TECHNICAL REFERENCE

CETCO NEEDLEPUNCHED REACTIVE CORE MAT® (RCM) MANUFACTURING QUALITY ASSURANCE AND QUALITY CONTROL (MQC) MANUAL

VERSION 1.2

CONFIDENTIALITY NOTICE

This manual contains confidential company information and is to be distributed exclusively to those personnel who are directly involved with the manufacturing and evaluation of Reactive Core Mat® (RCM). THIS DOCUMENT SHALL NOT BE PUBLICLY DISTRIBUTED WITHOUT THE EXPRESS CONSENT (VERBAL OR WRITTEN) OF COLLOID ENVIRONMENTAL TECHNOLOGIES COMPANY.

POLICY STATEMENT

The Reactive Core Mat (RCM) Manufacturing Quality Assurance/Quality Control Manual has been prepared by Colloid Environmental Technologies Company (CETCO), a wholly owned subsidiary of AMCOL International, Inc. This policy states that our primary goal is to achieve optimum productivity while assuring full customer satisfaction. To reach this goal, CETCO is committed to the pursuit of continuous improvement of all processes and materials utilized in the manufacture of RCM.

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SECTION 1

INTRODUCTION

1.1 Definitions

This manual contains objectives and criteria for maintaining CETCO Reactive Core Mat (RCM) Manufacturing Quality Control and Manufacturing Quality Assurance as defined below:

Manufacturing Quality Control (MQC) refers to a planned system of inspections for directly monitoring and controlling the quality of the RCM product during the manufacturing process. MQC is performed by CETCO to ensure that the specified values for RCMs are achieved.

Manufacturing Quality Assurance (MQA) refers to a planned system of activities that provide assurance that the manufactured RCMs product actually meets its specified properties.

The above definitions, provided by Koerner and Daniel, imply that MQC procedures are implemented to control the product during manufacture, while MQA procedures are implemented to ensure the product meets specifications after manufacture. CETCO needle-punched RCMs are assembled from three component materials, meaning that there are four materials streams (two geosynthetics, the active media, and the finished product) which are subject to either MQA or MQC. Quality control procedures are implemented on those components and finished products which are manufactured by CETCO.

The organizational structure of the CETCO RCM MQA/MQC Program is depicted in Figure 1-1. The “core” quality personnel are shown in the center of the diagram, with peripheral quality support provided by the other personnel. For each project, the CETCO RCM Sales Manager is the key liaison between the manufacturer and the engineer, and any special MQA/MQC issues which deviate from this manual should be communicated between these two parties prior to production for the project. Figure 1-2 presents the Order Review Process for discrepancies between contract specifications and CETCO standard RCM specifications.

1.2 MQA/MQC Objectives

CETCO RCMs are utilized in a wide variety of important environmental and engineering applications which often provide protection of human health and the environment from contaminated soil or water. Accordingly, CETCO RCMs have been designed with certain engineering properties which make it suitable for use in these critical applications. The quality of CETCO RCMs has a direct influence on the degree of environmental protection they provide. It is therefore of paramount importance that the entire manufacturing process for CETCO RCMs is tightly controlled and monitored through the implementation of a comprehensive quality management system. The Quality Manual and associated quality procedures, work instructions, calibration procedures, test procedures, and records, are saved electronically.

[1] Koerner, R.M. and D.E. Daniel (1992) Manufacturing and Construction Quality Control and Quality Assurance of Geosynthetics. Proceedings of the 6th GRI Seminar: MQC/MQA and CQC/CQA of Geosynthetics, December 10-11, 1992, Philadelphia, PA, pp. 1-14.

This MQA/MQC manual establishes the manufacturing guidelines and product testing procedures necessary to ensure that CETCO RCMs meet all of their design specifications. Where applicable, established ASTM sampling and testing methodologies and protocols for RCMs or its components are specified for use. The remainder of this manual is presented in three sections. Section 2 contains test procedures for RCMs and each of its components, and Section 3 describes the record keeping and reporting procedures which will document adherence to this plan and will verify the overall quality of the product.

1.3 Revisions

Because one of CETCO’s corporate commitments is continual product improvement, the procedures specified in this manual may require some modifications as such improvements occur. Interim revisions to the existing manual will be issued as required, and the manual itself will be updated and reissued on a regular basis to incorporate recent revisions. It is every employee’s responsibility to remain abreast of the continued revisions to the quality program.

