

**HDPE Pipe  
Quality Control/Quality Assurance  
Program**

**February 3, 2002**

A joint effort of the  
**North Carolina Department of Transportation**  
and  
**Members of the Corrugated Polyethylene Pipe Association**

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## Revisions

## I GENERAL DESCRIPTION

The HDPE 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 NCDOT. Also, it requires the NCDOT to perform quality assurance sampling, testing and record keeping to confirm the performance of the producers' control plan as set forth herein.

The types of samples and the lot sizes 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, a comparison of the Quality Control, Quality Assurance, and other sample data may be used by the NCDOT 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.
- The plant must have a qualified quality control technician 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 of raw materials and of the finished product, including lot sizes and type of tests performed as well as a description of equipment modifications, or equipment developed in-house to perform tests.
- 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. This plan must also include the tests run, the method used to determine what tests are run, and the person responsible for making the determination.
- A loading and shipping control plan which includes a description of the methods by which the products are to be loaded and shipped for use by NCDOT, including safeguards against loading non-specification material. The plan must also include methods of insuring that all products are accurately identified.

C. **Approved Laboratory** - The Program requires all tests to be conducted at laboratories approved by the NCDOT. 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. The Producer must make this request in writing and have written NCDOT 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 applicable specifications and standards such as AASHTO M-252 and M-294. Records on instrument

calibration and maintenance and sample collection and analysis must be maintained at the laboratory. NCDOT may require a demonstration of the equipment and procedures.

**D. Quality Control Technician** - All samples must be taken and tested by quality control technicians approved by NCDOT. The Producer must designate and identify the quality control technicians responsible at each plant. The designated QC technicians will be responsible for overall Quality Control at the plant. The NCDOT may require a demonstration of the equipment and procedures used by the technician.

**E. Annual Guarantee and Registration** - An annual guarantee and registration will be required. Any pipe found not to meet the specification requirements will be replaced by the Producer with no cost to the Department. The annual guarantee and registration must be submitted by December 31<sup>st</sup> of each calendar year.

**F. Plant Approval Process** - The approval process requires the Producer to write the State Materials Engineer at NCDOT, 1801 Blue Ridge Road, Raleigh, NC 27607, requesting the plant be considered for acceptance into the program. It must identify the specific products that are to be produced. Two copies of the Producer's written quality control plan must be submitted with the request for approval. A copy of the annual guarantee and registration must be submitted with the request.

The NCDOT 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 technician is on site and will be present when material is being produced 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 do not meet NCDOT 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.

**G. Certification for Participation in the QC/QA Program** - If the NCDOT has approved the Producer's written quality control plan and the on-site inspection confirms that the 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, and each subsequent year, NCDOT will conduct another on-site inspection after receipt of the annual guarantee and registration, and if all requirements are continuing to be met, the plant will be rectified for participation in the program for another year. Random inspections may be conducted at any time by NCDOT to verify compliance with the program requirements. Failure to perform all of the program requirements may result in a producer being removed from the Program.

### III SAMPLING AND TESTING PROCEDURES

**A. Producers' Quality Control** - The Producer's Quality Control (QC) samples are used by the Producer to monitor the quality of material being produced and shipped.

Standard Specifications - The Producer is to perform all sampling and testing in accordance with current specifications and procedures referenced in the *NCDOT Standard Specifications for Roads and Structures*.

Comparison Testing - Samples of materials and pipe taken by the NCDOT during plant visits shall be split with half of the sample being tested by the Producer and half of the sample tested by the Department.

#### Pre-production

1. Incoming material evaluations shall be performed on all polyethylene resins that may be used for the production of NCDOT pipe. The incoming material evaluations shall consist of a minimum density and melt index test on each lot of polyethylene resin.
2. A lot is defined as the portion of a shipment (railcar or truckload) of polyethylene resin which has been certified by the supplier.
3. In the event a shipment (railcar or truckload) has more than one lot of polyethylene resin and corresponding supplier certifications, then a material evaluation would be required for each.
4. The sample of incoming material shall be taken before the material is removed from the transport vehicle.

