trowel marks, to a Degree of Accuracy I.
- d.) **Power Float**
Here a high quality, dense, smooth and uniform surface, free of trowel marks is required. The Degree of Accuracy is I or II, as scheduled. Rubbing with a carborundum stone is permitted in certain circumstances but no plastering to correct imperfection will be permitted.

VA-G 5.5.11 Watertight Concrete

Add:

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a) Durability of the concrete

The durability of the concrete shall comply with SABS 0100: Part 2 - Annexure A and B and BS 8007.

b) Design of concrete: specification and materials

The concrete to be used shall be in accordance with BS 8007. A maximum water/ cement ratio of 0.45 shall be used with a minimum cement content of 420 kg/m³.

c) Crack widths

The maximum design crack width is 0.2 mm.

d) Joints

All joints shall be in accordance with BS 8007.

e) Protection of the concrete

The need for surface linings for protection to the concrete shall be according to SABS 0100-2 Annexure A.

f) Inspection and testing of structure

The complete structure shall be watertight, and the quality and finish of the work shall be such that no after-treatment of the work such as plastering or cement wash is necessary to ensure compliance with this requirement.

The *works* will not be certified complete by the *Engineer* until the structure has been proved by testing to be watertight, emptied and dried out.

Upon completion of construction of the water retaining structures and when so agreed by the *Engineer*, the structure shall be filled by the gradual admission of water until the water level reaches the designed maximum level. The water level shall then be carefully noted and recorded by the *Engineer* in relation to a fixed benchmark, and the structure shall be allowed to remain filled for a period of 3 weeks or such longer time as may be required to permit complete saturation of the concrete.

At the end of this stabilization period the level of the water surface should be recorded at 24 hour intervals for a test period of 7 days. During this 7-day test period the total permissible drop in level, after allowing for evaporation and rainfall, should not exceed the lesser of 1/500th of the average water depth of the full tank or 6 mm. The structure shall be considered to be watertight if the drop in water level does not exceed the above and if no leakage is apparent.

For an open structure, evaporation as determined by a Class A Evaporation pan situated in the Power Station terrace area, will be used.

On completion of the test for watertightness, the *Contractor* shall within 72 hours from the *Engineer's* acceptance that the structure is watertight, commence emptying the water in the structure and discharge it to a storm water drain in the proximity at a rate not exceeding 100m³/hour or at such other greater rate approved by the *Engineer*. The concrete structure shall then be dried out in preparation for the application of the surface protection.

The inspection and testing for water tightness of roofs shall be according to BS 8007.

VA-G 5.5.13 Grouting

Delete and replace with:

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VA-G 5.5.13.1 General

The *Contractor* is required to grout under structural steel base plates and machine bed plates erected.

Minimum grout specification will be as follows:

Non shrink, non metallic cementitious free flow grout with a minimum compressive strength at 28 days of 50 MPa.

VA-G 5.5.13.2 Preparation

The concrete surface is scrubbed (but is not to be so rough as to interfere with proper placing of the grout) and thoroughly cleaned so that all unsatisfactory material such as dust, oil, grease and laitance is removed.

All holding down bolt sleeves is thoroughly cleaned of any materials that may prevent the grout from flowing freely to the bottom of the bolt sockets.

The units are properly aligned and leveled and are maintained in that position during grouting.

Shimming is kept to a minimum. Steel plates are used for packing.

Grouting is not to be carried out until the alignment, of all units to be grouted, has been checked and approved by the *Engineer*.

The concrete base is kept wet for at least 12 hours prior to grouting. Standing water is removed by approved means before the commencement of grouting.

VA-G 5.5.13.3 Mixing

The grout is mixed to a "plastic" consistency to the grout supplier's specifications. Grout is discarded if not placed within 20 minutes of mixing. No partially set grout may be retempered.

VA-G 5.5.13.4 Placing

Waterproof shutters are securely fixed to three sides of the base plate and the grout forced in and tightly caulked using a wooden tamping tool. The cavity is slightly over-filled and a closing shutter introduced.

In case of obstructive leveling packs, two adjacent sides are shuttered and grout placed behind the packs before the third shutter is fixed and the grouting is completed.