1.4 Accreditations

CETCO manufacturing plant laboratory is accredited by the Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP) based in Folsom, PA.

SECTION 2

MQA/MQC PROCEDURES

This section of the CETCO RCM Manufacturing QA/QC Manual describes specific procedures carried out to evaluate the quality of each RCM component (top geosynthetic, bottom geosynthetic, organoclay), the quality of the actual production process, and the quality of the finished RCM product. This program allows immediate verification of critical production parameters used to monitor production quality, while the laboratory test program will verify the specified engineering characteristics of the RCM.

2.1 Geosynthetic Components

Depending upon the type of RCM the top and bottom geosynthetic components may consist either of a woven geotextile, nonwoven geotextile, or combination thereof.

2.1.1 Woven Geotextile

The woven geotextile is manufactured elsewhere and is delivered to the RCM plant in rolls up to 1,500 yards long, depending on the style being used. CETCO receives and maintains on file manufacturer's certifications stating that the products meet the engineering specifications listed in Table 2-1.

Each geotextile roll is labeled with a lot and roll number, and the date and time at which a roll is placed into RCM production is recorded on a daily operating log. This procedure allows the usage of the woven geotextile to be tracked such that its lot and roll number can be directly determined from the corresponding RCM lot and roll number.

If the overall quality of the of the woven geotextile roll is unknown (e.g., not certified by the manufacturer, lot and roll tag missing, or the data misplaced) full roll-width samples are obtained at a frequency of one per every 200,000 square feet to confirm that the geotextile is acceptable with respect to its required mass per unit area and grab strength values.

2.1.2 Non-Woven Geotextile

The non-woven needle-punched geotextile is manufactured in rolls up to 1,500 yards long by CETCO or elsewhere and is subjected to conformance tests at the plant of origin prior to delivery to the RCM plant. CETCO receives and maintains on file manufacturer's certifications stating that the products meet the engineering specifications listed in Table 2-1.

Each geotextile roll is labeled with a lot and roll number, and the date and time at which a roll is placed into RCM production is recorded on a operating log. This procedure allows the usage of the nonwoven geotextile to be tracked such that its lot and roll number can be directly determined from the corresponding RCM lot and roll number. If the overall quality of the of the nonwoven geotextile roll is unknown (e.g., not certified by the manufacturer, lot and roll tag missing, or the data misplaced) full roll-width samples are obtained at a frequency of one per every 200,000 square feet to confirm that the geotextile is acceptable with respect to its required mass per unit area and grab strength values.

2.2 Organoclay

Granular organoclay incorporated into the RCM is supplied by one or more organoclay manufacturing plants. The organoclay is typically shipped to the RCM plants in super sacks. Trucks hold approximately 24 tons. QA procedures for organoclay shipped to the RCM plant primarily involves collecting and maintaining lot data issued by the organoclay manufacturing plant for each organoclay shipment.

The quality parameters for the organoclay are its density and quaternary amine content, which is an indicator of RCM adsorbency. The organoclay has a density of 44-56 lb/ft^3. The organoclay has a quaternary amine loading of 25-33%. A summary of the organoclay MQA parameters is provided in Table 2-3. Additionally, organoclay lots are analyzed for oil adsorption capacity using 10W30 oil by CETCO Hoffman Estates laboratory. The organoclay has an oil adsorption capacity of minimum 0.5 lb/ lb of organoclay.

The CETCO organoclay test data are received and retained by CETCO, and the accompanying organoclay lot numbers are recorded in the operations log using procedures similar to those described in Section 2.1 for the geosynthetic components. In order to coordinate the usage of the certified organoclay and the production of RCM, the lot number and the time/date of use is recorded in the daily log. Thus, the daily log allows every roll of RCM to be traced to the organoclay lot number. More information regarding the reporting and record keeping procedures is presented in Section 3.

2.3 Production Processes

The machinery utilized for the production of RCMs is highly controlled, and critical production parameters are automatically monitored. Human input into the manufacturing process is critical, however, to the extent necessary to maintain the machinery and the requisite QA/QC information. As described below, quality control procedures during production focus primarily on maintaining the calibration and operation of the production system.

2.3.1 Punch Density (Needle-punched RCMs Only)

Punch density refers to the number of needle-punched fibers per unit area joining the top and bottom geotextiles of the needle-punched RCMs. The correct punch density has been determined to correspond to various operational parameters, which are maintained during production. Calibration of the needling machinery is performed regularly, and RCM peel test results provide a quantitative verification that the punch density meets minimum standards.

