ANNEXURE B3

VARIATIONS TO STANDARDIZED SPECIFICATIONS

VARIATIONS TO 1200G: CONCRETE (STRUCTURAL)

PSG: CONCRETE (STRUCTURAL)

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PSG CONCRETE (STRUCTURAL) (SANS 1200G)

PSG 1 SCOPE (CLAUSE 1)

The standard SANS 1200G: Concrete shall apply except as modified herein.

This specification covers the requirements for all structural concrete work (plain or reinforced) including precast and in-situ concrete.

In this specification the emphasis is on durability in the marine environment.

PSG 2 MATERIALS (CLAUSE 3)

PSG 2.1 Cements (Clause 3.2)

All cements and cement extenders used for concrete work shall comply with the relevant specifications listed under PSG 2.1.1.

The cement types given below are acceptable for use in the works, however the proportion of extender in factory blended cements shall conform to the requirements of section PSG 3.3.4. On no account shall masonry cements be used for concrete work, even if the strength designations are the same as for common cements.

Acceptable cement types:

i) CEM I 42,5	Portland Cement
ii) CEM I 42,5R	Portland Cement, rapid hardening
iii) CEM II/B-V	Portland fly ash cement
iv) CEM II/B-W	Portland fly ash cement
v) CEM III/A	Blast furnace cement

PSG 2.1.1 Applicable Specifications (Clause 3.2.1)

In addition to the specifications listed in Clause 3.2.1 of SANS 1200G, the following specifications shall also apply where relevant.

SANS 10100-2:2014	The Structural use of concrete - Part 2: Materials and execution of work
SANS 50197-1:2013	Cement Part 1: Composition, specifications and conformity criteria for common cements
SANS 55167-1:2011	Ground granulated blast furnace slag for use in concrete, mortar and grout - Part 1: Definitions, specifications and conformity criteria
SANS 55167-2:2011	Ground granulated blast furnace slag for use in concrete, mortar and grout - Part 1: Conformity evaluation
SANS 50450-1:2014	Fly ash for concrete Part 1: Definitions, specifications and conformity criteria
SANS 50450-2:2011	Fly ash for concrete Part 1: Conformity evaluation
SANS 53263-1:2011	Silica fume for concrete Part 1: Definitions, specifications and conformity criteria
SANS 53263-2:2011	Silica fume for concrete Part 1: Conformity evaluation

PSG 2.2 Aggregates (Clause 3.4)

Should the *Contractor* use a coarse aggregate type which is reactive with alkali the *Contractor* will have to ensure that the equivalent Na_2O content in the concrete mix is such that it is below the threshold value which causes the deleterious reaction in the concrete.

See Table PSG 1.

TABLE PSG 1:

TOTAL Na_2O EQUIVALENT THRESHOLD VALUES

ROCK TYPE	TOTAL Na_2O EQUIVALENT (kg/m^3)
Malmesbury Group metasediments	2.1
Table Mountain Group orthoquartzite	2.8
Cape Granite	4.0
Natal Group Quartzite, sandstone	2.8

$$\% Na_2O \text{ equivalent} = \% Na_2O + (0.658 \times \% K_2O)$$

A laboratory report by the *Contractor* on the mix design and trial mixes prior to construction will need to elaborate on the above matter. If required by the *Project Manager*, the *Contractor* shall submit 40 kg samples for approval at least 6 weeks before concrete is to be commenced. No aggregate shall be delivered for use in the works until the *Project Manager's* written acceptance is given.

PSG 2.2.1 Use of Plums (Clause 3.4.)

The use of plums in concrete will not be permitted unless otherwise specified in Particular Specifications.

PSG 2.3 Admixtures (Clause 3.5)

Admixtures containing chlorides will not be permitted in reinforced concrete.

PSG 2.4 Curing Compound

In all cases where a concrete curing compound is specified, the curing compound shall be clear or white pigmented membrane forming material complying with ASTM C309-11, except that the maximum permissible water loss in the test shall be 0.40 kilograms per square metre.

