

**Solid Concrete Masonry
Brick/Unit
Quality Control/Quality Assurance Program**



January 13, 2014

A joint effort of the
North Carolina Department of Transportation
and the
Carolinas Concrete Masonry Association

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I. GENERAL DESCRIPTION

The Solid Concrete Masonry Brick/Unit (CMU) Quality Control/Quality Assurance Program is designed to give producers more responsibility for controlling the quality of material they produce and to utilize the quality control information they provide in the acceptance process by the North Carolina Department of Transportation (NCDOT). It requires producers to perform quality control sampling, testing and record keeping on materials they ship for use by the Department. Also, it requires the Department to perform quality assurance sampling, testing and record keeping confirming the performance of the producers / controlling plan as set forth herein.

The types of samples and the lot sized required will be described in detail later in this document.

It is the intent of this program that acceptance or rejection of material be based on the total program. Therefore, comparison of the Quality Control, Quality Assurance and other sample data may be used by the Department for acceptance or rejection of a lot of material.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the *NCDOT Standard Specifications for Roads and Structures*.

II. PROGRAM REQUIREMENTS

A. Basic Requirements- There are three basic requirements for approval:

- The plant must have an approved in-house quality control plan.
- The plant must have an approved laboratory or have written approval to utilize an approved laboratory at another location.
- The plant must have a qualified quality control individual approved by the Department.

B. Quality Control Plan- The Producer must prepare a written quality control plan. The plan may be generic, but must be site specific. The plan must indicate in detail how the Producer proposes to control the equipment, materials and production methods to insure that the specified products are obtained. The plan must list the personnel responsible for production and quality control at the site and include information on how to contact each person. The following specific information must also be included in the plan:

- Identification of the physical location of the plant, to include a description of the property site and reference to the nearest identifiable points such as highways and towns.
- The method of identification of each lot of material during manufacture, testing, storage and shipment, including identifying it as intended for NCDOT usage.
- The method of sampling and testing raw materials and the finished product, including lot sizes and test performed.
- A plan for dealing with quality control sample failures. This plan must include how the Producer plans to initiate an immediate investigation and how the Producer will implement corrective action to remedy the cause of the problem. A description of the method used to insure that products not meeting Department specifications are not shipped to the Department projects and shall also be included.
- A loading and shipping control plan, which includes a description of the method by which the products are to be loaded and shipped for use by the Department, including safeguards against loading non-specification material. The plan must also include methods of insuring that all products are accurately identified.

Two copies of the Producer's written quality control plan signed by the Plant Manager and an executed Brand Registration and Guarantee must be submitted with the original request for plant approval. Two copies of an updated Plant QC plan must be submitted when changes are made to the plant's operations or ownership. A copy of the Plant's Ownership Update Form and Brand registration and Guarantee must be submitted by June 30th of each year.

- C. Approved Laboratory-** The Program requires all tests to be conducted at laboratories approved by the Department. Each source may establish and maintain its own laboratory for the performance of quality control testing, or the NCDOT will consider a producer's request to utilize an approved laboratory at another location. The producer must make this request in writing and have written the Department approval before testing material off site. The equipment required for an approved laboratory shall be sufficient to perform the required test procedures referenced by the ASTM specifications listed in Section 1040-1, 1040-2 and 1040-3 of the *NCDOT Standard Specification for Road and Structures*. Records on instrument calibration and maintenance and sample collection and analysis must be maintained at the laboratory. The Department may require a demonstration of the equipment and procedures.
- D. Quality Control Individual-** All samples must be taken and tested by quality control individuals approved by the NCDOT. The Producer must designate and identify the quality control individuals responsible at each plant. The designated QC individuals will be responsible for overall Quality Control at the plant. The The Department may require a demonstration of the equipment and procedures used by the individual.
- E. Plant Approval Process-** The approval process requires the Producer to write the State Materials Engineer at NCDOT, Materials and Tests Unit, 1801 Blue Ridge Road, Raleigh NC 27607, requesting that the plant be considered for acceptance in to the program. It must identify the specific products that are to be produced. Two copies of the Producer's written quality control plan signed by the Plant Manger must be submitted with the request for approval.

