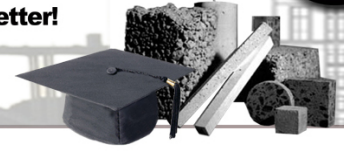




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Quality Management System for Ready Mixed Concrete Companies

**Parts A and B prepared by:
William C. Twitty, Jr., P.E.**

Part C Developed by the NRMCA P2P Steering Committee

**Reviewed and Approved by the
NRMCA P2P Steering Committee**



Quality Management System For Ready Mixed Concrete Companies

Part A: Preparation Guidelines for Quality Manual for Ready Mixed Concrete Companies

Part B: Sample Quality Manual: Global Ready Mixed Company

Part C: Ready Mixed Concrete Company External Quality Audit Checklist for Compliance with Quality Plan

February 2008

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Funding from the RMC Research & Education Foundation

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Part C

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NRMCA is a leading industry advocate working to expand and improve the ready mixed concrete industry through leadership, promotion, education and partnering ensuring that ready mixed concrete is the building material of choice.

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Part A: Preparation Guidelines for Quality Manual for Ready Mixed
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Preparation Guidelines for Quality Manual for Ready Mixed Concrete Companies

Foreword

The purpose of these guidelines is to assist ready mixed concrete producers in the preparation of a Quality Manual (QM). The Quality Manual documents the quality processes that the company has in place to insure quality of the company's products and services. The guidelines allow for the structured development of a Quality Manual that should be clear to all responsible personnel of a ready mixed concrete producer. The Quality Manual is flexible in design and can be customized to follow the quality processes of a specific concrete producer. In developing these guidelines the essential elements of Quality Management Standards of ISO 9000 were followed and this guideline was written so that they are pertinent to the ready mixed concrete industry.

These guidelines were developed to establish a minimum level of a Quality Management System (QMS) of a ready mixed concrete producer primarily to establish the producer's credentials when bidding on a performance based specification for ready mixed concrete. However, the document is not intended to be restricted solely for this purpose. The guidelines recommend specific sections and subsections and include a discussion of what should be covered in those parts.

There are several sections in this guideline that are primarily of an internal company focus and may not be of interest to the purchaser of concrete. For that purpose a subset of these sections has been developed as an audit checklist. The audit checklist specifically addresses those items that impact the quality of the product from a purchaser's perspective. The audit checklist was created in anticipation of possible future certification requirements or other qualification criteria, as set forth by the purchaser in the contract documents. When the purchaser, or other qualification process, requires items that exceed the scope covered in these guidelines or the audit checklist, those requirements should be clearly stated.

In addition to these guidelines for development of a Quality Manual, an example Quality Manual has been prepared for the fictitious organization, Global Ready Mixed Company (Global). The Global Quality Manual is for illustration purposes only and does not serve to indicate standard practice for items such as tests conducted or frequencies or minimum requirements for a Quality Manual. The Quality Manual for each producer will vary significantly in terms of the sections covered and the details, based on the size and capability of the organization, the type(s) of market served, and the geographic locations of their plants.

The elements of these Guidelines and the sample Quality Manual are recommendations and should not be considered as a standard of the National Ready Mixed Concrete Association.

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1. Introduction

1.1 General

Describe Company background, market and organizational structure. Include an overview of the Quality Manual and identify persons responsible for approval and ensuring conformance to it.

The Introduction Section of your Quality Manual provides an opportunity for you to summarize the attributes of your organization. Begin with a discussion about the purpose of your company, addressing each of the following items:

- *summarize the history of your organization;*
- *provide a description of your products and services;*
- *define the geographic area your company serves;*
- *identify your plant locations (and specific locations where this Quality Manual applies, if different); and,*
- *provide any additional information that you believe may help define your company.*

It is important that your organization have a documented Quality Policy. This Policy should identify your company's quality principles. A copy of your Quality Policy should be included in this Introduction Section and if your company has a Mission Statement, it should also be included.