VA-G 5.5.13.5 Stripping and curing

Once the grout has reached an initial set, the shutters are stripped and the exposed grout trimmed and floated to an angle of 45 degrees. Then a coating of curing compound or other approved means is applied to cure the grout.

VA-G 5.5.13.6 Alternative: Use of Liquid Grout

Should the *Contractor* so choose, the grout may be mixed to a free-flowing consistency and installed by means of a head box and tail reservoir shutter system to the grout supplier's specifications.

VA-G 5.5.13.7 Precautions

Special care is taken with grouting in hot or cold weather to ensure proper setting and gain of strength by having ice or hot water available, as the case may be, in accordance with the instruction of the

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manufacturer. Enclosures are provided for the grout such that, until it has set, its temperature will be in the range 15°C to 27°C.

Shields to protect the grout from the sun and from drying winds are provided by the *Contractor* when the circumstances require them.

The means of placing the grout is such that the grout completely fills the space to be grouted is thoroughly compacted and is free of air pockets and is evenly distributed over an area in excess of 90% of the bearing area of the item to be repaired.

Packing plates, shims, and other leveling devices is to remain in position.

VA-G 5.5.13.8 Epoxy Grout (epoxy mortar type only)

The manufacturer's instructions are observed when an epoxy grout is used.

VA-G 5.5.13.9 Testing

The *Contractor*, where so ordered, carries out a site test for each grouting procedure and for each grouting gang used. The tests are to be carried out on a dummy bedplate similar in configuration to that which is to be grouted, but not exceeding 1 m in area. When the dummy plate is dismantled, the underside is to show a minimum grout contact area of 90% with reasonably even distribution of the grout over the surface. The test shows evidence of good workmanship and materials and the results are to the satisfaction of the *Engineer*.

The *Contractor*, when so ordered, is to make standard test cubes from various grout mixtures and subject them to the relevant tests to determine whether the specified strength has been achieved. Test procedures are to comply with the relevant requirements of Clause 7.

VA G 5.5.14 Defects

VA-G 5.5.14.2 Delete and replace with:

After thorough inspection and investigation of the quality and strength of the work, as a first priority, the *Contractor* proposes the extent and method of repair for the *Engineer's* approval. However, the *Engineer* may order alternative or more extensive methods of repair or order the demolition and reconstruction of the whole of the defective element of work that he considers necessary.

The costs of such investigations, repair and remedial work and any demolition and reconstruction work are borne by the *Contractor*. All repair, remedial and reconstruction work is executed to the satisfaction of the *Engineer*

Add new clause:

VA-G 5.5.14.3

Concrete repairs to defective work shall also comply with ACI 546R-04 and ACI SCM-24(05). A method statement for all concrete repairs to defective work must be submitted for approval by the *Engineer*.

Add the following new clauses:

VA G 5.5.16 Massive Concrete - Large Concrete Pours

Large pours of concrete shall be designed and constructed to control heat of hydration and cracking according to SABS 0100-2, ACI 207.1R-05, ACI 207.4R-05, ACI SP-241, ACI 364.1, ACI 224R-01 and ACI 209R-92.

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A method statement for all relevant structures must be submitted for approval by the *Engineer*.

VA G 5.5.17 Concrete subjected to wet conditions

When concrete is subjected to wet conditions, the concrete shall comply with SABS 0100-2: Annexure A and BS 8007.

VA-G 5.5.18 Cast-in items

Whether cast-in items (embedment plates, puddle pipes, holding down bolts, sankey struts, etc) are supplied by the *Contractor* or the *Employer*, the *Contractor* takes delivery of these items and stores them on site in clean and dry conditions. He protects the items from corrosion and ensures that they are not damaged in any way during storage and installation in the works.

All cast-in items are cleaned of loose rust, dirt, oil and deleterious matter by the *Contractor* to the approval of the *Engineer* before being placed in position. Where a protective paint system has been applied, the coating is removed only from those parts of the item which are to be embedded.

Where protective paint, or galvanizing, has been damaged, the *Contractor* repairs this by approved means before installation.

Each item is held rigidly by means of accurately constructed templates and securely fixed in the positions indicated on the Drawings. The *Contractor* maintains the correct alignment during the placing of the surrounding concrete.

An exposed thread of holding down bolts is adequately protected with grease and sacking and this protection is maintained in all positions of the works, until they are taken over.

