



CARES Scheme for Approval of Post Tensioning Systems for Concrete Structures in Australia

Appendix APT03 Quality and Operations Schedule for the Production and Supply of Pre-bagged Grout Material for use in Post-Tensioning Systems



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Amendment Control Sheet

Amendment summary	Date
Initial Issue	18.02.2021
(Latest amendments highlighted throughout Appendix by an adjacent line)	



0 INTRODUCTION

This CARES quality and operations assessment schedule relates to the quality system requirements for the production and supply of factory produced pre-bagged grout material for use in post-tension in Australia.

1 SCOPE

This quality and operations assessment schedule describes the minimum quality and operational requirements for the production of pre-bagged grout material for the production of grout to meet the requirements of CARES Model Specification Australia for Bonded Post-tensioned Floors and Concrete Institute of Australia, Grouting of Prestressing Ducts.

1.1 Schedule of Operations

The organisation shall document the production processes, materials, equipment and human resources relevant to this Schedule in a CARES Schedule of Operations. The Schedule of Operations shall be used by CARES during the assessment and subsequent surveillance inspections and shall be updated when required.

2 DEFINITIONS

Authority. The UK Certification Authority for Reinforcing Steels (CARES), a company limited by guarantee

Batch. A quantity of grout which has been manufactured during a prescribed production shift / day or period where the process conditions and raw material feedstock have been maintained to ensure final tests carried out are a true reflection of the batch properties.

Client. The body for which the works are being carried out.

Customer. The body engaging the organisation for the purpose of supplying the products described in this schedule.

Grout. A mixture of pre-bagged grout materials mixed with water and injected into the duct to fill the space around the tendon.

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Organisation. The body responsible for the production and supply of pre-bagged grout materials in accordance with this schedule.

Quality plan. The document setting out the specific quality practices, procedures, resources and sequence of activities relevant to the product.

Quality system. The organisation's organisational structure, responsibilities, procedures, processes and resources for implementing quality management.

Pre-bagged grout materials. A pre-bagged blended mixture of cement and additives, for mixing with water to produce grout for injecting into the duct to fill the space around the tendon.



Supplier. A body approved by the organisation for the provision of specified materials, equipment or services.

Tendon. One or a number of prestressing steel elements, i.e., wire, strand or bar.

Type A tendons: multi-strand tendons in bridges and structures and tendons in aggressive or potentially aggressive environments.

Type B tendons: low profile ducts for post tensioning typical flat slab buildings in enclosed or benign environments.

The distinction affects the grouting procedure only, with a simpler procedure being used for Type B tendons.

3 OPERATION OF THE SCHEME

The Scheme will operate as follows:

3.1. Certification of the Organisation

Certification of the organisation will be granted after a satisfactory assessment of the organisation's procedures, operations and products by CARES in accordance with the requirements of this Schedule and BS EN ISO 9001.

3.2. Maintenance of approval.

In order to maintain approval, the organisation shall be subject to:

- a) Quality management system inspections twice per year.
- b) Product testing and evaluation in accordance with this schedule
- c) The periodic fees levied by the Authority.

4 QUALITY MANAGEMENT SYSTEM REQUIREMENTS

The organization shall operate a quality management system that complies with BS EN ISO 9001 and this schedule. This Schedule interprets those elements that are particularly relevant to the production of pre-bagged grout for post-tensioning systems to ensure consistent product quality and continued compliance with this schedule.

4.1. Documentation Requirements, Control of Records

The organization shall establish and maintain records to show conformity with this schedule and shall define their retention period and their disposition.

Records relating to the technical details of pre-bagged grout shall be retained for a minimum period of 12 years and a copy of these shall, when required, be sent to the client.

Where documents and records are stored electronically, the data shall be regularly backed up to ensure no loss of data and readily retrievable with minimal loss of information in case of failure.



4.2. Management Responsibility

Top management shall provide evidence of its commitment to the development and implementation of the quality management system and continually improving its effectiveness by:

- a) Communicating to the organization the importance of meeting customer as well as statutory and regulatory requirements.
- b) Establishing the quality policy.
- c) Ensuring that quality objectives are established.
- d) Conducting management reviews.
- e) Ensuring the availability of resources and control of such.