2.3.2 Roll Length and Width

The dimensions of the RCM panels are directly evaluated. Length measurements are made through continuous monitoring by an electronic linear measuring device connected to the wind-up roll at the end of the production line. When the standard length of 100 feet is reached, the roll is cut and prepared for storage or shipment. Periodically, a RCM roll is manufactured to a length of 102-103 feet such that a full roll-width QA sample may be taken.

It is noted that shorter rolls are produced when production is temporarily suspended for materials re-supply. These short rolls are often useful for completing the square footage requirements for a particular job. The length of all short rolls is recorded as well.

The correct width of 15 feet is maintained by periodic width measurements are made prior to roll-up using a tape measure placed perpendicular to the machine direction of the RCM.

2.3.3 External Markings

RCMs are furnished with two dashed lines (“lap line” at 12 inches) on each end of the upper geosynthetic to facilitate its installation. The lines are applied to the finished RCM as it passes by a system of rotating stationary inking devices. The ink reservoirs are checked frequently during each shift to ensure an adequate supply during production. Visual observations of lap line placement are also conducted by the shift supervisor. The system is automated and requires few adjustments, although the locations of the lines are measured at a frequency of at least once per shift. The lines on standard rolls of RCM are located within 1/4 inch of the 12-inch points as measured perpendicular from each edge.

2.3.4 Equipment Inspection

The mechanical equipment and appurtenant devices used in the manufacture of RCM are regularly inspected and maintained in accordance with the overall plant maintenance program.

2.4 Finished RCM

This section of the manual describes the sampling and testing procedures implemented to ensure that each roll of RCM has been manufactured to meet its standard design specifications. CETCO defines a lot of RCM as one week of production of a product at a particular plant. Besides the organoclay mass per unit area, grab tensile strength and permittivity/permeability, CETCO also performs peel strength testing on its needlepunched RCM products. Based on testing frequency, rolls are identified during production so that their length may be extended by 3 feet in order to accommodate sampling. Table 2-4 presents the finished RCM MQA test specifications.

The organoclay mass per unit area test procedures are performed at a frequency of one per 40,000 square feet. The organoclay mass per area test is performed in accordance with the following CETCO test method. Five test 1’ x 1’ specimens are die cut from five sections cut across full roll-width sample as shown in Figure 2-1. The number of test specimens obtained per sample may be modified as variability data is generated. Organoclay mass per area is calculated by subtracting out the nominal weight of the geosynthetics. The geosynthetic weights are typical values because it is neither possible nor practical to attempt removal of the organoclay entirely from the RCM in order to weigh each component separately.

The specimens for grab tensile testing are taken from the same full roll width samples at a frequency of one per 200,000 square feet and are tested according to modified method ASTM D4632 (grab strength, reported in lbs or N).

Peel testing is performed on RCM needle-punched products at a minimum frequency of one per 40,000 square feet. Peel testing is performed following CETCO test method, which reports average peel strength over the sample width, in lbs/in or N/cm. In the peel test, a RCM specimen is partly de-laminated by cutting the needle-punched bonds between the geotextiles just enough to allow each geotextile to be separately inserted into the grips of the tensile testing device.

Permittivity/permeability testing are performed periodically (approximately once per quarter). Permittivity is run per modified ASTM D4491 and permeability is calculated by measuring the RCM thickness. Samples are sent to an outside testing laboratory.

Finished RCM product testing may be run at different frequencies per project requirements.

Specimens of finished RCM are archived for 12 months and then are discarded. These samples can be utilized for post-project testing if a dispute arises. However, it is the purchaser's responsibility to ensure that representative samples of the RCM are retained if testing is requested after this one-year period has expired.

2.5 Needle Detection and Removal

The production of needle-punched reinforced RCMs, involves driving thousands of needles at hundreds of strokes per minute through the organoclay and encapsulating geotextiles. Significant forces are applied to the needles during this process. A few needles will inevitably break, and needle fragments must be removed. CETCO follows a three-part strategy of prevention, detection, and removal, to prevent the presence of needle fragments in the finished product.

Needle breakage is minimized by implementing several measures related to optimization of organoclay particle size, needle type selection, and the operation of the needling loom (including frequent bed plate and stripper plate cleaning). However, even with these measures, some breakage is inevitable. Therefore, a set of powerful magnets is arranged downstream from the loom, across the width of the RCM. Positioned just over the surface of the textiles, the magnets effectively remove needle fragments that break after striking a clay particle. Almost all needle fragments are removed by the magnets, but a few do remain in the product and must be detected and, if protruding, removed.