The Department will review the Producer's written quality control plan and if it is approved an on-site inspection will be scheduled. This on-site inspection will verify that the Producer's quality control plan has been implemented and is being followed and that at least one qualified quality control individual is on site and will be present when material is being produced or shipped under this program. The laboratory will be inspected and approved if it meets the requirements and has not already been approved. If either the Producer's quality control plan or laboratory does not meet the Department requirements, the Producer will be informed of the deficiencies in writing. Once the deficiencies have been addressed, the Producer may again request approval in writing to the State Materials Engineer.

- F. Certification for Participation in the QC/QA Program-** If the Department has approved the Producer's written quality control plan and the on-site inspection confirms that the initial program requirements have been met; THE Department will issue a certificate, valid for one year, certifying the plant for participation in the program. At the end of the year, upon receipt of a Plant Ownership update

Form and an executed Brand Registration and Guarantee, The Department will conduct another on-site inspection and if all requirements are continuing to be met, the plant will be recertified for participation in the program for another year. Random inspections may be conducted at any time by The Department to verify compliance with the program requirements.

- G. Notification of Production of Materials for use by the Department-** The Producer shall notify the Department when production of material for use by the DEPARTMENT is scheduled. This notification shall be made by telephone, facsimile, or by electronic mail. The notification shall be made to the Section Materials Specialist assigned to the plant. Manufacture of products for the DEPARTMENT may commence as soon as the notification is made. The telephone numbers and electronic mail address for the Section Materials Specialists are given in Exhibit C.
- H. Identification of QC/QA Products-** The Producer will identify each cube of brick or masonry unit with a label. The label shall have as a minimum, the following information: company name, plant name and NCDOT number, date of manufacture and QC lot number. A sample label shall be submitted with the Plant Ownership Update Form. The CMUs are to be tinted pink.

III. SAMPLING AND TESTING PROCEDURES

- A. Producer's Quality Control-** The Producer's Quality Control (QC) samples are used by the Producer to monitor the quality of material being produced.
1. **Standard Specifications-** The Producer is to perform all sampling and testing in accordance with current specification and procedures referenced in the *NCDOT Standard Specifications Road and Structures*.
 2. **Lot Size-** Quality Control lot sizes for 16" solid CMUs will be a plant run, or 100,000 units, whichever occurs first. Quality Control lot sizes for 8" solid CMUs shall be plant run, or 300,000 units, whichever occurs first.
 3. **Sampling-** The approval plant quality control individual is to obtain a sample from each lot. QC samples will consist of one sample per lot. The sample will consist of a minimum of ten units with the units randomly taken at a rate of two units per hour of production. Each unit will be marked with the time or day that it was samples. One unit from each hour of production will be used by the Producer; the other unit from that hour will be retained for use by the Department.
 4. **Check Samples-** If the test results for a sample indicate the material does not meet the specification requirements; a sample is to be immediately obtained by the Producer. Check samples are to be twice the number and taken in the same manner as the original samples. The samples are to be clearly identified and shared with one half tested by the Producer and the other half provided to the Department.

If the check sample indicated the material meets the specification requirements, the Producer is to record on the test report form what is felt to be the reason for the original failure and then may resume normal testing procedures.

If the check sample indicated the material does not meet the specification requirements, the Producer is to initiate an investigation to determine the cause of the failure. The investigation is to include a review of the sampling procedures, the equipment used in the production and the testing of the material and the testing procedures for the individual. If the cause can be attributed to one of the above categories, the Producer is to take corrective action to bring the material, equipment or procedure into compliance. The Producer is to then record the corrective action on the test report form and take another check sample after the corrections have been made.

If the investigation into the cause of the failure of the first check sample cannot be attributed to one of the above reasons, the Producer is to notify the Department, obtain a second check sample and continue the investigation into these failures and work with the Department to determine the cause of the failure.

If the second check sample indicates the material meets the specification requirements, the Producer may resume normal testing procedures.

If the second check sample indicates the material does not meet the specification requirements, the Producer is to notify the Department and stop the shipment of material. The Producer is to continue the investigation into these failures and work with the Department to determine the cause.