4.2.1 Quality Management System Planning

The organisation shall produce a quality plan for factory production control. The quality plan shall identify the: human resources, responsibilities, processes, materials, equipment, controls, inspection, measuring and test equipment, reference standards and levels of acceptability required to meet the contract requirements.

4.3. Provision of Resources

The organisation shall identify the resource requirements in the quality plan and provide adequate resources, including materials, equipment, inspection, measuring and test equipment and trained personnel for the management, supervision and performance of the work and verification activities.

4.3.1. Competence, Awareness and Training

The organization shall:

- a) Determine the necessary competence for personnel performing work affecting product quality, including inspection and verification activities.
- b) Provide training or take other actions to satisfy these needs.
- c) Evaluate the effectiveness of the actions taken, and where required, certificate the trained individuals.
- d) Ensure that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives.
- e) Maintain appropriate records of education, training, skills and experience.

4.4. Purchasing

The organisation shall have a documented procedure for purchasing materials and services from suppliers. All materials and services shall be purchased from sources approved by the organisation.



4.4.1. Purchasing Information

The purchase orders shall include all aspects of the material or service specification, which are important in ensuring satisfactory product quality, traceability and identification. Purchasing specifications shall be readily available

4.4.2. Evaluation of Suppliers

The organisation shall have a documented procedure for the evaluation and selection of suppliers. Records of acceptable suppliers shall be maintained. The assessment shall account for all aspects of the service or material specification, which are important in ensuring satisfactory quality and identification of the material or service.

4.5. Product Identification and Traceability

The organisation shall have a documented procedure to maintain traceability during all stages of production through to delivery. Traceability records shall be included in Quality Records and shall include the following:

- a) Records of the source and specification of materials used for the production of pre-bagged grout.
- b) Records of production and testing.

4.6. Determination of Requirements Relating to the Product

The organization shall review the requirements related to the product. This review shall be conducted prior to the organization's commitment to supply a product to the customer and shall ensure that:

- a) Product requirements are defined.
- b) Contract or order requirements differing from those previously expressed are resolved.
- c) The organization has the ability to meet the defined requirements.

Records of the results of the review and actions arising from the review shall be maintained.

5. PRODUCTION AND SERVICE PROVISION

5.1. Preservation of the Product

5.1.1. Receipt

The organisation shall have a documented procedure for the receipt of incoming material that includes inspection of material and, where appropriate, correlation of advice notes and test certificates. Incoming materials shall be checked for compliance with specification and purchasing data.



5.1.2. Storage

The organisation shall have a prescribed procedure, which ensures that materials are stored and segregated in a manner, which prevents deterioration and contamination.

- a) Where applicable, the organisation shall have a documented procedure for recording and identifying all materials held in stock and subsequently processed. The procedure shall ensure materials are identified to the original batch information, as applicable.
- b) All test and inspection information shall be maintained as specified in the appropriate standard. Material shall not be released for production from storage until verification of conformity to specified requirements has been received.

5.1.3. Handling

The organisation shall have a documented procedure for handling materials that prevents them from becoming contaminated.

5.1.4. Delivery

The organisation shall ensure that products are protected up to and including delivery to the customer.

5.2. Control of Monitoring and Measuring Devices

The organisation shall have a documented procedure which ensures that all equipment that is used for processing, measuring and testing is identified, defined and regularly calibrated and maintained in accordance with a prescribed calibration and maintenance programme. The calibration and maintenance programme shall include any contract-specific requirements.

The procedure shall comply with ISO10012-1 to ensure validity of the results of any measuring equipment used, and the basis of the calibration used for verification of results clearly detailed.

Measuring equipment shall be capable of measuring to the required resolution (including contract specific requirements) and shall be of a known and appropriate accuracy.

5.3. Internal Audit

The organisation shall have a documented procedure for the planning, implementing and objective reporting of internal quality audits in order to verify the effectiveness of the quality system.

The internal audit shall:

- a) Verify that quality activities comply with requirements specified in the organisation's quality management system.
- b) Determine the effectiveness of the quality management system.

The results of the audit shall be recorded and shall include:

- a) Objective evidence of audit findings.