VA-G 6 TOLERANCES

VA-G 6.1 BASIS OF MEASUREMENT

VA-G 6.1.1 General

Add:

The tolerances are not to be cumulative.

VA-G 6.2 PERMISSIBLE DEVIATIONS

VA-G 6.2.1 General

Add:

Degree of Accuracy I apply to all parts of the *works* with the exception of Reinforcing and Foundations and sliding for which Degree of Accuracy II applies.

VA-G 6.2.3 Specified Permissible Deviations

Replace:

- d) Elements or components above foundations
- 4) Level (deviation from designated level with reference to the nearest transferred datum (TD) of the upper surface of any slab or other element or component:

DEGREE OF ACCURACY I

Delete - 10 mm + 0 mm

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and replace with: ± 4 mm

7) Exposed Concrete Surface:

DEGREE OF ACCURACY I

- i) Flatness of Plane surface 3mm

Delete and replace with:

- i) All elements 3mm
ii) Abrupt changes in a continuous surface

Add:

Concrete surfaces adjacent to steel angle edges of cable trenches is laid at a level such as to ensure that the specified floor covering can be laid and finished off flush with the angles with no abrupt changes in levels.

f) Location of holding down bolts.

- 1) the centre line of a holding down bolt from its designated location in plan ± 2 mm.
2) the top of the bolt from its designated elevation ± 4 mm.

g) Constituents in concrete mix.

Delete the PDs given for Degrees of Accuracy I and replace with:

Water 2%

Cement 2%

Aggregates 3%

But with a total cumulative max of 5%

Add a new clause:

h) Location of Built-in Items

Permissible deviations for Degree of Accuracy I are as follows:

- 1) From the defined positions in plan - 25 mm
2) From the defined position in level - in accordance with the tolerances specified for the formwork to which it is related.

VA-G 7.1 FACILITIES AND FREQUENCY OF SAMPLING

VA-G 7.1.1 Facilities

Add:

The *Contractor* is fully responsible for providing the trained laboratory personnel and equipment necessary to carry out, and evaluate the sampling and testing of concrete at the frequency set out in this specification.

The facilities provided for testing of all materials and of manufactured concrete is provided, operated and maintained to a standard which is satisfactory to the *Engineer*.

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Should the *Engineer* find that the tests and testing facilities are not to an accepted commercial concrete laboratory, the *Contractor* may be ordered to have testing carried out by an accepted commercial laboratory at no extra cost to the *Employer*.

VA-G 7.1.2 Frequency of Sampling

Add:

Every time a sample is taken, a slump test is performed on the same batch of concrete and the result recorded.

From every sample, 6 No 150 mm cubes are made and 3 cubes tested at 7 days and 3 cubes tested at 28 days. A slump test is also taken for each sample and the result recorded.

Samples are taken at the point of placing.

VA-G 7.2 TESTING

VA-G 7.2.1 General

Add:

Testing conforms to the *Contractor's* Quality Assurance Program and SABS 0100-2, in addition to the *Employer's* requirements.

Add a new clause.

VA-G 7.4 Testing of cement

The *Contractor* receives, and keeps a record, for the *Engineer's* inspection, of the Manufacturer's test certificates for each assignment of cement, covering all the requirements of SABS 471 or the relevant SABS specification for the particular cement used. Assignment is defined as cement delivered per week.

From each consignment delivered, the cement is sampled and tested for time of setting and compressive strength.

VA-G 8 MEASUREMENTS

Add:

These measurements are in addition to the requirements per *Contract*.

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**1200GE VARIATIONS AND ADDITIONS TO SABS 1200GE PRECAST CONCRETE
(STRUCTURAL)**

VA-GE 7.3 PERMEABILITY TESTS

The *Contractor* shall furnish the *Engineer* with concrete test slabs 125mm in diameter by 50mm thick gauged in the specified proportions, for permeability tests. Such slabs, when seven days old, will be subjected to water pressure equivalent to 18m head and will be required to withstand the pressure for twenty hours without showing signs of dampness on the underside.

A suitable apparatus for this test shall be provided by the contractor for this purpose, and the cost of this apparatus will be deemed to be included in the price.