5. **Test Procedures-** Required test procedures shall be those required to meet the ASTM specifications referenced in Sections 1040-1, 1040-2 and 1040-3 of the *NCDOT Standard Specifications for Roads and Structures* except that concrete brick and masonry units shall be tinted red.
6. **Sample Identification and Record Keeping-** It is critical that care be taken to properly label samples and record test data accurately.

Producer's Quality Control samples are to be identified with consecutive numbers: QC-1, QC-2, etc. The samples are to be numbered consecutively for the entire calendar year.

All Quality Control test results are to be entered on an approved Quality Control Test Summary Form. The form shall indicate that Quality Control sample number, type and quantity of material represented by the sample.

Quality Control and Quality Assurance data is to be retained by the Producer for at least one year and made available to the Department upon request.

After a QC Test Summary Form is completely filled with data, a copy is to be given to the NCDOT Materials Inspector and the Producer is to retain the original. At such time when it becomes possible for the Producer to transmit data directly into the Department's computerized database, or when the volume of QC tests does not result in at least one completely filled form per month, copies of these summaries are to be provided to the Department at a minimum frequency of once per month.

- B. NCDOT's Quality Assurance-** the Department's Quality Assurance (QA) samples are used by the Department to verify the performance of the Producer's quality control plan.
1. **Standard Specifications-** the Department shall perform all sampling and testing in accordance with current specification and procedures referenced in the *NCDOT Standard Specifications for Roads and Structures*.

2. **Lot Size**- Quality Assurance lot sizes for 16” solid CMUs will be a maximum of 500,000 units or fraction thereof. Quality Assurance lot sizes for 8” solid CMUs shall be a maximum of 1,500,000 units, or fraction thereof.
3. **Sampling**- the Department’s Quality Assurance samples are to be taken randomly from each lot and tested by the Materials and Tests Unit. QA samples will consist of one sample per lot. The sample will consist of ten 8” CMUs for regular and jumbo and five 16” CMUs.
4. **OC/OA Comparison**- If the results of the Quality Assurance sample are not in agreement with the results of the corresponding Quality Control sample, i.e. greater than five percent difference, and investigation will include a review of the sampling and testing procedures and the testing equipment. The results of the investigation will be recorded on the Plant Quality Assurance Form.
5. **Resolution System**- In the event the above referenced investigation does not resolve the difference and the results of the next Quality Assurance sample are not in agreement with the corresponding Quality Control sample, a resolution system will be employed. The resolution system will require that two additional samples be taken from the same location in the stockpile and in the same manner that the original Quality Control samples were taken by the approved plant individual. The samples are to be twice the number of the original samples. The samples are to be taken by NCDOT Materials and Tests Unit personnel and are to be shared, with one half to be tested by the Producer and the other half taken by the Department to be tested at its facility. The average test results of the two Quality Control samples and the average test results of the two Quality Assurance samples are to be within the appropriate specification limits and the comparison of the two averages is to be within five percent of each other. If these results are not within the appropriate specification limits and the comparison of the average test results is not within five percent, the material will be rejected. If rejected, the material is to be disposed of in a manner approved by the Department.

If test results indicate that the material is within the specification requirements, but the comparison of the Quality Control samples and the Quality Assurance samples are not within five percent, the material will be accepted for use. However, the Producer, with the assistance of the Department, must determine the cause of the differences in test results. If the cause is determined to be improper sampling or testing procedures by the Producer or the Department, the appropriate approved individual will be notified. If the problem continues, the individual’s approval will be revoked. If the cause is determined to be in the Producer’s testing equipment or handling of the material, the Producer is to take corrective action. If this problem continues, the Producer’s approval to provide material to Department may be revoked. If the cause is determined to be in the Department’s testing equipment, the Department will take corrective action.

6. **Sample Identification and Record Keeping**- It is critical that care be taken to properly label samples and record test data accurately.

The Quality Assurance samples are to be numbered with a number corresponding to the appropriate Quality Control sample. The number following “QA” is the number of the corresponding Quality Control split samples, QA-1, QA-6, etc.

- C. **Independent Assurance**- Independent Assurance (IA) samples are to be taken at least annually from each production site by a representative of the Materials and Tests Unit.