- *Provide a brief overview of the Quality Manual. The intent of this Manual is to provide detailed, concise documentation of your organizations comprehensive QMS. This QM does not provide detailed work instructions. The Manual references but does not duplicate other industry standards or company programs (ASTM Standards, Safety Manual, etc.).*
- *The Quality Manual should be endorsed and approved by the Company's chief executive and be the responsibility of the Quality System Coordinator.*
- *The pages should be numbered by Section for ease of revisions.*

1.2 Quality Policy

Outline the Company's Quality Policy and quality goals that are clearly understood by all employees

Your "Quality Policy" should identify those items that your senior management considers important to your organization. State goals that generally support your quality policy. Examples include:

- *Appreciation of our employees as the "driving force" of our business,*
- *Provide ready mixed concrete designed and proportioned to meet the performance criteria identified or purchasers requirements,*
- *Hire and train individuals to establish the best qualifications for the positions to be filled,*
- *Deliver concrete courteously,*
- *Continual training of our employees is important,*
- *Recognizing our suppliers as partners and a valuable, integral part of our business,*
- *Responsive to the needs of our customers,*
- *On time deliveries,*
- *Continuously improve preferably in measurable terms,*
- *Purchasing and maintaining the best equipment available for the tasks required,*
- *Manufacturing and delivering consistent ready mixed concrete,*

- *Delivering concrete safely,*
- *Having the best looking trucks in our market area.*

How does your company communicate your Quality Policy and how often is the policy reviewed?

1.3 Terms and Definitions

Define terminology that is used in your Quality Plan

Some definition of terms will help clarify the intent when these terms appear in the Quality Plan.

QUALITY CONTROL - also called **PROCESS CONTROL** - is defined

** as those quality assurance actions and considerations necessary to assess production and construction process so as to control the level of quality being produced in the end product. This concept of quality control includes sampling and testing to monitor the process but usually does not include acceptance sampling and testing.*

*** the sum total of activities performed by the seller (producer, manufacturer and/or contractor) to make sure that a product meets contract specification requirements. Within the context of highway construction this includes materials handling and construction procedures, calibration and maintenance of equipment, production process control and any sampling, testing and inspection that is done for these purposes.*

**** Actions taken by an organization to provide control and documentation over what is being done and what is being provided so that the applicable standard of good practice and the contract documents for the work are followed*

QUALITY ASSURANCE (QA) - is defined

*** All those planned activities and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. Within an organization, QA serves as a management tool. In contractual situations, QA serves to provide confidence in the supplier.*

**** Actions taken by an organization to provide and document assurance that what is being done and what is being provided are in accordance with the contract documents and standards of good practice for the work.*

A QUALITY CONTROL PLAN - is defined

*** A detailed description of the type and frequency of inspection, sampling and testing deemed necessary to measure and control the various properties governed by agency specifications. This document is submitted to the agency for approval by the contractor during the pre-construction conference.*

**** The term quality plan is utilized within the context of quality manual as the overview document that your company will produce to describe your Quality Management System (QMS).*

* *Glossary of Highway Quality Assurance Terms*, Transportation Research Circular Number 457, Transportation Research Board, April 1996.

** *Quality Assurance Guide Specification*, A Report of the AASHTO Highway Subcommittee on Construction, February 1996.

*** *Guide for Concrete Construction Quality Systems in Conformance with ISO 9001*, ACI 121R-08, American Concrete Institute, Farmington Hills, Michigan.

2. Quality Management System (QMS)

2.1 General

Describe the general outline of Company's Quality Management System (QMS) that is represented in the Quality Manual (QM)

Every ready mixed concrete company has a Quality Management System (QMS) in place. The System may be relatively informal with minimal documentation or quite elaborate with a comprehensive Quality Manual (QM). The desired level of documentation for your company is dependent upon the size and complexity of your organization and the competence of your personnel.

2.2 Documentation Requirements

Describe your company's purposes or goals for documenting your QMS.

The QMS consists of those processes, resources, policies, materials and activities that influence your product and service quality. It is important that you define, document, implement, maintain, and continuously improve your QMS. Documentation of your QMS should not be the goal, but instead be a means of achieving your goal. Identify the purposes for documenting your QMS which may include to:

1. *demonstrate to your customers your ability to consistently provide ready mixed concrete that meets their performance criteria and/or applicable specifications;*
2. *provide continuity and uniformity of processes;*
3. *enhance training;*
4. *improve customer satisfaction; and*
5. *establish a measurement system to facilitate continuous improvement through statistically-based concepts, when applicable.*

2.2.1 Quality Manual (QM)

Outline the activities that support you company's QMS

Defining and documenting your QMS is merely a part of a company-wide quality initiative. Hiring competent personnel, purchasing the necessary equipment, and implementing a sampling and testing program, do not necessarily assure production of quality concrete. These efforts might only serve to enlighten your management on the current shortcomings of company operations and concrete production. Other decisions need to be made to make your QMS a worthwhile investment.