A system of magnetic metal detectors distributed across the width of the RCM is used to scan the product for needle fragments. Located after the magnets, the detectors divide the roll into discrete segments. If a needle fragment is detected in one of the segments, a production crewperson stops the material in-line and checks for needle fragment(s). This segment of the roll is visually inspected for any protruding needle fragment(s). Any protruding needle fragments are removed, and the rolls is then wound and packaged. The needle detection and removal process is shown in Figure 2-2.

2.6 Plant Storage and Handling

Care is taken at the plant to handle and store the finished rolls of RCM in a manner that prevents damage to the product and its packaging. All handling of the product must be executed with a forklift or other suitable vehicle outfitted with a carpet pole or "stinger." The stinger must be strong enough to support the weight of a full roll of RCM with minimal bending.

RCM storage is limited to a stack height that provides easy equipment access and minimizes the chance for damage to the roll core and to the RCM itself. The inventories of RCM and its component materials will be rotated for additional protection against potential long-term, storage-related damage.

SECTION 3

RECORDING AND RECORD KEEPING

RCM is manufactured from three different raw materials, each requiring its own QA/QC testing and record keeping. The finished RCM product also requires testing, so comprehensive documentation of all RCM manufacturing activities is essential in order to properly manage the large amount of information generated during production. This section of the RCM MQA/MQC Manual lists the quality-related information recorded and provides the procedures for maintaining the records.

3.1 Plant Records

Daily Operations Log: Plant records include both a continuous daily operations log and a log of QA test data. Items included in the daily production log include:

- Current date and shift
- Current lot and roll number in production.
- Length and width of each roll produced.
- A record of raw material usage, including lot/roll numbers of relevant information affecting production

QA Log. A separate log is maintained at the plant to record information pertaining to test data. Information included in the QA log includes:

- Date, time, lot, and roll number of all tested samples
- QA test results summarized in tabular form
- Name of person conducting the tests
- Actions taken if test results were unsatisfactory

The QA log may be kept electronically as data is tabulated directly on an available computer or may be kept in writing, at the discretion of the shift supervisor. For future reference, both of these logs shall be maintained at the plant indefinitely. Copies of test results recorded on the QA log will be provided as required. The daily production log and the QA log are the most important means by which RCM quality is documented; therefore, these logs must be neatly and accurately maintained.

Product Labeling: Adhesive labels are placed on the outer wrap of every RCM roll and on the core. The labels themselves provide the following information:

- Length and width of roll
- Total weight of roll
- Product identification (material codes and type designation)
- Lot number and roll number

Packing Slips: The plant provides the site manager or his designate with a packing slip for each shipment of RCM to the project site. The packing slip includes the following information:

- CETCO order number and customer P.O. number.
- RCM lot numbers, roll numbers, roll dimensions, and roll weights.
- Shipment address.

Copies of the packing slips shall be maintained at the plant.

3.2 Supplemental Laboratory Records

CETCO shall maintain complete records of all testing performed at its laboratories or outside laboratories in the event that supplemental MQA testing is required for a particular project. Using standard laboratory record keeping procedures, CETCO shall maintain records, as required for the project, of:

- Results of physical, chemical and hydraulic tests on geosynthetic components, organoclay, and RCM
- Documentation of follow-up action, if any, after evaluation of test data.

3.3 RCM Manufacturing Certification Report

Each shipment of RCM for which MQA/MQC documentation is required will be properly accompanied by an electronic copy MQA/MQC Data Package. The package includes a certification statement indicating to the customer that the purchased RCM complies with all of the properties certified by CETCO Remediation Technologies.

The supplier data for the organoclay for density and quaternary amine content will be included in the certification reports. The RCM MQA/MQC test data reports for organoclay mass per unit area, grab tensile strength will be furnished, as well as the QA tracking forms identifying the organoclay lots associated with each RCM lot and roll number for the order. Due to the time required to run the permittivity/permeability testing, this information, when required per the project specifications, will be forwarded under separate cover.

