Eastern States' Consortium (ESC)
Quality Control Requirements
For HDPE Pipe Manufacturers

I General Description:

The purpose of this document is to establish the minimum quality control requirements for manufacturers supplying High Density Polyethylene Pipe (HDPEP) to State Departments of Transportation (DOT) participating in this program. A manufacturer's quality control procedures must provide adequate assurance to the State that the products purchased meet relevant AASHTO, ASTM, and Industry Standards. The principle standards governing the specification of HDPEP shall be AASHTO M252 and M294. A manufacturer's procedures must be documented in a bound Quality System Manual (QSM) and it must contain or address the following:

- A Quality Mission Statement
- Quality Control of Raw Materials
- Quality Control Inspection and Testing
- Statistical Analysis of Test Results
- Resolution of Non-Conforming Test Results
- Retention of Test Results and Product Traceability from Resin Lot to Finished Pipe
- Quality Control Testing Facilities
- Qualification of Quality Control Personnel
- Marking, Storage, Shipping, and Handling of Finished Pipe
- Quality Audits of Each Plant Producing Product
- Annual Submission of Pipe Samples and Resin to an Independent Laboratory for Testing and Release of Data to the ESC
- A List of Plants and Quality Control Testing Facilities Including Addresses and the Names and Telephone Numbers of the Quality Control Contacts for Each Facility
- Written Copies of all Company Developed Test Procedures

The QSM shall be submitted to the ESC for review and use in the manufacturer qualification process. As a minimum, the QSM cover page must include the company name, company logo, date, and the title "Quality Systems Manual" for the "Eastern States Consortium HDPEP Program". The abbreviation for each participating state must also be included: CT, DE, DC, ME, MD, MA, NC, NH, NJ, NY, PA, RI, VT & VA. The QSM shall indicate the sizes and types of product for which qualification is requested by production facility, and the qualification, if granted, will then be specific to those products at the designated facilities.

Each manufacturer will maintain its own testing facility for the purpose of quality control testing, or will designate an alternate testing facility. The facilities will be reviewed for qualification by the ESC. Qualification will be based on the facilities ability to perform the required test procedures in accordance with the applicable standards, the use of qualified testing technicians, the calibration and verification of all testing equipment, and

record keeping. The ESC may require a demonstration of the equipment and procedures, split sample testing with a participating state, and/or round robin testing before granting testing facility qualification.

Each manufacturer must designate a single quality control manager responsible for all aspects of its quality control program and use only qualified quality control technicians at each plant or facility involved in the production or testing of pipe for the ESC. The quality control manager shall meet requirements established by the manufacturer and shall be responsible for qualification of technicians. The quality control manager's resume shall be included in the QSM. The technician's qualification shall be based on training and demonstrated ability to satisfactorily perform the required inspection, testing, reporting, and record keeping. The ESC may review the qualifications of any qualified technician and may require the demonstration of equipment and procedures, split sample testing with a participating state, and/or round robin testing.

The manufacturer's QSM shall be submitted electronically to the ESC Lead State in Microsoft® Word or Adobe® Acrobat® format for coordination of the review process. Once accepted, the provisions of the QSM will be in effect for one year. If any changes occur in the QSM during the year, updated information must be submitted to the ESC Lead State. If the manufacturer desires qualification for a subsequent year, a written request must be sent to the Lead State before November 1 of the current year along with an updated electronic copy of the QSM, in Microsoft® Word or Adobe® Acrobat® format, that clearly identifies all changes made since the previous Manual was reviewed. The updated QSM must also include a summary of all independent laboratory testing for products produced to meet the AASHTO M294 Specification including the corresponding manufacturer's split sample test results. The Lead State will coordinate the qualification process, which will be based on the manufacturer's satisfactory implementation of its QSM provisions as determined by testing facility inspections, sample testing if done, independent laboratory test results, and past performance.

The QSM shall state that State DOT inspectors, or their agents, are allowed to enter any manufacturing plant or testing facility, unannounced, to observe the manufacturing process, review quality control testing and testing records, to obtain samples for testing, or to inspect testing facilities, product storage and transport.