Your "QMS" defines a number of functions which not only include the design and control of your company's products, but a number of activities only indirectly related to control of quality. Define representative quality activities that are addressed in your QM, which may include:

- *sampling and testing of concrete and concrete materials;*
- *plant and field control of concrete production;*
- *personnel training;*
- *user education efforts;*
- *company representation in industry and professional groups;*
- *evaluation and procurement of new equipment and tools to improve quality;*
- *concrete mixture optimization;*
- *various promotional activities;*
- *research and development testing;*

- *specification review; evaluation of concrete performance; and*
- *failure analysis and prevention.*

ACI 121, Quality Management System for Concrete Construction, is a “guidance document for the development and implementation of quality systems for concrete construction projects”. The development of the Company’s Quality Manual should refer to ACI 121 requirements for a Material Supplier.

2.2.2 Responsibility and Authority

Identify responsibilities for maintaining the Quality Manual

In this sub-section you should identify who is responsible for QMS documentation and how changes to the Manual are made. You need to establish a Quality Committee for the oversight of your QMS and identify the composition of the Committee and the frequency that the Committee meets. The Committee should evaluate quality improvements, determine if the improvements are achievable, and determine whether the anticipated cost to achieve the improvement is worth it.

Executive Management must designate a Quality System Coordinator. The Quality System Coordinator should be responsible for assigning the Quality Manuals, monitoring the QMS, and controlling future revisions to the Manual. The Quality System Manager should report directly to Executive Management regarding QMS issues and be a member of the Quality Committee.

2.2.3 Control of Documents

Establish procedures for control and distribution of the Quality Manual and the process of incorporating and implementing revisions.

Control of your documents and maintenance of your records is an important part of your QMS. You should identify who is responsible for distributing your Quality Manuals, how you record recipients of your QM, how you revise your QM, and how you maintain consistency with each Controlled Manual. This distribution can be done electronically ensuring that the document cannot be modified by the recipients.

2.2.4 Control of Quality Records

Identify types of records and responsibility. Establish record retention policy.

Identify what quality records your company maintains, who keeps what records, where the records are kept, and for how long? A record retention list that includes period of retention and responsibility should be maintained by the Quality System Coordinator.

3. Management Responsibility

3.1 General

State the support and commitment of Company's management to the Quality Policy

The senior management of your company establishes the significance of quality in your organization. It is important that your senior managers demonstrate their commitment to your company's quality initiative. There is a investment by the company associated with establishing and maintaining a QMS and supporting future improvements. This investment will be returned many times over. Your management must be committed to the development and implementation of the QMS and to the continuous improvement of your organization.

*The **Quality Policy** illustrated in Section 1 of your Quality Manual should reflect the quality principles important to your senior management and subsequently your organization. The level of your company's management commitment to quality should be addressed. The selection of the cement content for the various strength classes of concrete may indicate a certain level of quality, however, the overall (quality related) decision-making process addresses many other important issues. Examples of other quality issues may include a willingness to maintain product quality regardless of competitive pressures or establishing appropriate limits for the re-use of returned concrete.*

3.2 Planning

Outline the Company's planning process for business, financial and quality for the Company.

Discuss business and quality planning within your organization. Your routine planning may consist of daily or weekly managers meeting to plan for on-going and up-coming projects, seasonal variations, staffing, etc. Comprehensive planning may include budgeting and annual updates of your Business Plan.

3.2.1 Quality Objectives

Define the Company's quality objectives in measurable terms that support its Quality Policy.

Before your company fully develops your quality plans, you should identify and/or review your quality objectives, which must be consistent with your Quality Policy. Explain what your company's quality objectives are. The quality objectives should be measurable and the method of measurement defined. Examples of quality objectives include:

- *achieving and maintaining Company Certification;*
- *ACI Certification of all of our Concrete and Laboratory Technicians;*
- *achieving 90 percent on-time delivery;*
- *having a fleet of ready mixed concrete trucks with no single truck over five (5) years old;*
- *achieving and maintaining NRMCA Plant Certification for each of our ready mixed concrete plants;*
- *achieving 95 percent customer satisfaction;*
- *maintaining plant standard deviations, based on general construction testing and designated mixes, less than 500 psi;*
- *tracking and quantifying the reasons and cost of rejected loads;*
- *quantifying the cost to the company for quality related problems and resolution*

3.2.2 Quality Management System (QMS) Planning

Describe the Company's process and persons responsible for planning to ensure continuous improvement to the QMS.