#### During production

1. Material evaluations shall be performed on all polyethylene resins used for the production of NCDOT pipe. The material evaluations shall consist of a minimum density and melt index test on each lot of polyethylene resin. Samples will be taken from the last access point before the material is incorporated into pipe
2. The Producer shall conduct continuous visual inspections on the exterior and interior wall for bonding, blowouts, and for workmanship items as described in AASHTO M252 and M294, continuously during production.

#### Post production

1. A lot shall be defined as the amount of pipe manufactured per type per diameter per machine per day.

2. A representative piece of pipe shall be randomly selected from each lot defined above for testing. The pipe shall be cut into lengths for testing according to the appropriate specification for the size of pipe and the tests to be performed.
3. A brittleness test shall be conducted in accordance with the requirements specified in AASHTO M 252 or M294; whichever is applicable to the pipe being tested.
4. Unit weight shall be performed
5. Wall thickness measurements for uniformity shall be performed. This shall be performed with an approved measuring device such as calipers or micrometers or in accordance with ASTM D 2122.
6. Melt Index, and Density will be performed on the finished product when a piece is rejected because of defects that are suspected of being related to material properties. The bad pipe will be ground up and the test performed on the material as a verification check or as a step in problem resolution. These tests may not have to be performed if it is determined that the defects are caused by mechanical problems in production.
7. A final visual inspection shall be performed on the finished pipe.

Check Samples - If the test results for a sample indicate the material or pipe does not meet the specification requirements, a check sample is to be immediately obtained by the Producer. Check samples are to be the same size and taken in the same manner as the original sample. The samples are to be clearly identified and split with one half tested by the Producer and the other half provided to the NCDOT.

If the check sample indicates the material or pipe meets the specification requirements, the Producer is to record 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 or pipe 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 of the technician. 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 second check sample indicates the material or pipe meets the specification requirements, the Producer may resume normal testing procedures.

If the second check sample indicates the material or pipe does not meet the specification requirements, the Producer is to notify the NCDOT and stop the shipment of the affected

pipe. The Producer is to continue the investigation into these failures and work with the NCDOT to determine the cause.

#### Notification of Product Failure

1. The producer will notify the Department immediately of any test failures on pipe that has been shipped to a NCDOT project or Maintenance Facility or that cannot be resolved by the producer.
2. The Producer will segregate and scrap any material that does not comply with AASHTO specifications. In that event, no notification of test failures will be required.

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

1. Producer's Quality Control samples are to be identified with consecutive numbers. QC-1, QC-2, etc. for the entire calendar year. Producer QC Sample number series shall be maintained for each resin sampling location and for each individual size and type of pipe produced.
2. Quality Control and Quality Assurance data is to be retained by the Producer for at least two years and made available to the NCDOT upon request.
3. Quality Control test reports shall include the lot identification.
4. Test reports do not have to be filed for specific projects.
5. Test reports shall indicate the action taken to resolve resin or product failures.
6. Test reports on finished pipe shall be traceable to the original resin supplier's certification for the resin used to manufacture the pipe and shall include all internal quality control tests performed on the material.

**B. NCDOT's Quality Assurance** - The NCDOT's Quality Assurance (QA) samples are used by the NCDOT to verify the performance of the Producer's quality control plan.

Standard Specifications - The NCDOT shall perform all sampling and testing in accordance with current specifications and procedures referenced in the *NCDOT Standard Specifications for Roads and Structures*.

Lot Sizes - Quality Assurance lot sizes for finished pipe will be a maximum of 20,000LF for each size of pipe produced.

Comparison Testing - Samples of materials and pipe taken by the NCDOT during plant visits or distribution yards shall be split with half of the sample being tested by the Producer and half

of the sample tested by the Department. Samples of pipe taken by the NCDOT will also be compared to the Producer's QC Samples previously taken from the same lot.