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**SANS 10100-2 VARIATIONS AND ADDITIONS TO SANS 10100-2: STRUCTURAL USE OF
CONCRETE: Part 2: MATERIALS AND EXECUTION OF WORK**

VA 3.3 Conditions of exposure

Add:

All concrete not exposed to aqueous liquid will be treated severe as a minimum. All concrete exposed to aqueous liquid will be treated as very severe as a minimum and assessed according to SANS 10100-2 Annexure A.

VA 4.4 Admixtures

VA 4.4.1.2

Add:

No chlorides are allowed in admixtures.

VA 6.1.2 Strength

VA 6.1.2.1 Compressive strength

Add:

Minimum strength for reinforced concrete is 35 MPa and 15 MPa for unreinforced concrete.

VA 6.1.2.2 Maximum cement content

Add:

The minimum cement content for reinforced concrete is 420 kg/m³.

VA 6.1.7 Chloride content

Add:

The chloride content must also comply with SABS 1200G, VA-G 3.4.5, VA-G 3.4.6 and VA 5.5.1.4

VA 6.1.8 Sulphate content

Add:

The sulphate content must also comply with SABS 1200G, VA-G 3.4.5 and VA-G 3.4.6

VA 6.1.9 Alkali-silica reaction

Add:

The alkali-reactivity must also comply with SABS 1200G and VA-G 3.4.5

VA 6.2 Durability

VA 6.2.1.1 Impermeability

Add:

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The durability of all concrete shall be identified according to SANS 10100-2 Annexure A for the type of concrete class and concrete protection method. All concrete exposed to aqueous liquid shall be a minimum Class 3 concrete according SANS 10100-2 Annexure A. Minimum cover shall also comply with VA-G 5.1.3

VA 6.2.1.2 Cement content

Add:

The minimum cement content shall be 420 kg/m³

VA 6.3 Mix proportions

VA 6.3.2 Concrete exposed only to mild condltions

Replace the value 20 MPa with 35 MPa. Minimum cement content to be 420 kg/m³.

VA 8 REINFORCEMENT

VA 8.2 Cover to reinforcement

Add:

Minimum cover from Table 5 must comply with VA-G 5.1.3

VA 10.6 Concrete for water-retaining structures

VA 10.6.2 Replace the value 2.0 with 2.22

VA 10.9.3 Repair of surface defects

Add:

Defects must also comply with SABS 1200G clause 5.5.14

VA 11 MASSIVE CONCRETE

VA 11.1 General

VA 11.1.1 Add:

This concrete must also comply with VA-G 5.5.16.

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PARTICULAR SPECIFICATION FOR CONSTRUCTION USING SLIDING FORMWORK

(PA-1)		Concrete Construction using Sliding formwork
General	PA-1 - 1	The Contractor shall submit with his tender the following information relating to the proposed methods of construction of the structure walls: (1) If the method of construction involves the erection of scaffolding, a drawing of the internal scaffolding from which the walls will be constructed, showing clearly scantlings of component parts, bracing in vertical and horizontal planes and details of joints and splices, a description of methods proposed for prevention of sway and vibration of the scaffolding. Alternatively, if any other method of construction is proposed this does not involve the erection of scaffolding, a drawing and description of the plant and appliances to be used. (2) A description of certain vital operations in connection with the construction of the structure walls, namely: (i) Details of the wall formwork, including methods for erection and stripping thereof. (ii) Detailed method of construction of formwork used for the construction of any annular stiffening rings in the walls. (iii) Plumbing of the walls and setting out of diameters lift by lift. (iv) Hoisting, handling and placing of concrete. (v) Minimum time between placing of the wall concrete and stripping of formwork. (vi) Loading imposed on walls during construction and means to minimise loading. The Contractor shall ensure that the structure walls forms be such as to preclude any leakage of mortar at the joint between the bottom of the lift being cast and the top of the previous lift as well as the side joints of forms.  The Contractor shall be fully responsible for all piled foundation for Unit 1 for ensuring that the founding material and level thereof fully meets all the requirements of the accepted design. Under no circumstances will the Engineer be called upon to provide the final assessment of founding suitability for these foundations.
Storage capacity	PA-1 - 2	The Contractor shall only be permitted to store materials sufficient for one week's production at his yard adjacent to the chimneys. The remainder of his materials shall be stored at his main yard. Adequate and suitable storage for material shall be provided at both areas.