The following sections of this document provide more detail about the required provisions of each manufacturer's Quality System Manual

II Quality Mission Statement

The quality mission statement shall be endorsed by the company's Chief Executive Officer and also be made available to all employees

III Quality Control of Raw Materials

General

The QSM must include quality control testing of the polyethylene resins. The required material properties for the resins are as described in AASHTO M252 and M294, Section

6, Materials. The ESC requires that the following properties be tested at the noted frequencies:

- Density – ASTM D1505 or ASTM D792, one test per lot
- Melt Index – ASTM D1238, one test per lot
- Notched Constant Ligament-Stress (NCLS) for M294 product – AASHTO M 294 & ASTM F 2136, once on initial use of a resin blend and then quarterly with continued use of the resin blend

In addition, the following procedures apply when producing products for the ESC:

For M252 Products

- If produced from a single stream resin - there must be a C of A (certificate of analysis) indicating the virgin resin meets the melt index and density requirements of M252. The resin can be used with follow-up verification testing of melt index and density for the lot.
- If produced from a blend of virgin resins – the pipe manufacturer must test the melt index and density of each component resin and it must be found to reasonably conform to the C of A results. The pipe manufacturer's test results must be used to determine the blend ratios. Each blend of resin components establishes a lot, and a new lot is established each time a component resin or a component ratio changes more than allowed by the blend tolerances (±1.5%). The melt index and density of each blend lot must be tested prior to use.

For M 294 Products

- If produced from a single stream resin -the virgin resin must be certified to meet the requirements of section 6.1 of M294, either through PPI listing or recognized third party testing. The resin may be used before testing, but the melt index and density must be verified for each lot by subsequent testing.
- If produced from a blend of virgin resins – only those blends certified to meet the requirements of section 6.1 of M294, either through PPI listing or recognized third party testing, with component variations limited to ± 1.5%, are acceptable. The pipe manufacturer must perform follow-up testing for melt index and density for each lot to verify the certification, and the pipe manufacturer or an independent laboratory acceptable to the ESC must perform the full cell classification testing including the NCLS test with the initial use of any lot and then quarterly with continued use. The component resins and percentages of each in the PPI or third party approved blend must be provided to ESC auditors so that it can be verified that an approved blend is being used to produce the M294 product.

A lot for a manufacturing facility is defined as a railcar compartment or hopper truckload of resin. If the shipment consists of gaylord boxes, 40 boxes will comprise a lot. The location and method of sampling the resin must be included in the Manual. A lot number must be established for each lot and must be carried through to the finished product.

Reworked plastic may be used provided it meets the requirements of Section 6.2 of

AASHTO M252 and M294. Recycled plastic will not be allowed.

The QSM shall document where fittings and couplings are manufactured, the source of the components, and the fabrication process used. It shall also document the process used to assure that all resins used to manufacture fittings and couplings meet the material requirements of section 6 of M252 and M294, including those components purchased from another party. There shall be traceability from the fitting or coupling back to the resin lot used to manufacturer it. Documentation establishing traceability shall be maintained along with the inventory.

Resin test reports and resin producer certifications, including supporting test reports, must be maintained and available for review for a period of 5 years.

IV Quality Control Inspection and Testing

The manufacturer shall conduct visual inspections of the exterior and interior walls for bonding, blowouts, and for workmanship items as described in AASHTO M252 and M294, during production. The manufacturer shall monitor the process and finished product.

The QSM shall define the quality control tests, the method for random sampling, the size of the sample, and the lot size for production facility quality control sampling and testing. It shall also include an example of a quality control test report form. A pipe lot shall be no larger than the amount of pipe produced per type per diameter per machine per production run. An AASHTO, ASTM, or Company procedure shall be referenced for each quality control test. If a company procedure is referenced, it must be described in the QSM and is subject to approval.

The ESC requires that at least the following quality control tests, or inspections, be performed at the minimum frequency noted below:

- Unit Weight, two per work shift
- Wall Thickness, two per work shift (See Appendix 1)
- Carbon Black Content (AASHTO M252 or M294 and ASTM D3350), one per day
- Inside Diameter, one per work shift
- Pipe Length, one per work shift
- Perforation Locations and Dimensions (Type “CP” and “SP”), one per work shift
- Water Inlet Area (Type “CP” and “SP”), one per work shift
- Pipe Stiffness, two per week
- Pipe Flattening, two per week
- Elongation (M252 Only), one per year
- Low Temperature Flexibility (M252 Only), one per year
- Brittleness, two per week
- Joint Integrity, one per week for welded bell/spigot, quarterly for integral bell/spigot
- Environmental Stress Cracking, one per year

- Workmanship (per AASHTO M252 and M294)
- Marking (per AASHTO M252 and M294)

Each sample selected for quality control inspection and testing shall be designated with a sample control number for record keeping and traceability. The test report for each sample shall identify the plant, date, shift of manufacture, production line, and lot designation for the polyethylene resin. The quality control test reports (not samples) must be maintained and available for review for 5 years.