Your Company's senior management is responsible for identifying and subsequently allocating the resources necessary for the on-going implementation and continuous improvement of your company's QMS. Describe the procedures used for monitoring and maintaining your QMS.

3.2.3 Product Realization

Define processes employed towards product realization and monitoring systems.

In order to manufacture and deliver the products and services you provide, you should identify and monitor the sequence of processes (and sub-processes) that you employ. You should also discuss how you have organized your production processes and the methods used for monitoring those processes.

3.2.3.1 Planning

Describe the planning activities for the Company's products and identification of processes and resources.

Identify the products and services that your company provides and who in your organization determines what products to add and/or delete. What planning does your organization do to expand your market or add products and services?

3.3 Responsibility and Authority

Identify the Company Executive(s) responsible for approving the Quality Manual and subsequent documentation.

The Owner, President, or General Manager of your company should be responsible for approving and signing your Quality Manual. Identify who in your organization is responsible for the documentation of your QMS. Implementation and monitoring of your QMS should be the responsibility of your Quality Committee.

3.4 Internal Communications

Identify the methods of communicating the Company's QMS to the employees

What methods does your company use to communicate your QMS? Methods of communication could include:

- 1. Discussion and review of your QMS at your scheduled managers meeting.*
- 2. Distribution of Sections of your Quality Manual to those individuals affected by that portion of the Manual.*
- 3. Encouraging the review of and strategically placing Sections of your Manual for the convenience of your employees.*
- 4. Including the maximum number of employees in the review process of Internal and External Quality Audits.*
- 5. Including different employees as rotating members of your Quality Committee.*
- 6. Distribution of revisions to this Manual to ensure that all are operating from a current version.*
- 7. The Operations Manager meets periodically with each Plant Manager to review QMS and safety issues.*

8. *Quality training for all production employees at certain stated intervals. This meeting provides the opportunity to insure that your production employees are familiar with the provisions and content of your Quality Manual.*

3.5 Management Review

Describe the review process for implementing the Company's QMS.

As previously discussed, your senior management is responsible for establishing your Quality Committee to implement and maintain your QMS. The role and composition of the Committee should be as defined in Section 2, Quality Management System. The frequency of meetings and the tasks to be accomplished at each meeting should be addressed.

3.6 Work Environment

Describe the Company's work environment that supports optimum performance of employees and infrastructure requirements to ensure product conformity.

Describe the company's work environment as needed to achieve optimum workplace performance of its employees and to achieve conformity to product requirements. This item may address office and plant infrastructure needs and associated management. Some items that might be addressed include workspace, process hardware and software, health and safety conditions, facilities for ergonomics, and other work conditions.

4. Customer Focus

4.1 General

State the general goals and the measurement that supports the Customer Focus of the Company.

Begin your Customer Focus documentation with a brief discussion of your company's methods of determining your customer's needs and requirements. You should then discuss how you determine your success, or lack thereof, in meeting those customer requirements. Specific items to be addressed should include customer satisfaction, customer input, complaint management and customer connections.

4.2 Customer Satisfaction

Define the Customer and the means of measuring customer satisfaction.

Identify your customers (external and internal) and then define how you measure their level of satisfaction with your products and services. Although many of your customer requirements are documented in the project specifications, many of their needs and inherent requirements are not specifically stated.

How do you evaluate your customers' perceptions of your organization or their level of satisfaction with your performance on a particular project? How do you monitor your proposals, quotations, purchase orders and contracts to determine that you are addressing the requirements and needs of the customer? Discuss the process by which internal pricing decisions are made including input from Operations and Technical Services personnel.

4.3 Customer Input

Describe methods used to capture customer feedback.

Discuss the methods that you employ to "listen to your customers". Do you receive customer input regarding your organization's products and performance? Do you solicit advice from your customers and potential customers? Do you have a Customer Advisory Committee?

4.4 Complaint Management

Describe the process of managing and responding to customer complaints.

Complaint management is especially challenging for the ready mixed concrete producer. Complaints may be received by virtually any employee of your organization. Drivers, dispatchers, sales personnel, quality control/quality assurance, plant personnel, accounting and management personnel all receive complaints. You should describe how you capture complaints and how the complaints are processed. Many organizations have a simple "Complaint" form on a small pad which they provide to all employees. Regardless of the method that you use to record the complaint, always double check the correctness of data and the spelling of names. The correctness in detail assists the acceptance of information by others. It is important to promptly act on even the smallest of complaints. Delays or inaction may result in further customer dissatisfaction and ultimately in costly litigation. You should have procedures in place to tabulate complaints and prepare summary reports for management. These reports should be factual and objective.