FIGURE 1-1

CETCO RCM MQA/MQC PROGRAM ORGANIZATION CHART

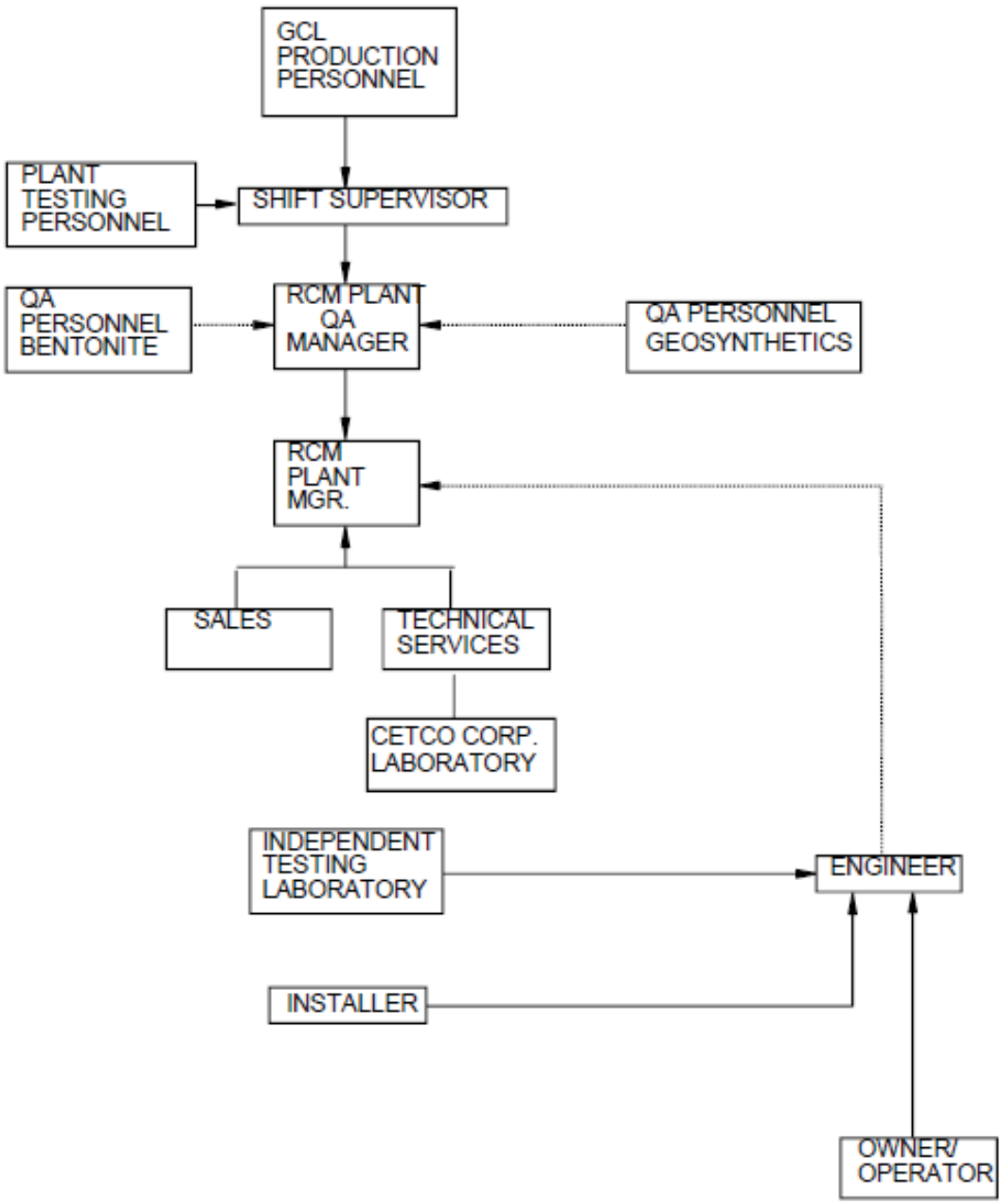


FIGURE 1-2

CETCO ORDER REVIEW PROCESS

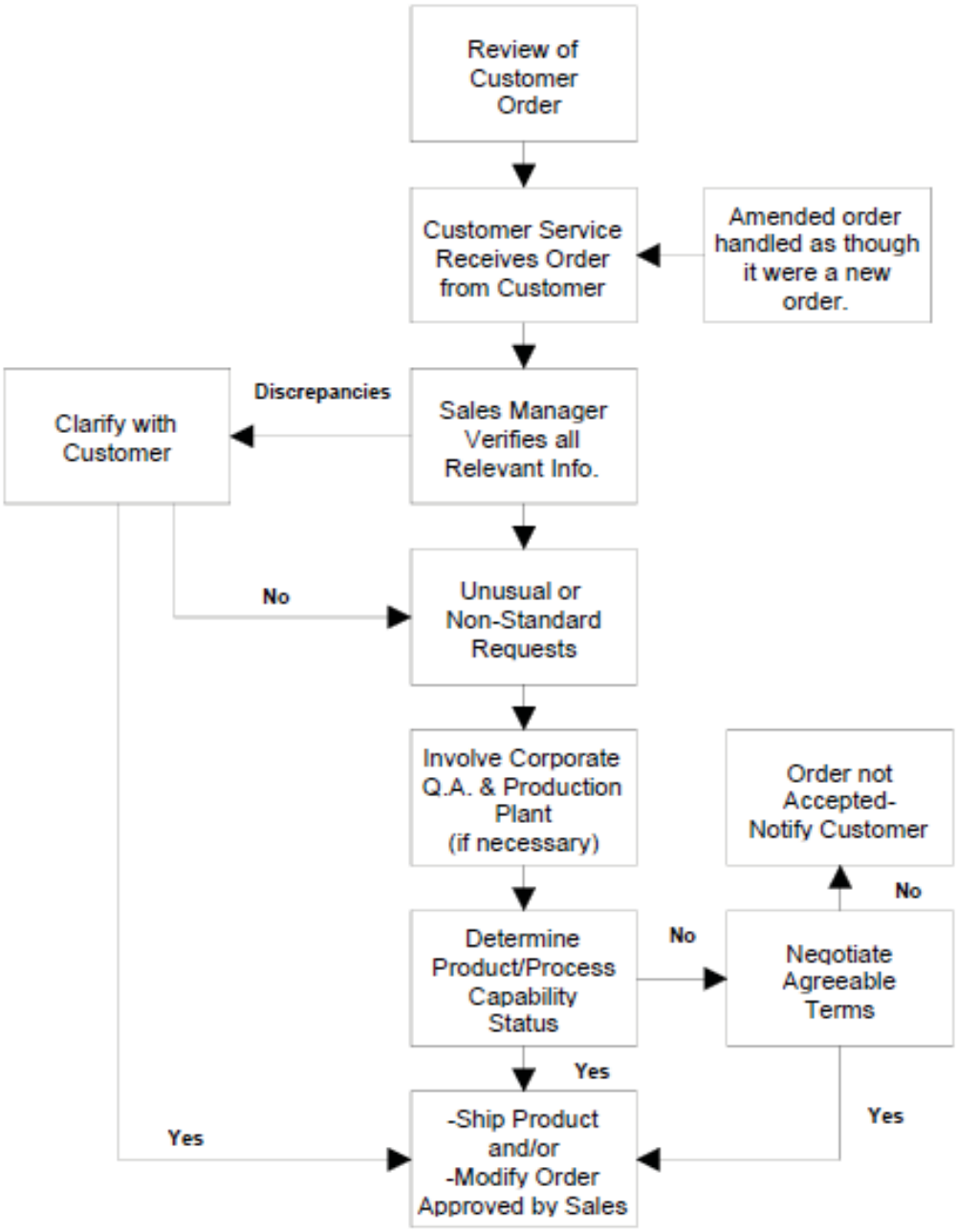
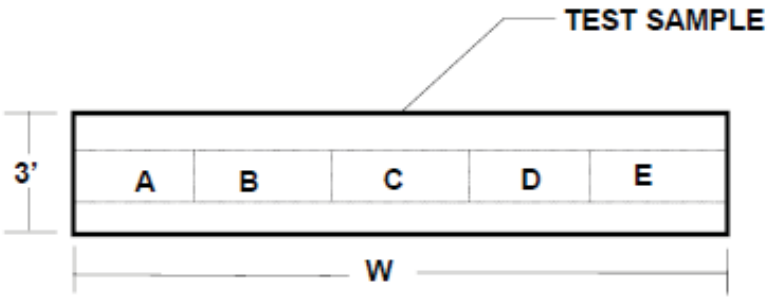


FIGURE 2-1

GUIDE FOR OBTAINING SAMPLES AND TEST SPECIMENS



NOTES

1. Dashed lines represent acceptable "windows" from which test specimens A, B, C, D, and E are cut.
2. The specimens are cut at random locations within each window. For the standard 15-foot wide RCM product, the windows are 3 ft long.
3. All samples must be cut using a die and hydraulic punch.
4. At least one 1' x 1' specimen is archived (see Section 3).
5. The above figure depicts sampling guidelines for nonwoven geotextile manufactured by CETCO as well as the finished RCM product.