IV. APPENDIX

Exhibit A

Sampling Procedures

I. Introduction

In order to reduce the number of variables that affect the correlation between, it is important that all samples be obtained following procedures outlined in the *Standard Specifications*, or as outlined in this program.

II. Sampling Procedures

The Designated Quality Control Individual will obtain Quality Control Samples by randomly selecting CMUs from the finished product line prior to placement of the CMUs in the designated storage area. The Designated Quality Control Individual shall obtain twenty CMUs for testing purposes. These samples shall be taken randomly in pairs at the rate of no less than two units per hour of production. Each unit will be marked with the time or day that it was sampled. Ten 8" CMUs (regular and jumbo) and five 16" CMUs will be tested for compliance, the remaining samples will be held for check sampling by the plant if necessary or for testing by the Department. The units selected for compliance testing shall consist of one CMU from any pair.

The samples will be labeled appropriately and transported to an NCDOT approved testing laboratory.

III. Sample Retention

Samples taken by the Designated Quality Control Individual that are not used for testing will be retained for at least three months before being discarded.

Exhibit B

Quality Control Test Form

**State of North Carolina
Department of Transportation – Materials and Tests Unit
Raleigh, North Carolina**

Producer's CMU Quality Control Test Summary

Laboratory Number:		Date Sampled:	
Report on sample of:		Date Received:	
Sampled by:		Date Reported:	
Sample taken from:		Furnished by:	
Quantity Represented:		Location of supply:	
Testing Laboratory:			
Address:			

Number	Length (in.)	Width (in.)	Thickness (in.)	P.S.I.
Average				

Number	Length (in.)	Width(in.)	Thickness (in.)	Density	Abs. (#/ft. ³)
Average					

Remarks:	

QC Individual _____

Exhibit C

Contract Information for Notification Prior to Production of NCDOT Products

Prior to manufacturing CMUs for NCDOT use, the Producer shall contact the local Section Materials Specialist assigned to the plant. Manufacture of products for the DEPARTMENT may commence as soon as the notification is made.

Section Materials Specialists

Name	DOT Divisions/Office Location	Phone number/email
Maria Long	Divisions 1 Williamston	(252)792-7627 mlong@ncdot.gov
Milton Rudd	Divisions 2 Wilmington	(910) 371-6964 mrudd@ncdot.gov
Dan Allen	Division 3 Wilmington	(910) 371-6964 dallen@ncdot.gov
Bobby Watkins	Division 4 Wilson	(252) 296-3576 bwatkins@ncdot.gov
Darrell Lumley	Division 5 Raleigh	(919) 329-4221 dlumley@ncdot.gov
Guy Christian	Division 6 Fayetteville	(910) 485-7196 gchristian@ncdot.gov
Robert Fosque	Division 7 Greensboro	(336) 993-2300 rfosque@ncdot.gov
Rusty Tucker	Division 8 Asheboro	(980) 521-9039 rtucker@ncdot.gov
Sandra Potts	Divisions 9 Salisbury	(704) 636-3367 spotts@ncdot.gov
Mark Thomas	Division 10 Matthews	(704) 847-1314 mthomas@ncdot.gov
Tracy Church	Divisions 11 North Wilkesboro	(336) 903-9105 tchurch@ncdot.gov
Charles Bullock	Division 12 Shelby	(704) 480-5472 cbullock@ncdot.gov
Rob Rhymer	Division 13 Asheville	(828) 299-1498 rrhymer@ncdot.gov
Dean M. Wood	Division 14 Franklin	(828) 349-1732 dmwood@ncdot.gov

Cabell W. Garbee, II, PE Field Operations Engineer (919) 329-4224 cgarbee@ncdot.gov	Sam Frederick Quality Systems Engineer (919) 329-8495 sjfrederick@ncdot.gov	Daniel I Miller, PE Quality Assurance Engineer (919) 329-8495 dimiller@ncdot.gov
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Exhibit D

Sample Brand Registration and Guarantee

Each plant will submit copies of an annual brand registration and guarantee prior to Dec. 31, of each calendar year to the Quality Systems Engineer.

(COMPANY NAME)
(COMPANY ADDRESS)
(COMPANY TELEPHONE NUMBER)

**BRAND REGISTRATION AND GUARANTEE
FOR SOLID CONCRETE MASONRY BRICK AND BLOCK MATERIALS**

This guarantee verifies that solid concrete masonry brick and block furnished by (COMPANY NAME) conforms to the requirements of the Solid Concrete Masonry Brick/Unit Quality Control/Quality Assurance Program and the NCDOT Standard Specification, for the material specified in the contract or purchase order.

Any material found not in conformance will be replaced at no cost to the North Carolina Department of Transportation.

DATE: _____ BY: _____
NOTARY: _____

Exhibit E

Plant Ownership Update Form

Name of Company: _____

Corporate Address and Contact Information:

Street:		
Street:		
City:	State:	Zip:
Telephone:	Fax:	
Email:		
Name and Title of Contact:		

Name of Facility: _____

NCDOT Facility Number: BB _____

Facility Mailing Address and Contact Information:

Street:		
Street:		
City:	State:	Zip:
Telephone:	Fax:	
Telephone:		
Email:		
Name and Title of Contact:		

Facility Physical Address:		
Street:		
Street:		
City:	State:	Zip:
Driving Directions from Major Landmark:		

Plant Personnel Responsible for Quality:

Name	Title	Cert. Number
1.)		
2.)		
3.)		
4.)		
5.)		

The Quality Control Plan for this facility HAS been revised since it was NCDOT Approved?

YES NO

If YES, attach copy of current Quality Control Plan to this document and submit for review.

I certify that the foregoing entries are correct.

Signature: _____

Title: _____

Date: _____

*List NCDOT assigned Technician Certification Number if applicable.

Exhibit F

Testing Procedures

Test all CMUs in accordance with ASTM C140.

The option to cut the larger CMU block that is given in the specification will be taken. The block will be cut in half. One half is to be tested for absorption and the other half is to be tested for compressive strength.

For absorption, test in accordance with ASTM C140.

For compressive strength, test in accordance with ASTM C140.

The CMU will be air dried for 48 hours before capping.



Picture 1. 2"x4"x8", 4"x4"x8", 4"x8"x16" CMUs, all dimensions are nominal

(Note: Regular CMU shown is cut from 16" CMU, finish surface shall be the same as the other CMUs)

Exhibit G

Solid CMU Plant Monitor Report

Date:		
Plant Name/Number:		
Plant Owner:		
Location:		
Inspected By:		
Plant Manger		On Site (Y/N)
QC Individual		On Site (Y/N)

Raw Materials:

Material	Producer/Source	Approved Source?	Cert/Test Rept

Raw Material Storage/Handling (list methods, irregularities, etc.):

IA Product Sample (ten pieces each for 8” CMUs, five pieces for 16” CMUs)

Size	HiCams Number	Result (P/F) (Dimension, Strength, Absorption)
Item	Satisfactory (Y/N)	Note:
Sampling Rate		
Sampling Location		
Sampling Method		
Sampling by QC Indiv.		
Sample Disposition		
Corrective Action Taken?		
Non-Shipment of Bad Mat.		
Labeling of Shipment		
Method of Shipment		
Haul Unit Inspection		
Product ID on truck		
Product Color		

Exhibit H

Solid Concrete Masonry Laboratory Monitor Report

Date:	
Lab: Name/Number:	
Lab Owner:	
Location:	
Inspected By:	
Lab Manager	On Site (Y/N)
Technician	On Site (Y/N)
Technician	On Site (Y/N)
Lab certifications by other Agencies? List:	

Internal Quality Management at the Lab:

Item	Satisfactory (Y/N)	Note:
Accreditation? (agency)		
Round Robin Sampling?		
Technician Certification?		
Rating		
Equipment		
Scale		
Caliper		
Compression Machine		
Bearing Blocks		
Bearing Plates		
Sample Storage		
Capping Material		
Capping Surface		
Balance		
Suspension Apparatus		
Other		

Note: see ASTM C140 for equipment/procedure description, also ASTM C1093 for lab QSM.