PSG 3 CONSTRUCTION (CLAUSE 5)

PSG 3.1 Reinforcement (Clause 5.1)

Minimum concrete cover to all steel reinforcement shall be as shown on the drawings or as given in the Particular Specifications and maintenance of this minimum cover during casting of concrete shall be strictly enforced. Concrete which is cast with insufficient cover to the reinforcement shall be demolished and re-cast at the *Contractor's* cost.

Cover blocks used to ensure the cover to reinforcement shall be made of cement mortar. They shall be dense and have a minimum 28 day crushing strength of 50 MPa, and shall be cured in water for at least 14 days before being used. Steeldale or other similar approved proprietary cover blocks shall be used – site made blocks will not be permitted. Cover blocks made of plastic will not be permitted.

PSG 3.2 Formwork (Clause 5.2)

All exposed concrete surfaces will require a smooth finish to a Degree of Accuracy II as specified in Clause 6 of SANS 1200G, unless otherwise specified in the Particular Specifications.

The *Contractor* shall take particular care to ensure that formwork joints are tight enough to prevent leakage of cement mortar. Shutters that are damaged, or that leave a surface that is unacceptable to the *Project Manager*, shall be removed and repaired or discarded.

PSG 3.3 Concrete (Clause 5.5)

PSG 3.3.1 Quality (Clause 5.5.1)

Before the start of concrete work on site, the *Contractor* shall submit a quality assurance plan which will ensure compliance with specification and provide acceptable documentary proof that all specified operations have been carried out satisfactorily. The quality assurance plan shall make provision for

intervention points, to be agreed with the *Supervisor* for his inspection of the Works.

PSG 3.3.2 Potential Heat Generation

Measures, subject to the acceptance of the *Project Manager*, shall be applied to reduce heat development in concrete of which the minimum dimension to be placed during a single pour is larger than 600 mm, and the cement content exceeds the values given in table PSG 2.

TABLE PSG 2:
HEAT GENERATION – LIMITING CEMENT CONTENTS

STRUCTURAL ELEMENT	**CEMENT TYPES I AND III/A (kg/m^3)**	**CEMENT TYPES II/B-V AND II/B-W (kg/m^3)**
Reinforced Concrete	400	450
Prestressed Concrete	500	550

PSG 3.3.3 Chloride Content (Clause 5.5.1.4)

The chloride content in steel reinforced concrete at the time of placing shall not be greater than 0,15% by mass of the cement.

PSG 3.3.4 Durability (Clause 5.5.1.5)

In order to enhance durability and notwithstanding strength considerations the concrete mixes shall satisfy one of the mixes given in Table PSG 3 below and prior written acceptance for the mix shall be obtained from the *Project Manager*.

TABLE PSG 3:

CONCRETE MIXES

CONCRETE TYPE	CEMENT TYPE & % CONTENT	EXTENDER TYPE & % CONTENT	MINIMUM CEMENT + EXTENDER CONTENT kg/m^3	MAXIMUM WATER/CEMENT RATIO
STEEL REINFORCED	CEM I 50% – 60%	GGBS 40% – 50%	400	0.40
STEEL REINFORCED	CEM I 70% - 75%	FA 25% –30%	400	0.40
PLAIN	CEM I 100%	NIL	340	0.50
PLAIN	CEM I $\geq$75%	FA $\leq$ 25%	340	0.50
PLAIN	CEM I 35% - 65%	GGBS 35% – 65%	340	0.50
PLAIN	CEM I 65% – 74%	FA 26% – 35%	320	0.55

NOTE:
1) CEM I may be CEM I 42,5 or 42,5 R.
2) GGBS - Ground Granulated Blast furnace Slag
3) FA - Fly Ash
4) Factory blended cements (CEM II/B-V, CEM II/B-W or CEM III/A) will be accepted provided that they conform to one of the blends specified in the table. The *Contractor* shall supply certification thereof.
5) Water-reducing admixtures may be used to improve workability (See also Clause PSG 2.3 above). The water cement ratio shall include the water content of admixtures.

Blends of CEM I and Condensed Silica Fume (CSF) are not acceptable for steel reinforced concrete. Ternary blends such as CSF with CEM I and FA or GGBS

may be considered provided that they can be shown to be equivalent in durability to the mixes given. The onus will be on the *Contractor* to prove to the *Project Manager* the adequacy of the blend.