- b) Recommendations for corrective and preventive actions.
- c) Verification of corrective and preventive actions.

The results of internal audits shall be included in the management review.

5.4. Monitoring and Measuring of Processes and Product

The organisation shall have a documented procedure that ensures inspection and testing is conducted in accordance with the quality plan, appropriate reference standards and contract specifications.

Records of inspection and test information shall be maintained as specified by the customer and the appropriate standard or specification.

The organisation shall have a documented procedure to ensure that the initial formulation of the product is documented and achieve the final properties required in accordance with Section 6. Initial type testing of the initial formulation shall be recorded.

Changes in formulation must be recorded together with justification and the testing carried out.

5.5. Control of Nonconforming Product

The organisation shall have a documented procedure for processing nonconforming product which shall include:

- a) Adequate product segregation and identification of nonconforming product.
- b) Review of non-conformances and appropriate corrective and preventive action.

5.6. Improvement

The organization shall continually improve the effectiveness of the quality management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review. Corrective action procedures shall provide for dealing with customer complaints relating to product subject to this CARES scheme.

Records of all complaints received and action taken shall be retained.

5.7. Corrective Action

The organisation shall have documented procedures for corrective actions to eliminate the cause and potential cause of nonconformities. The procedures shall include complaints to the organisation and complaints from customers relating to the product, which are subject to this CARES assessment schedule. Records of all complaints and the corrective and preventive action taken shall be maintained.



5.8. Technical Service

When requested by a customer or client, the organisation shall provide technical advice to customers regarding the processing and application of products and operations which are the subject of this schedule where required.

As a minimum, guidance in use of the product shall be provided to ensure the maintenance of properties as detailed in section 6 following, including operating conditions such as (but not limited to) temperature limits in use.

6. PRODUCT REQUIREMENTS

Cement shall comply with AS 3972. Pre-bagged grout materials shall be bagged to an accuracy: $\leq \pm 2\%$ by weight. Grout produced with the pre-bagged grout materials in accordance with the organisations recommendations shall achieve the following properties across the specified temperature range and specified w/c ratio.

Sieve test:	Grout should contain no lumps and be of size $< 2.4\text{mm}$
Fluidity:	Immediately after mixing: Efflux time 15 - 20 s 45 minutes after mixing: Efflux time 15 - 20 s
Bleed:	$< 0.5\%$
Volume change /Expansion:	$\pm 0.5\%$ at 3 hours (Normal QC / surveillance testing) $\pm 0.5\%$ at 24 hours (Qualification test at Initial assessment)
Characteristic strength: (cube strength)	32 MPa at 7 days
w/c ratio:	≤ 0.40

The addition of chlorides or sulfate is not permitted, and the bagged grout should not contain more than:

Cl	$< 0.10\%$ by weight of cement;
SO ³	$< 4.50\%$ by weight of cement;
S ²⁻ ions	$< 0.01\%$.

The addition of gas-forming additives such as aluminium powder is not permitted. Gas-forming additives can produce damaging effects within a tendon, leading to excessive expansion and increased chloride permeability of the grout.

6.1 Product Testing

For the initial approval grout shall be subject to the tests prescribed in 6.1.1 and achieve the requirements in clause 6 above.



The samples to be tested shall be representative of those used in practice. The tests shall either be undertaken by an independent NATA accredited laboratory that is acceptable to CARES or, where appropriate, at the organisation's premises by prior agreement with CARES.

6.1.1 Assessment Test Programme

- a) Sieve test in accordance with Appendix A.
- b) Fluidity; cone test method in accordance with ASTM C939
- c) Bleed and volume change test in accordance with ASTM C940 with modifications for wick test as detailed in Appendix B
- d) Compression strength test in accordance with AS 1478.2 Appendix A.
- e) Density shall be measured in accordance with AS 1012.5

Extent of Assessment Testing

Fluidity, wick-induced bleeding, and density shall be tested for the minimum and maximum temperature of the declared temperature range, and for the reference temperature of $(20 \pm 3) ^\circ\text{C}$. However, if the minimum and maximum are within $15 ^\circ\text{C}$ or less and centred approximately around $20 ^\circ\text{C}$, then testing at the reference temperature of $(20 \pm 3) ^\circ\text{C}$ shall be considered sufficient. Other tests are carried out only at the reference temperature.