1. NCDOT will sample incoming material during plant visits in order to evaluate polyethylene resins used for the production of pipe. The evaluations shall consist of a minimum density and melt index test on a lot of polyethylene resin. The material sampled does not have to be material that is to be incorporated into pipe produced for the NCDOT. Samples will be taken from the last access point before the material is incorporated into pipe. A minimum of two quarts of material will be removed from the access point and will be split into two equal portions. One portion will be given to the Producer for use as a QC Sample; the other portion will be used by the Department as a QA Sample.
2. NCDOT samples taken during plant or distribution yard visits will be tested for brittleness, elongation, flexibility, stiffness, and flattening. These samples will be split, with the Producer performing the same tests for comparison.
3. NCDOT QA Samples of pipe shall be taken by randomly selecting a representative piece of pipe from each QA Lot defined above for testing. The pipe shall be cut into lengths for testing according to the appropriate specification for the size of pipe and the tests to be performed. The pipe section is to be cut into as many test sections as is practical. Alternate tests sections cut from the length of pipe will be retained by the Producer for use as a QC Sample.
4. The QC Sample obtained by the Producer from the split QC/QA Samples pairs taken during a NCDOT visit shall be numbered as the next QC Sample for the material.

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

1. NCDOT's Quality Assurance samples are to be identified with the corresponding Quality Control sample number assigned by the Producer's representative. The QA Sample number shall be in the form of QA-1, QA-3, QA-8, etc. QA Sample test reports shall include the Producer's lot identification and the number of the corresponding Quality Control test.

**C. Quality Control/Quality Assurance comparison** - The Producer's Quality Control samples and the corresponding NCDOT's Quality Assurance samples will be compared to verify the performance of the sampling and testing procedures and results.

**QC/QA Comparison** - If the results of the Quality Assurance sample are not in agreement with the results of the corresponding Quality Control sample an investigation will be made to determine the source of the difference. The 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. The investigation will be performed when the reported values for a test are greater than the ranges listed below.

QC/QA Comparison Ranges

- Density 3% (ASTM D1505)
- Melt Index 15% (ASTM D1238)
- Pipe Stiffness 20% (ASTM D2412)
- Other Tests 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 NCDOT 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 the 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 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 NCDOT, the appropriate approved individual will be notified. If the problem continues, the individual's approval may 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 NCDOT's testing equipment, the NCDOT will take corrective action.

**D. Independent Assurance** - Independent Assurance (IA) samples are used by the NCDOT to verify the performance of the Quality Control/Quality Assurance program. Samples will be taken both at the plants and on selected projects.

Standard Specifications - The NCDOT shall perform all sampling and testing in accordance with current specifications and procedures referenced in the *NCDOT Standard Specifications for Roads and Structures*

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

Project Sampling - Independent Assurance (IA) samples shall be taken on all FHWA projects by a representative of the Independent Assurance Section.

- 1) Independent Assurance samples shall be taken on all FHWA projects at a rate of one sample per diameter of pipe received on the project.
- 2) Samples of pipe taken by the NCDOT during project visits shall be tested for weight per linear foot and flattening.

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

- 1) NCDOT's Independent Assurance samples are to be identified with consecutive numbers for each project visited and for each diameter pipe sampled; IA-1, IA-2, etc.
- 2) Independent Assurance test reports shall include the Producer's lot identification.

## IV Product Identification Procedures

In addition to the markings required by the applicable AASHTO specifications, and by the NCDOT Standard Specifications, the pipe shall be marked as having been produced at a participant of this program.

The pipe produced at a participant of this program shall be designated with a QC sticker or permanent marking method as described below.

**A. Stickers**- Stickers with the company name, "QC," QC lot number, and plant name are to be affixed to the pipe. The stickers are to be applied to 100% of the pipe in a load, with the stickers applied to within one foot of the end of the pipe. For pipe eight inches in diameter or less, the stickers may be applied to the banding straps used to tie bundles of pipe. The stickers are to be a minimum of 2 ½ x 1" in size. Information required by national certification programs or by other State DOTs may be incorporated on the sticker.