V Statistical Analysis of Test Results

The QSM shall contain a description of the manufacturer's statistical process control plan. The plan shall use methods such as statistical control charts to monitor production facility quality control test results for the purpose of identifying trends and being able to make production adjustments as necessary. The plan shall monitor each production plant separately and total manufacturer product quality trends.

VI Resolution of Non-Conforming Product or Test Results

The QSM shall contain provisions for resolving non-conforming product or test results. The test report will clearly identify the deficiencies and all product produced subsequent to the previous testing shall be identified and quarantined pending investigation of the failure. The investigation shall include obtaining and testing check samples. If the check sample meets requirements, the manufacturer shall document the reasons for the original failure and may release the quarantined material and resume normal production and testing. If the check sample fails, the manufacturer shall take corrective action to bring the product into conformance and shall note the corrective action on the test report. A second check sample shall be taken to verify the deficiency has been corrected. If this sample also fails, the process shall be repeated until the deficiency is corrected.

All non-conforming material shall be segregated in the inventory and re-worked or scrapped.

VII Retention of Test Results and Product Traceability

The QSM shall describe in detail the retention of quality control test reports for at least 5 years and they shall be available to the ESC upon request.

The product and test reports will be identified in such a way that the test results for any pipe can be located, including the test results for the resin used to manufacturer the pipe.

Test reports shall indicate the action taken to resolve resin or product failures.

The manufacturer shall maintain a copy of the ESC inspection documentation for a facility on file at the facility for at least 5 years.

VIII Quality Control Testing Facilities

The QSM shall describe in detail the requirements for the testing facilities. As a minimum, the following requirements shall be included:

- The manufacturer's quality control manager shall be responsible for quality control testing at all facilities and shall assure that all sampling and testing is done by technicians meeting the requirements of the manufacturer's technician qualification program described in section IX.
- The facilities shall maintain current versions of all AASHTO, ASTM, and Company test procedures for all tests performed and a current version of the Company's QSM.
- The facilities must adequately house and allow proper operation of all required testing equipment.
- The testing equipment shall be calibrated/verified in accordance with the equipment manufacturer's recommendations at least once every 12 months by personnel customarily involved in such work as documented in the QSM.
- All testing facility equipment shall be properly maintained and maintenance activities shall be documented.
- The testing facilities shall maintain records of all ESC reviews and actions taken to resolve any noted deficiencies
- Records of equipment calibration, verification, and maintenance will be retained and available to the ESC for review upon request.

IX Qualification of Quality Control Personnel

The manufacturer's quality control manager must meet the requirements established by the manufacturer and is responsible for the qualification of the technicians performing the quality control testing. Quality control personnel must be familiar with the tests they perform and have sufficient authority to assure that corrective actions are carried out when necessary.

As a minimum, a manufacturer's quality control technician qualification program shall include training in the AASHTO, ASTM, or Company test procedures, demonstration of competency in each required test, and demonstration of ability to properly document test results. It shall also include annual auditing of each technician's ability to satisfactorily perform the required tests. The training shall include the operation of equipment, the procedures to be used, calculations required, and reporting. Re-training shall be provided when the test method is revised. Training and competency reviews shall be documented in such a way that compliance with the requirements for the initial and updated training and the initial and annual competency reviews can be demonstrated for each technician for each test the technician performs. The documentation shall include the date of the training or competency review and contain the hand written signature or initials of the trainer/reviewer and the technician. This documentation shall be maintained at each facility where quality control testing occurs and shall be available for ESC inspectors to review. See Appendix 2 for examples of forms that can be used to meet these documentation requirements.

The QSM shall indicate the line of authority from the quality control testing technicians to the quality control manager, which must demonstrate their authority to require corrective action. The quality control manager must be independent of production management and of equal status.

X Marking, Storage, Shipping, and Handling of Finished Pipe.

The QSM shall describe a method for permanently marking the pipe in accordance with the minimum requirements of AASHTO M252 and M294.

The Manual shall describe procedures for product handling, storage, and shipping to ensure that these processes will not adversely affect the material composition, characteristics, or product quality.

XI Quality Audits of Each Plant

The QSM shall include a description of quality audits of each plant producing product for ESC states. The company, or an independent auditor hired by the company, shall perform these audits on an annual basis unless problems in the quality control program or with the quality of the product indicate more frequent audits are necessary. The audits shall include the following as a minimum:

- Inspection of plant inspection and testing equipment and calibrations
- Observation of resin sampling and lot control procedures
- Observation of sampling and testing procedures
- Review of product certification procedures
- Review of inspection and testing report documentation
- Review of nonconforming product documentation and actions taken

The audit findings shall be discussed with plant management and testing technicians and documented in a report. Corrective actions will be taken as necessary and documented in the report. The most recent report shall be included in the initial or updated QSM submission.

XII Annual Submission of Pipe Samples to an Independent Laboratory and Release of Data to the ESC

The QSM shall include information on the annual submission of pipe samples and resin for testing to an independent laboratory qualified for testing pipe samples for the National Transportation Product Evaluation Program (NTPEP). Each manufacturer shall have the laboratory evaluate two sizes of pipe in accordance with M294 on an annual basis for each manufacturing plant furnishing pipe. An ESC representative will select and label the samples to be tested. Each sample will be a split sample, with the manufacturer performing comparative testing. The manufacturer shall report the independent laboratory

test results and the results from the split samples to the ESC using the standard format provided in the document section of the ESC website http://www.nh.gov/dot/espc/library.htm The submission shall also include an explanation of any significant differences between the independent laboratory and split sample test results, including any corrective actions found necessary in the manufacturing process or testing procedures. The cost of the sampling, shipping, and independent laboratory testing will be borne by the manufacturer.

XIII List of Plants, Quality Control Testing Facilities, and Technicians

The QSM shall include the address and telephone numbers of all plants and quality control testing facilities for which the manufacturer desires ESC qualification. The quality control contact for each facility shall also be identified with contact information and lines of responsibility shown.

XIV Company Test Procedures

The Quality System Manual shall include all Company developed test procedures used in quality control testing. Company developed tests shall only be used if there is no ASTM or AASHTO test method.

Appendix 1

Wall Thickness Measurement

The ESC has decided to allow the use of ultrasonic thickness gauges for measuring wall (liner) thickness if the following procedure is followed:

- Each gauge and transducer will be identified and calibrated.

- Records will be maintained to record all calibration activities, including the person doing the work, date performed, and every time during the year it is done.

- The ESC auditor will witness the calibration of an instrument used and sign the form. A copy will be included with the ESC audit forms.

- When new transducers are required, they will be identified and calibrated with the instrument.

- "Calibration Blocks" will be maintained at all plants.

- Use of gauges:

  – The ESC requires two (2) liner thickness readings per work shift, comprised of at least eight (8) readings. All these numbers will be recorded.

  – Of the two (2) sets of readings, a minimum of one (1) set will be taken with a micrometer in accordance with ASTM D2122.

  – The other set can use the ultrasonic gauge, if the producer desires. Any thickness readings not required by M 294, M 252, the ESC, or the QSM, can be taken based on producers' discretion.

  – The reading will indicate if it is done with ultrasonic or micrometer on the form.

Appendix 2

Suggested Forms for Documenting Training and Competency Requirements

Laboratory Training / Competency Form

[Place Company Name on This Line]
Quality Control/Assurance Training/Competency Evaluation

Lab Location: _____

Tr'ee = Trainee, Tr'er = Trainer

Trainee Name:	Weight			Liner Thickness			Inside Diameter			Pipe Length			Brittleness			Workmanship			Carbon Content		
	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial

Trainee Name:	Marking			Perforations			Inlet Area			Pipe Stiffness			Elongation			Resin Melt Index			Resin Density			Resin NCLS		
	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial

1) To attest that the training took place, the initials of both the trainee and the trainer are required.
2) The initialing trainer attests that the technician satisfactorily demonstrated the test.
3) If the training is due to test method modification, indicate by an asterisk next to the initials of the trainee.

To obtain an electronic copy of this form, please visit the following web site:
http://www.nh.gov/dot/espc/library.htm

Plant Training / Competency Form

[Place company Name on This Line]
Quality Control/Assurance Training/Competency Evaluation

Plant Location: _____

Tr'ee = Trainee, Tr'er = Trainer

Trainee Name:	Weight			Liner Thickness			Inside Diameter			Pipe Length			Brittleness			Workmanship			Carbon Content		
	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial	Date	Tr'ee Initial	Tr'er Initial

1) To attest that the training took place, the initials of both the trainee and the trainer are required.
2) The initialing trainer attests that the technician satisfactorily demonstrated the test.
3) If the training is due to test method modification, indicate by an asterisk next to the initials of the trainee.

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