PSG 3.3.5 Strength Concrete (Clause 5.5.1.7)

The strength of the concrete mixes as specified on the drawings or given in the Particular Specifications for the works, shall conform to the following requirements, as Class x/y, where:

	x	=	minimum 28 day crushing strength in MPa.
and	y	=	maximum aggregate size in mm.

PSG 3.3.6 Batching (Clause 5.5.2)

All aggregates shall be precisely measured by mass using approved precision weigh batching equipment, unless otherwise permitted by the *Project Manager*.

Should any variation in the composition of the aggregate become apparent, the *Project Manager* shall be notified and a further sample of the aggregate submitted immediately for his acceptance.

PSG 3.3.7 Off-Site Batched Concrete (Clause 5.5.3.2)

The use of ready-mixed concrete is permissible. Concrete test results obtained from the production facility will be acceptable, provided that the tests are carried out in accordance with the specifications.

PSG 3.3.8 Underwater Concrete

Casting concrete underwater is subject to the acceptance of the *Project Manager* with respect to the methods, equipment and materials that the *Contractor* intends to use. Use of a concrete admixture such as Sika UCS-01

ZA or other similar approved proprietary admixture to minimise the washout of cement paste is recommended.

Unless otherwise permitted, the technique adopted for placing of concrete and any dewatering shall be designed to prevent the washing out of cement from the concrete mixture, minimise the segregation of materials and the formation of laitance, and prevent the flow of water through or over new concrete less than 24 hours old.

After commencement, the placing of concrete shall be continuous until completion, unless otherwise permitted.

No vibration shall be carried out until the top of the concrete is above water or tide level.

The maximum size of aggregate shall be 50 mm, and the aggregates shall be well graded.
The slump shall not be less than 80 mm or more than 150 mm.

The seabed onto which the concrete is to be cast shall be cleaned of silt and loose material, and must be passed by the *Project Manager* before concrete is placed.

PSG 3.3.9 Methods of Depositing Concrete

(i) By Tremie

The top section of the tremie shall consist of a hopper of greater capacity than the pipe.

The tremie shall be sturdily constructed of steel, and be not less than 200 mm in diameter. It shall be strong enough to withstand the full hydrostatic pressure, even if a partial vacuum develops in the pipe, and shall be completely watertight.

The lower end of the tremie shall be equipped with an approved automatic check valve which shall be watertight.

Initial filling of the tremie shall be carried out with the valve closed, in such a manner as to avoid air locks.

When concrete is deposited, the tremie shall penetrate the concrete bed and shall be slowly raised to discharge a uniform flow of concrete. The end of the tremie shall be under concrete during the whole operation.

Concreting shall continue to such a point that laitance can be removed and a sound surface left at the final finished level.

(ii) By Pumping Concrete

The same conditions and criteria as for concreting by tremie as described in (i) above, apply.

(iii) By Grouting Aggregate

Coarse aggregate, 40 mm or larger, shall first be placed and compacted in position.
Grout in a colloidal state shall be pumped into the voids through a pipe which shall reach to the bottom of the aggregate. The grout shall rise through the aggregate until all voids are filled.

PSG 3.3.10 Placing (Clause 5.5.5)

Inspection of Excavation

The size, shape and depth of any excavation shall be approved by the *Project Manager* before concrete is placed.

Inspection of Reinforcement

Unless otherwise permitted by the *Project Manager*, no concrete shall be placed until the fixed reinforcement has been inspected and written acceptance obtained from him before casting any concrete.

PSG 3.3.11 Construction Joints (Clause 5.5.7)

It is essential that a good bond is achieved between casts at construction joints. The joint surface of the concrete is to be roughened while still green by means of brush and water spray to expose the coarse aggregate. Retarders may be used on stop-ends, which should be removed after 12 hours for green cutting. Mechanical roughening of hardened concrete using power tools will only be permitted upon written acceptance of the *Project Manager*. Mechanical roughening shall be performed in such a manner as to prevent the dislodgement of coarse aggregate.

All surfaces must be cleaned and kept continuously wet for 24 hours before pouring of the adjoining cast.