Details of the number of tests for the initial assessment test are detailed in table 1 below

6.1.2 Periodic Test Programme

During ongoing production of a particular grout type, periodic audit testing shall be performed at regular intervals to confirm the validity of the results of the assessment testing. Audit testing of grout at the reference temperature of $(20 \pm 3) ^\circ\text{C}$ shall be considered acceptable.

Extent of audit testing

Tests for bleeding and volume change are performed on the same sample.

Tests shall be done at reasonably regular intervals during the year per table 1 below:

Table 1

Property	Test Method	Minimum number of Tests per batch during Assessment testing	Test frequency following initial assessment testing (Number of tests per year)
Homogeneity	Sieve test	1 test per batch	4 per annum
Fluidity	Cone Method per ASTM C939	Batch test: 1 test immediately after mixing, 2 tests 45 min after mixing	4 batch tests per annum
Bleeding	Wick Induced – See Appendix B	3 per batch	3 per batch, 6 times per annum
Volume Change/Expansion	Wick Induced – See Appendix B	3 per batch	3 per batch, 6 times per annum
Compressive Strength	Cubes	3 per batch	3 per batch, 4 times per annum
Density	Weight to volume	1 test immediately after mixing	1 test immediately after mixing, 4 times per annum



7. NORMATIVE REFERENCES

The following standards are relevant to the application of this scheme document.

Unless agreed otherwise during the application process, the latest version of the product or management system standards will apply. The applicable standard and date shall be stated in the CARES product and/or management system certificate published on the CARES website.

AS/NZS ISO 9001: 2016 Quality Management Systems – Requirements.

ISO10012-1: 2003: Quality assurance requirements for measuring equipment.

CARES Model Specification Australia for Bonded Post-tensioned Floors

AS 3972:2010: Portland and blended cements Standards Australia.

AS 1478.1:2000 Chemical admixtures for concrete, mortar and grout – Admixtures for concrete Standards Australia.

AS 1478.2:2005 Chemical admixtures for concrete, mortar and grout – Methods Admixtures for concrete Standards Australia.

AS 1012.5: 2014 Methods of testing concrete Determination of mass per unit volume of freshly mixed concrete

ASTM C940: 2016 Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory

ASTM C939: 2016 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)

Concrete Institute of Australia: Recommended Practise for Grouting of Prestressing decks (2007)



APPENDIX A – SIEVE TEST

This test method is based on the requirements of ASTM C939

Principle of test

The test consists of pouring a quantity of grout mixed with water to the prescribed ratio through a sieve to check for the absence of lumps on the sieve

Apparatus

A 150 mm diameter sieve with an aperture of 2.4 mm.

Test Procedure

Pour a minimum of 1 litre of freshly mixed grout through the sieve.

This may be carried out while filling the fluidity test cone as detailed in Appendix B.

Reporting

Report the absence of lumps on the sieve.



APPENDIX B – VOLUME CHANGE / BLEED – WICK-INDUCED TEST METHOD.

This following test method is a modified version of ASTM C940-2016

Principle of test

This test provides both volume change and bleeding measurements. Bleeding is measured as the volume of water remaining on the surface of the grout which has been allowed to stand protected from evaporation.

The volume change is measured as a difference in percentage of the volume of grout between the start and the end of the test. The test measures mainly the volume change caused by sedimentation or expansion.

Equipment

As detailed in ASTM C940-2016 with the addition of:

- approximately 1000 mm of 15.2mm, 7-wire strand
- a method by which to centralise the strand in the cylinder.

Procedure

Modify the test method to simulate wicking of strands as follows:

Cut a 1000 mm long piece of 15.2 mm, 7-wire prestressing strand.

Wrap the strand with 50 mm wide duct or electrical tape at each end prior to cutting to avoid splaying of the wires when it is cut.

Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before temperature conditioning.

Insert the piece of strand vertically and centrally into the grout cylinder using a centraliser and secure in position.

Introduce the grout into the graduated cylinder as per the test method.

Take readings as per the test method.

Reporting of results

Report the bleeding and expansion as detailed in ASTM C940-2016