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Mixing plant	PA-1 - 3	If automatic or semi automatic pan mixers are to be used, the Contractor shall demonstrate, by means of tests during the casting of the foundations, that the mixing machines are capable of achieving, and sustaining, the maximum rate of output required for the construction of the walls. This shall be done for both main and backup plant.
Sliding formwork	PA-1 - 4	The following guidelines are given with respect to the minimum design criteria of the shutterwork. The shutter structure is designed such that it is adequately braced and no deformation, or change of shape, will take place under jacking or other normal construction loads (such as lifting or depositing concrete). Sliding shall be to be controlled by linked, hydraulically operated jacks that are driven by an electrically operated pump, with standby equipment and with provision of manual operation in the event of a breakdown. A water-level system, together with a laser or optical plumb, shall be established in order to provide monitoring and control of the platform in horizontal, vertical and rotational senses. The shaft shall be plumb and true to dimensions within the tolerances specified in Clause PA 6 hereunder. Safe and adequately sized working platforms shall be provided to all working levels of the shutter structure, together with adequate and safe access between these levels. The Contractor shall provide, for the acceptance by the Engineer, drawings, detailing the layout and operation of the required controls to maintain the works within tolerance. No concreting shall be permitted to commence until the Engineer has approved the shutter structure and control mechanism. The shutter structure shall have an adequate grip length and lead to ensure that the walls are formed smoothly and evenly without steps, waves or other irregularities of the surface, in the event of the works having to stop. The position and arrangement of jack rods shall be submitted to the Engineer for approval. Double jack rods are permitted and jack rods may be removed from the slide. Jack rods shall be 25 mm diameter, or greater, and of adequate strength to carry their designed load under all operating conditions, without any possibility of buckling.

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The joints of the bars are such that they can be made in an acceptable manner, taking into account the following:

- a) Transmit the full compressive forces with safety, and the ends of the rods shall be machined.
- b) The rods shall be screwed, or welded together, in such a manner that a possible bending of the bars, or a possible traction can be withstood. Where the bars are screwed together, the joint has a minimum tensile strength equivalent to that of a 12 mm high yield steel reinforcing bar.
- c) The joints shall in no way affect the operation of the ratchet wheels of the jacks.

All the jack rods shall be straight and free from any mill scale, rust, oil, or any other foreign deposits. The jack-rods shall be stored under cover and, if necessary, be thoroughly cleaned and handled with care during the transport and setting into position.

The construction of the working platforms shall allow for the uniform distributing of loads carried on the jacks and designed so as to allow the platforms to be kept clean.

Areas where concrete can accumulate and dry out shall be avoided. Dried concrete and any foreign substances shall be swept up and removed so that they do not enter the wall shutter. The platforms shall be designed in such a way that the operations and traffic on them take place smoothly, and without disruption of the construction operation.

If the platform does not extend over the full plan area of the structure, any central openings shall be covered with tarpaulins to provide a curing cover to the inside wall surfaces of the slide.

The slide mechanism shall have independent controls to counteract any tendency of the structures to go out of plumb or to slew, twist, rock or float.

Construction PA-1 - 5

General PA-1 - 5.1

The Contractor shall provide all necessary standby and back up generating plant, batching plant, pumps, water supplies, lighting equipment and labour to ensure that the works are not disrupted by normal supply of these services.

The Contractor shall ensure that all materials required for the work are available on site and are properly identified and stored.

The Contractor shall take all necessary steps to ensure that the work proceeds in one continuous, uninterrupted operation, except where planned stops are required.

The Contractor shall give the Engineer at least two working days notice (48 hours) of the commencement of the work.

The Contractor shall place concrete in complete horizontal "lifts" and only when placing and compaction of each "lift" is complete will work on the next "lift" be allowed to continue.

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Safety	PA-1 - 5.2	The Contractor shall take all normal and special steps to ensure the safety of all labourers and personnel involved in all aspects of the sliding operations. Sufficient lighting shall be provided to the working platforms and working areas to allow safe working conditions during night shift operations.
Monitoring of Construction	PA-1 - 5.3	Monitoring of the work shall be carried out using a laser, optical plumb or any other approved system. These shall be used to monitor the plumb of the walls, the shape of the walls and the twist of the shutters. A fixed taping system shall be used to monitor the elevation of the platform. Monitoring of the sliding shall be carried out at every lift and is recorded in a "slide log" at the lesser of every 4 hours or 0.5m. The "slide log" shall be kept on the platform at all times and shall be available for the Engineer's inspection. The plumb and twist readings shall be recorded in terms of difference from correct position and related to height. The format of the "slide log" shall be agreed with the Engineer before sliding is allowed to commence.
Reinforcement and Cast-in items	PA-1 - 5.4	Splicing, or joining of reinforcing bars, shall be made only as and when shown on the working drawings. Generally, the vertical reinforcing steel shall not be spliced all at the same level. No two adjacent horizontal bars either in each face or vertically shall be spliced at the same position. Horizontal bars in the walls shall be wired to vertical reinforcement but shall not be wired to jackrods used in the moving forms. The vertical spacing of wall reinforcement shall be carried out with due care using suitable vertical spacers. Reinforcement exposed for future bonding of extensions to the works, shall be protected from corrosion and shall be thoroughly cleaned before being cast into the final construction. The Contractor shall ensure that the required amount of horizontal steel reinforcing has been correctly tied into the walls, and at least two layers of reinforcing are visible at any time, i.e. the legs of the jack frames are long enough and the cross-bars of the legs are at least 400 mm above the top point of the wall. Should the Contractor wish to modify any of the reinforcing details shown on the construction drawings to suit his method of operations, such details, of changes proposed, shall be submitted to the Engineer for approval, at least six weeks prior to the time of commencement of the sliding operation. Any such changes required, if approved by the Engineer, shall be revised on the construction drawings prior to commencement of the works.

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Cast-in items shall be fixed flush to the shutters and reinforcement may be slightly displaced to allow the cast in items to be fixed in their correct position.

Where the layout of the sliding shutter system makes vertical rebates in the concrete unavoidable, cover and concrete sizes shall be measured to the narrowest part of the forms.

Weather

PA-1 - 5.5

The Contractor shall provide standby equipment to heat concrete mix water in the event of very cold conditions, below 5°C. The water shall be heated to a maximum temperature of 35°C.

In order to avoid flash set, the water and aggregates shall be thoroughly mixed before the cement is added.

The rate of sliding shall also be reduced to a safe rate.

Tarpaulin covers and heaters shall also be provided to the floating platforms to raise temperatures in these areas.

In the event of abnormally hot conditions above 32°C, the Contractor shall take all necessary precautions to prevent dehydration of the concrete during the initial setting and curing period. Covers shall be provided to shield the concrete from direct sunlight during the first four hours after casting.

Rate of sliding

PA-1 - 5.6

The Contractor shall ensure that the concrete strength achieved and the rate of movement of the sliding formwork is such that the concrete at the bottom of the sliding formwork has achieved sufficient strength that it can support itself and all loads that may be imposed upon it during construction.

The Contractor shall limit the rate of sliding according to the constructional, environmental and contractual factors affecting the work. The rate of sliding together with air temperature and wind conditions shall be recorded in the "slide log" referred to in PA.5.3 above.

Sliding shall proceed continuously at a rate approved by the Engineer. During sliding no stoppage longer than 15 minutes will be permitted. The shutter shall be kept as full of concrete as possible with the surface of the concrete maintained level. The rate of movement of the sliding formwork is not such as to allow the concrete inside to adhere to the sides of the shutter.

The relationships between rates of sliding and concrete setting times for each mix designation for the various environmental conditions and production requirements shall be established. Before sliding commences the relationships between concrete setting times, concrete temperatures and additive dosages where used shall be established using the methods described in ASTM C403 for the appropriate degree of set.

Delays in sliding

PA-1 - 5.7

If interruptions in the slide occur as a result of circumstances completely beyond the control of the Contractor, or on the instruction of the Engineer, special arrangements shall be made to avoid the adhesion of setting concrete to the sliding formwork, and if such adhesion takes place, to break it in such a fashion that the uppermost layers of concrete are not cracked or lifted. Jacks shall be reversible so that the formwork can be lowered between 12 mm and 25 mm.

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Should an interruption occur, a construction joint shall be formed in a manner which will least impair the durability, appearance and proper functioning of the concrete. The sliding shutter shall be lowered before new concrete is poured so as to avoid a stepping effect in the face of the wall. In recommencing the pouring operation, particular care shall be taken so that no adhesions shall occur which will "lift" new concrete. Should adhesions cause cracks, they, shall immediately upon exposure under the formwork, be made good to the satisfaction of the Engineer.

Cracks of surface width 4 mm and less shall be carefully examined for extent and pressure grouted with an approved low viscosity (with filler where crack width is greater than 2 mm) epoxy resin to a method approved by the Engineer.

Cracks of surface width 4 mm to 8 mm which, in Engineer's view, do not otherwise affect the integrity of the structure, shall be cut back to their full depth and extent and filled with a dry pack mortar of predetermined and tested mix proportions, strength and placing method approved by the Engineer..

Cracks over 8 mm width or which, in Engineer's view, affect the integrity of the structure shall be investigated and remedied on an individual basis to the approval of the Engineer.

The Contractor shall submit detailed proposals of materials and methods of application and testing to the Engineer for approval before such repairs are carried out.

Should the slide be continued within a period of 24 hours of a stoppage, all laitance shall be removed from the surface of the construction joint before any fresh concrete is added.

Should the slide be continued after a period of 24 hours has elapsed the procedure outlined below shall be followed.

The top surface shall be scabbled back, to the satisfaction of the Engineer, to expose clean aggregate. Mortar leakage, which may have occurred, shall be removed. Clean away all loose material and thoroughly wet the concrete surface. The first concrete mixture to be deposited in the shutters shall contain between 7% and 10% additional fine aggregate, with a corresponding reduction in normal aggregate related to the mix.

The method to be used by the Contractor to prevent adhesion of concrete to shutters and forms and to form a construction joint, shall be fully documented and accepted before the start of the sliding.

Openings and cast-in plates

PA-1 - 5.8

Openings and cast in plates shall be set out and positioned to within the tolerances specified in PA 6 hereunder. The setting out shall take account of the overall position of the slide at the time the opening is fixed. Construction tolerances are not cumulative.

Should jacking rods pass through an opening, buckling of the jacking rods shall be prevented by the provision of a properly braced temporary column.

Curing, Protection and finish

PA-1 - 5.9

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Curing	PA-1 - 5.9.1	Immediately after concrete emerges from the forms, it shall be worked to close all minor cracks and to give a finish as specified in SANS 1200 G Clause 5.2.1(b). Curing compound shall then be applied to the finished concrete surface, or after a time period recommended by the manufacturer of the compound. Should large, or abnormal cracks be apparent when concrete emerges from the forms, or excessive surface flooding of the concrete be noted, this shall be immediately brought to the attention of the Engineer. The event shall also be noted in the "slide log". The Contractor shall use a curing compound(s) which shall be compatible with any future repair work applications, materials and paintwork to the chimney windshield and their method and rate of application shall be approved by the Engineer before sliding is allowed to commence. Details of these shall be submitted for acceptance not less than 15 days before acceptance is required.
Protection	PA-1 - 5.9.2	Tarpaulins, or covers as described in PA-1-.5.5 above, shall be provided to protect the recently cast concrete during curing periods of cold (below 5°C) or hot (above 32°) weather, and where high winds occur. These covers shall be installed before the temperatures described above are reached. Covers shall be at all times provided to protect the fresh concrete from direct sunlight.
Finish	PA-1 - 5.9.3	The concrete shall be floated and finished to the standard described in SANS 1200 G Clause 5.2.1(b). Where the sliding shutter system makes vertical rebates unavoidable, these shall not be filled, or "blended-in", to the adjacent concrete.
Ready mixed concrete	PA-1 - 5.10	The use of ready-mix concrete shall not be permitted for sliding concrete work. Ready mixed concrete is defined as concrete mixed off site outside the Power Station construction area.
Construction joints	PA-1 - 5.11	The Contractor shall plan and agree with the Engineer the location of construction joints. Details of planned construction joint shall be submitted to the Engineer for approval not less than 30 days before the particular section of work affected is to be commenced.
Permissible deviations	PA-1 -6	The permissible deviations for items not specified in SANS 1200-G Clause 6.2.3 are specified in Table 1 below. For rectangular shapes, the diameter as mentioned in table 1 below should be replaced with either the width or depth of the rectangular shape when the width or depth deviation is assessed.