The design of the sticker used at a plant will be submitted with the plant's Quality Control Plan.

**B. Permanent Marking** - Permanent marking of the pipe will be evaluated on a case by case basis by the Department. The company name, "QC," QC lot number, and plant name are to be applied to the pipe. The marking is to be applied to 100% of the pipe in a load, with the marking applied to within one foot of the end of the pipe. The marking shall have characters that are a minimum of ½" in height. Information required by national certification programs or by other State DOTs may be incorporated in the same marking scheme.

The design of the permanent marking shall be submitted with the plant's Quality Control Plan.

## **Appendix A**

### **Sampling Procedures**

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

Each plant will describe in detail the particular sampling, splitting, and testing procedures used at the plant in the plant's quality control plan.

Samples taken by the Department during plant visits will be taken in the same manner as the Quality Control samples taken at the plant.

## Appendix B

### Testing Procedures

The following is a partial reference list of common test names used in this manual and their corresponding ASTM or AASHTO designations. This list is not intended to be all inclusive, nor is it intended to be a list of all tests required for certification of the products and materials produced using this program.

#### Quality Control Tests

##### Raw Materials

- Minimum Density (ASTM D1505)
- Melt Index (ASTM D1238)

##### Pipe

- Brittleness (ASTM D2444)
- Dimensions (AASHTO M294 or M252, ASTM D2122), Perforations (AASHTO M252)
- Unit Weight
- Minimum Density (ASTM D1505) - if needed
- Melt Index (ASTM D1238) - if needed

#### Quality Assurance Tests

##### Raw Materials

- Minimum Density (ASTM D1505)
- Melt Index (ASTM D1238)

##### Pipe

- Brittleness (ASTM D2444)
- Flexibility - Pipe ten inches in diameter or smaller (AASHTO M252-9.6)
- Elongation (AASHTO M252-9.3)
- Stiffness (ASTM D2412)
- Fattening (ASTM D2412)
- Dimensions (ASTM D2122) and Perforations (AASHTO M252)
- Unit Weight

#### Independent Assurance Tests

##### Pipe

- Flattening (ASTM D2412)
- Unit Weight

## **Appendix C**

### **Quality Control Test Forms**

Each plant will submit copies of all final quality control test report forms used with the plant's quality control plan.

Test reports shall contain the following information:

- A. Name and address of the testing laboratory
- B. Identification of the report and the date issued
- C. Identification of the lot represented by the sample.
- D. Description, identification, and condition of the test sample.
- E. Date of receipt of the test sample.
- F. Date(s) of test performance.
- G. Identification of the standard test method used and a notation of all known deviations from the test method.
- H. Test results and other pertinent data required by the standard test method.
- I. Identification of any test results obtained by a subcontractor.
- J. Name of the person(s) accepting technical responsibility for the test report.

Information included in Items A, E, F, G, and I, do not have to appear on individual test reports as long as it is included in the Plant Quality Control Plan and is included in tests records and is traceable to the test reports.

## Appendix D

### Sample Brand Registration and Guarantee

Each plant will submit copies of an annual brand registration and guarantee prior to December 31, of each calendar year to the State Materials Engineer.

[COMPANY NAME]  
[COMPANY ADDRESS]  
[COMPANY TELEPHONE NUMBER]

#### BRAND REGISTRATION AND GUARANTEE FOR HIGH DENSITY POLYETHYLENE PIPE MATERIALS

This guarantee verifies that all high density polyethylene (HDPE) pipe materials to include tees, elbows, reducers, flared end sections, coupling bands, and accessories furnished by [COMPANY NAME] conforms to the requirements of the HDPE Quality Control/Quality Assurance Program, the NCDOT Standard Specifications, and the applicable AASHTO Specifications M-294 or M-252 for the class and type of pipe 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: