

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

January 2, 2025

A joint effort of the
North Carolina Department of Transportation
and the
Carolinan 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 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 ensure that products not meeting Department specifications are not shipped to NCDOT projects 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 ensuring all products are accurately identified.

A copy 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. A copy 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 Specifications for Roads 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 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 request the plant be considered for acceptance into the B&B program. The request shall be submitted to the NCDOT State Materials Engineer via email to: facility.updates@ncdot.gov. Plants must identify the specific products that are to be produced. Two copies of the Producer's written quality control plan signed by the Plant Manager 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. The 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 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

After approval of the Producer's written quality control plan and on-site inspection confirms initial program requirements have been met, NCDOT 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, NCDOT will conduct another on-site inspection and if all requirements are 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 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 NCDOT is scheduled. This notification shall be made to the Concrete Products Engineer and the Materials & Tests Inspectors assigned to the plant. The notification shall include a product technical detail sheet of the product(s) to be manufactured. Manufacture of products for NCDOT may commence as soon as the notification is made. The e-mail address for the Concrete Products Engineer and M&T inspectors are noted in *Appendix 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, 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 for Roads 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 sampled. 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 test results for a sample indicate the material does not meet the specification requirements, another 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; one half tested by the Producer and the other half provided to NCDOT.

If the check sample indicates 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 indicates 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 must notify NCDOT, 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 must notify NCDOT 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, email a copy to the NCDOT at BBandSRW@ncdot.gov, 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. Submit forms to BBandSRW@ncdot.gov.

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. **QC/QA 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 referenced in *Appendix B*.
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 NCDOT.

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 NCDOT, 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 NCDOT 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.

APPENDICES

Appendix 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 for Roads and Structures*, 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.

Appendix 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 _____

Appendix C

Contract Information for Notification Prior to Production of NCDOT Products

Prior to manufacturing Solid Concrete Brick and Block for NCDOT use, the Producer shall contact the Materials and Tests Unit. Manufacture of products for NCDOT may commence as soon as the notification is made.

General contact information should be addressed to: BBandSRW@ncdot.gov

The required annual updates, certifications and QC Plan should be submitted to:
Facility.Updates@ncdot.gov

Appendix D

Sample Brand Registration and Guarantee

Each plant will submit copies of an annual brand registration and guarantee prior to June. 31, of each calendar year to Materials & Tests at Facility.Updates@ncdot.gov.

(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: _____

Appendix E

**NCDOT Materials & Tests Unit
Sample Brick & Block Facility Ownership Update**

Facility Information

NCDOT Facility Number: _____ Date: _____
Name Of Facility: _____
Name And Title Of On-Site Contact: _____
Facility Physical Address: _____
City: _____ State: _____ Zip: _____
County: _____
Phone: _____ Fax: _____
Email Of On-Site Contact: _____
Comments: _____

Main Office

Name Of Company: _____
Owner Of Company: _____
Address: _____
City: _____ State: _____
Zip: _____ County: _____
Phone: _____ Fax: _____
Comments: _____

Facility Personnel Responsible for Quality:

Name:	_____	Title:	_____
Name:	_____	Title:	_____
Name:	_____	Title:	_____

I certify that the foregoing entries are correct

Representative: _____

Date: _____

Appendix 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)

Appendix 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		

Appendix 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.

Appendix I

**North Carolina Department of Transportation
Materials & Tests Unit
Sample Brick & Block Annual Facility Audit Checklist**

M&T Technician: _____ **Division:** _____ **Date:** _____

Facility Owner: _____ **Facility Number and Location:** _____

The following steps are to be performed during the annual plant inspections unless noted.

<u>Pass</u>	<u>Fail</u>	<u>Documentation</u>
_____	_____	Current Brand Registration is on-site
_____	_____	Ownership facility update form is complete and on site
_____	_____	Current in-house quality control plan is available
_____	_____	Facility has an approved laboratory
_____	_____	Facility has a qualified and approved (active status) Quality Control Technician on-site
_____	_____	Approved materials (cement, fly ash, aggregate, admixtures) per approved mix designs
_____	_____	Storage of raw materials meets specification
_____	_____	Facility is in compliance with their QC plan
_____	_____	Sample submittal/result documentation is complete per NCDOT/M&T policy
_____	_____	Facility yard walk through – note failures/discrepancies in comments section
_____	_____	Color of product meets NCDOT/M&T policy

Comments: _____

Samples Obtained

SAMPLE	SAMPLE TAKEN FROM	HiCAMS #	COMMENTS
8" CMU			10 pieces required (2"x4"x8" or 4"x4"x8")
16" CMU			5 pieces required (4"x8"x16")

Facility Personnel Responsible for Quality

NAME	TITLE	CERT. NO.

M&T Representative: _____ **Title:** _____

Appendix J

**North Carolina Department of Transportation
Materials & Tests Unit
Sample Brick & Block Annual Laboratory Audit Checklist**

M&T Technician: _____ **Division:** _____ **Date:** _____

Facility Owner: _____ **Facility Number and Location:** _____

The following steps are to be performed during the annual laboratory inspections unless noted.

<u>Pass</u>	<u>Fail</u>	Documentation
_____	_____	Ownership facility update form is complete and on site
_____	_____	Current in-house quality control plan is available
_____	_____	Facility has a qualified and approved (active status) Quality Control Technician on-site
_____	_____	All equipment is currently calibrated, and calibration is performed a minimum of once per year
_____	_____	Sampling frequency meets NCDOT standards and policies
_____	_____	Testing procedures meet NCDOT standards and policies
_____	_____	Laboratory is in compliance with their QC plan
_____	_____	Sample submittal/result documentation is complete per NCDOT/M&T policy
_____	_____	Laboratory walk through – note failures/discrepancies in comments section

Comments: _____

Laboratory Location

Facility Name: _____

Facility Address: _____

Facility City/State/Zip Code: _____

Facility Personnel Responsible for Quality

NAME	TITLE	CERT. NO.

Laboratory Walk Through Verification

Item	Satisfactory (Y/N)	Note:
Accreditation? (agency)		
Equipment		
scale		
caliper		
compression machine		
bearing blocks		
bearing plates		
sample storage		
capping material		
capping surface		
balance		
suspension apparatus		
other		

M&T Representative: _____ **Title:** _____