FIGURE 2-2

SCHEMATIC OF NEEDLE DETECTION AND REMOVAL SYSTEM

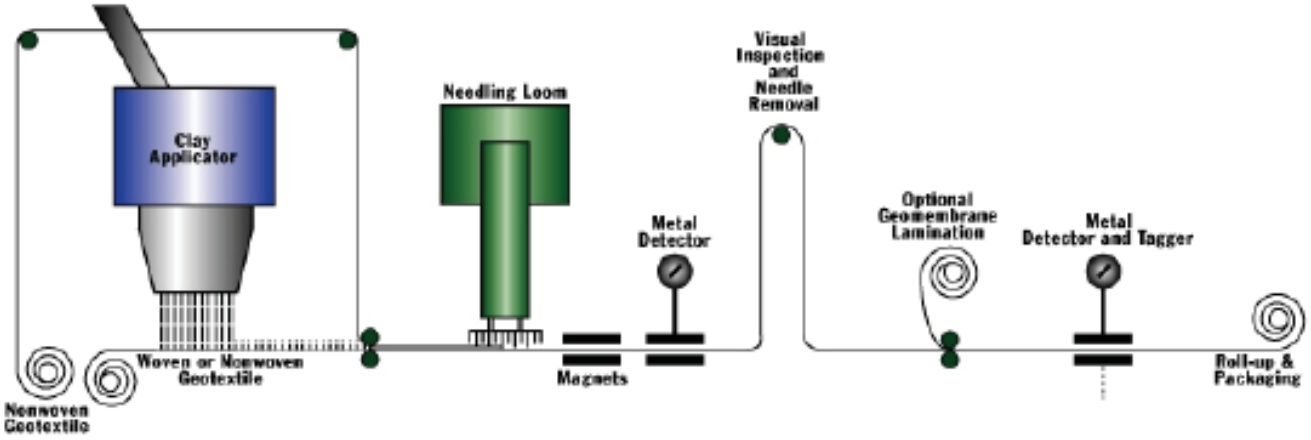


TABLE 2-1

MQA PARAMETERS FOR GEOTEXTILE COMPONENT OF RCM			
Property[1]	Test Method	Frequency	Required Value[1]
Grab Strength	ASTM D 4632	200,000 sq. ft	Typical and MARV
Mass per Unit Area	ASTM D 5261	200,000 sq. ft	MARV

NOTES
[1] Values represent geotextile testing prior to incorporation into RCM.

TABLE 2-2

MQA PARAMETERS FOR ORGANOCLAY COMPONENT OF RCM			
Property[1]	Test Method	Frequency	Required Value[1]
Bulk Density Range	CETCO Test Method	1/lot	44 – 56 lbs/ft^3
Oil Adsorption Capacity	CETCO Test Method	1/lot	0.5 lb of oil per lb of organoclay, minimum
Quaternary Amine Content	CETCO Test Method	1/lot	25 – 33% quaternary amine loading

NOTES
[1] Values represent organoclay testing prior to incorporation into the RCM.

TABLE 2-3

MQA PARAMETERS FOR RCM FINISHED PRODUCT			
Property	Test Method	Frequency	Required Value[1]
Organoclay Mass per Area	CETCO Test Method	1/40,000 ft^2	0.8 lb/ft^2 minimum
Mat Grab Strength[1]	Mod. ASTM D4632	1/200,000 ft^2	90 lbs. MARV
Peel Strength[1]	Mod. ASTM D4632	1/40,000 ft^2	1 lb/in minimum
Hydraulic Conductivity[2]	Mod. ASTM D4491	Periodic	1 x 10^{-3} cm/sec minimum

NOTES
[1] Grab and peel strength in machine direction.
[2] Hydraulic conductivity calculated from permittivity and thickness per D5199.

APPENDIX A

REFERENCED STANDARDS AND TEST METHODS

ASTM D4632 Standard test method for grab breaking load and elongation of geotextiles

ASTM D4491 Standard test method for water permeability of geotextiles by permittivity

ASTM D5199 Standard test method for measuring nominal thickness of geotextiles and geomembranes

ASTM D5261 Standard test method for measuring mass per unit area of geotextiles