Unless otherwise shown on the drawings, the exact position of horizontal construction joints shall be marked on the formwork by means of grout checks in order to obtain truly horizontal joints.

Stub columns, stub walls and stays on footings shall be cast integrally with the footings and not afterwards, even where another class of concrete is being used.

Joint lines shall be so arranged that they coincide with features of the finished work.

At contraction joints (joints having no reinforcement passing through the joint), no bond is required between casts. Contraction joints shall be smooth, and shall have a bond breaker (one coat of limewash or PVA paint) applied to the older surface prior to casting the newer concrete.

The *Project Manager*'s prior written acceptance must be obtained before the adjoining concrete is cast.

PSG 3.3.12 Curing (Clause 5.5.8)

In order to enhance the long term durability of the concrete in the marine environment it is essential that it is correctly cured so that adequate hydration of the cement and extenders may take place.

The following curing methods are permissible:

a) For plain concrete:

i) Retaining forms in place on vertical surfaces provided they are made with non-absorbent facing materials.

ii) Ponding of water on horizontal surfaces. Curing water shall be fresh and not be more than 10°C cooler than the concrete on which it is to be applied in order to avoid surface cracking.

iii) Covering with sand, earth, straw, sawdust, cotton, jute, burlap or hessian or similar moisture retaining materials. The materials shall be kept continually moist and shall not be allowed to dry out as alternate wetting and drying is detrimental to the curing process. The material shall be free of injurious amounts or substances such as sugar or fertiliser that may harm the concrete or cause discoloration.

iv) Sprinkling or spraying with water. This may be done at frequent intervals provided that the concrete surface remains continuously moist and is not allowed to dry out between wetting. Erosion of the fresh concrete surface must be avoided.

v) Covering with plastic sheeting, waterproof or other curing paper. The covering material shall be firmly and continuously held in place along its edges such that the concrete surface is not allowed to dry out. Care must be taken not to tear, puncture or otherwise disrupt the continuity of the curing film. Plastic film shall not be black, and preferably not white or clear.

vi) Liquid membrane-forming curing compounds which comply with the requirements of PSG 2.4 may be used. Only resin type compounds will be permitted. The formulation must be such as to form a moisture retentive film shortly after being applied and must not be injurious to portland cement paste. White or grey pigments or dyes must be incorporated to enable the compound to be visible on the surface for inspection purposes.

For unformed surfaces the compound shall be applied after finishing and as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the liquid curing compound will be absorbed into the concrete. For formed surfaces, when forms are removed, the exposed concrete surface shall be wet with water immediately and kept moist until the curing compound is applied. Immediately prior to application, the concrete shall be allowed to reach a uniformly damp appearance with no free water on the surface. Application of the compound should then begin at once. The compound should be applied at a uniform rate with two applications at right angles to each other to ensure complete coverage, and may be applied by hand or power sprayer. Pigmented compounds must be adequately stirred to assure even distribution of the pigment during application, unless the formulation contains a thixotropic agent which prevents settlement.

The compound manufacturer must supply a certificate confirming compliance with PSG 2.4 and the manufacturer's directions with respect to preparation and application. The manufacturer's preparation and application directions for the compound must be strictly adhered to.

The total application rate shall be as specified by the manufacturer, or 0.30 litres per square metre, whichever is the greater.

In the case of concrete surfaces with run-off problems, it may be necessary to apply more than one coat of membrane forming curing compound to obtain the specified total or cumulative application rate.

When the wind velocity exceeds 5 m/s and/or the ambient temperature is above 25 deg C and/or the relative humidity is below 60%, the initial 24 hour curing of concrete surfaces not covered by formwork shall be carried out by ponding, covering with constantly wetted sand or mats, or continuous spraying in accordance with SANS 1200G, unless otherwise permitted by the *Project Manager*.

b) For steel reinforced concrete:

i) Covering with burlap or hessian or similar moisture retaining materials. Requirements are as given in (a) (iii) above for slabs and bases.

ii) Sprinkling or spraying with water. Requirements as given in (a) (iv) above.

iii) Releasing the forms slightly and allowing a flow of water between the form and the concrete.

iv) Curing methods using sealing materials such as plastic or liquid membrane forming compounds will not be allowed for steel reinforced concrete structures due to the low W/C ratio of the concrete mix. The water provided by the moist curing is required for completion of the hydration of the concrete in the cover layer.

All water for curing shall be clean, fresh water and under no circumstances will seawater be permissible.

The curing period for concrete containing CEM I only shall be 7 days. The curing period for concrete's containing CEM I plus cement extenders (GGBS, FA) shall be 10 days. The period will start on completion of the concrete pour and for formed surfaces shall include the time for which forms are still in place after the pour.

The *Project Manager* prior written acceptance of the curing method to be used must be obtained before any concrete is cast.

Concrete which in the *Supervisor*'s judgement has not been cured adequately shall be removed from the Works and re-cast at the *Contractor's* cost.

PSG 3.3.13 Concrete Surfaces (Clause 5.5.10)

All exposed concrete surfaces shall have a neat, smooth, even and uniform finish, free from any honeycombing and blow holes.

PSG 3.3.14 Records (Clause 5.5.15)

The *Contractor* shall maintain the following daily records for every part of the concrete structure and shall make these available at all times during the progress of the work for inspection by the *Project Manager*/*Supervisor*:

(i) The date and times during which concrete was placed.
(ii) Identification of the part of structure in which the concrete was placed.
(iii) The mix proportions and specified strength.
(iv) The type and brand of cement.
(v) The slump of the concrete.
(vi) The identifying marks of test cubes made.
(vii) Curing procedure applied to concrete placed.
(viii) The times when shuttering was stripped and props were removed.
(ix) The date of despatch of the cubes to the testing laboratory.
(x) The test results.

The records shall be delivered to the *Project Manager* each week except in the case of sub-standard concrete, when the *Project Manager* shall be informed immediately.

PSG 4 TOLERANCES (CLAUSE 6)

Deviations shall be within the limits listed in SANS 1200G for Degree of Accuracy II, specified in clause 6, unless stated otherwise on drawings or elsewhere in the Project Specification.

PSG 5 TESTS (CLAUSE 7)

Before the start of any concrete work on the site, the *Contractor* shall supply the *Project Manager* and *Supervisor* with a statement of the mix proportions that he proposes to use and the target strength for each grade of concrete.

PSG 5.1 Facilities and Frequency of Sampling (Clause 7.1)

PSG 5.1.1 Frequency of Sampling (Clause 7.1.2)

Frequency of sampling and testing shall be as specified in SANS 1200G, sections 7.1 and 7.2, subject to the testing of a minimum of 3 sets of samples per day from each grade of concrete placed in each independent structure if the concrete quantity from which these samples were taken, exceeds 40 m^3, and the testing of a minimum of 2 sets of samples per day when such quantity is equal to or less than 40 m^3.

Where required the two-point loading method of the flexural strength tests, as described in SANS 5864 shall be used.

PSG 5.2 Acceptance Criteria for Strength Concrete (Clause 7.3)

Acceptance criteria shall be as specified in SANS 1200G, section 7.3. If the *Contractor* disputes test results on concrete cubes, the concrete represented by the cubes will be considered acceptable if the *Contractor*, at his own cost, proves to the satisfaction of the *Supervisor* that the estimated actual strength of the cores taken from the structure, determined in accordance with SANS 5865, is not less than the specified strength.

If the strength of concrete fails to meet the acceptance criteria stipulated, the *Project Manager* may in his sole discretion and in addition to the options listed in SANS:

(i) accept the concrete subject to approved remedial measures being undertaken by the *Contractor*; or
(ii) permit the concrete to remain subject to the payment of a penalty.

The penalty will be determined as follows:

Penalty = V x R x F

where

V = Volume (in the opinion of the *Supervisor*) of concrete of unsatisfactory strength represented by the test result.

R = Relevant scheduled rate.

$$F = 1 - \sqrt{\frac{\text{Average strength of unsatisfactory concrete}}{\text{Specific strength + 6 MPa}}}$$

where the relevant schedule rate (R) includes the cost of formwork or

$$F = 1 - \frac{\text{Average strength of unsatisfactory concrete}}{\text{Specified strength + 6 MPa}}$$

when the relevant scheduled rate (R) excludes the cost of formwork or where no formwork was involved.