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Table 1

Tolerances in the concrete work are defined in a statistical way and expressed in terms of

- a) the mean inaccuracy $\bar{m}$ between a specified dimension L_n and the real dimension L measured at several points chosen at random
- b) the standard deviation S of the measurements.

The values $\bar{m}$ and S shall not exceed the appropriate values

Upper limit for absolute value of mean inaccuracy $\bar{m}$ and standard deviation S

		$\bar{m}$ (m)	S (m)
Wall Thickness (m)	$t < 0.3$ m	0.005	0.01
	$t > 0.3$ m	$0.002 + 0.01 t$	$0.004 + 0.02 t$
Shell Diameter(m)		$0.05 + 0.01 d$	$0.05 + 0.01 d$
Deviation from Vertical Axis (m)	$h < 50$ m	0.05	0.05
	$h > 50$ m	$0.001 h$	$0.001 h$

Note 1: The mean value of the wall thickness at one level over a 60 degree arc shall be taken to represent one measurement.

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Structure walls	PA-1 - 6.1	The structure walls shall be constructed within the following dimensional tolerances: The setting out point of the walls at any horizontal section shall be located within 100 mm diameter circle drawn around the true centre of the walls at that section. The correction of any deviation from the true centre, within the limits stated above, shall not exceed 10 mm in any 5 m rise of the walls but not more than 200mm in total over the full height. The inside radius or width/2 or depth/2 of the walls at any horizontal section, measured from the setting out point, shall not differ from the specified dimension by more than +/- 20 mm. The thickness of the walls shall not differ from the specified thickness by more than + 10 mm or - 6 mm. When correcting dimensional deviations in any vertical plane through the setting out point, within the limits as above, the wall profile shall not change direction, other than in accordance with the required batter and rise, by more than 10 mm per 5 meter rise. The rate of spiralling of the shutter if circular shall not exceed 10 mm circumferential rotation per 1 m of vertical travel. The maximum deviation in either direction shall not exceed 50 mm.
Location of Built-in Items	PA-1 - 6.2	(a) From defined positions in plan, measured on vertical centre line of plate ± 10 mm (b) From defined position level, measured on horizontal centre line of plate ± 10 mm (c) Out of square and out of plumb ± 5 mm in 1 metre
Testing	PA-1 - 7	
Frequency of sampling	PA-1 - 7.1	The stated frequency of sampling is the minimum which is necessary to demonstrate compliance with the design strength requirements of the concrete. For sliding concrete the frequency and size of samples taken shall be approved by the Engineer on the basis of the requirements for "early strength" results. The frequency and size of sample are not less than that stated in SANS 1200 G 7.1.2 and the variations and additions.

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Integrity testing

PA-1 - 7.2

The concrete shall be sample tested by coring to confirm that the concrete is free from voids, cracks and honeycombing when requested by the Engineer. The Contractor shall drill the equivalent of one core for each 10 m height of wall structure. The position of the cores shall be determined in conjunction with the Engineer. The core shall be examined for defects and the results reported to the Engineer.

The coring of the concrete shall be undertaken after the installation of the intermediate floors. The locations of the cores shall be determined by the Engineer after reviewing the construction log book. The Contractor shall be required to provide scaffolding from the intermediate floor to the location where the cores are required. The cores shall not penetrate through the thickness of the wall structure, but shall stop after having intersected the outer layer of reinforcement on the outer face, or if no reinforcement is intersected, an equivalent depth, so as to leave a thickness of concrete approximately equal to the external cover to the reinforcement to assist in closing the core holes.

The crushing strength results of the cores shall correlate to those of the cubes. The core shall be examined for defects and tested for 28 days compressive strength and the results reported to the Engineer. Core holes shall be made good, to the Engineer's approval.

The Contractor may, in addition, be required to carry out other forms of integrity testing by NDT instruments, or by cutting out samples and making good from the hanging scaffolds.

Where defects in concrete are found, the Contractor shall determine the extent of all the concrete in the works represented by the defective sample. The Contractor shall submit proposals for, and implement remedial work to the concrete in the works, so that the design criteria for the structure are satisfied and that the structure is otherwise fit for this purpose, including partial or total replacement of defective concrete, supplementary works and the like.