It is important to remember that all customer complaints and inquiries are not related to concrete. The motoring public may complain about a driver's driving; a customer may question your invoice; or a neighbor may complain about noise from a plant. Each complaint provides your company with

someone else's perspective of your organization and gives you an opportunity to placate a customer or interested party and improve your processes.

Support any opinions presented in the reports with reference to printed materials, whenever possible. Distribute the summary reports as appropriate. Depending upon the circumstances, it may be appropriate to forward a copy of the report or a letter of explanation to the customer.

4.5 Customer Connections

Describe methods used to interact with Company's customers.

Explain the methods that you use to "connect" with your customers. On what occasions do you visit your customers' offices? How do you promote your business and industry to your customers and potential customers? Examples of promotional activities that you may employ include:

- *Presentations to customers of your performance records on previous major or special projects, including records of dependable early strengths of concrete (as required in high-rise construction).*
- *Demonstration of the scope and qualifications of your company's quality control organization, including reference to its participation in inspection and accreditation programs of outside agencies.*
- *Proper procedures for sampling, handling, testing ready mixed concrete;*
- *Expanding markets and applications of ready mixed concrete, to include a wider use of concrete by owners, designers, and builders.*
- *Documentation of plant and mixer inspection schedules and plant certification, if applicable.*
- *Assisting your customers with evaluating cost efficiencies and recommending quality improvements in placing and finishing concrete.*
- *Distribution of technical literature including NRMCA Concrete In Practice (CIP) brochures and other publications with the company imprint, as applicable to various job situations.*
- *Finishing demonstrations emphasizing the importance of correct timing of finishing operations.*
- *Demonstrations with local testing agencies on correct testing practices and discussion of adverse effects of various improper testing procedures.*
- *Suggested standard practices for ordering concrete which will help ensure that concrete of the proper quality level will be provided for typical local uses in commercial and residential construction.*

Do you jointly promote with other firms in your area and/or your state Ready Mixed Concrete Association? Do you offer promotions and demonstrations to Architectural and Engineering Firms, specifiers, community organizations, educational institutions and other interested groups?

Possibly you schedule seminars for local builders, contractors and concrete finishers in which the basics of quality concrete and proper placement practices are explained. Suitable subjects for these seminars may include: control of mix water content; importance of air-entrainment; cold and hot weather concreting; crack prevention in flatwork through correct joint design; and benefits of proper curing of concrete.

Through your state association and/or with other local producers you may promote the uses of concrete and realism in concrete specifications. Additional joint presentations may include:

- *Presentations explaining the advantages and efficiencies of using concrete in various applications including tilt-up construction; city street and parking lot pavements; thermal insulation value due to concrete mass factor.*

- *Sponsor manufacturers' presentations on innovations in the use of various chemical admixtures and supplementary cementitious materials and benefits imparted to handling characteristics; hot weather performance of concrete; and durability of concrete. In general, the versatility of concrete as a construction material is demonstrated.*
- *Panel discussions on realism in concrete specifications, including the cost-effective use of local materials; the need for appropriate tolerances in strength, slump and air-entrainment; reduction in job mix variables for optimum plant control of concrete; limitations of the water-cement ratio concept in mix design and field control of concrete; reasons for concrete cracking; and sampling and testing of concrete -- the right way. Stress the importance of receiving copies of acceptance test reports to facilitate further product quality monitoring and improvements.*

You may elect to have presentations and demonstrations at lunch meetings, with your company or association providing box lunches. Professionals attending your seminars and demonstrations may be able to obtain Professional Development Hours (PDH) for their attendance.

*One critical forum for your customer focus is the pre-bid, pre-construction, and/or pre-pour conference. Describe your participation in these conferences. You may wish to use the **Checklist for the Concrete Pre-Construction Conference**, developed jointly by the National Ready Mixed Concrete Association (NRMCA) and the American Society of Concrete Contractors (ASCC), to assist in planning on major and unique concrete projects. A copy of the complete Checklist is illustrated in Appendix E.*

5. Human Resources

5.1 General

Provide an overview of the Company's philosophy in recruiting and retaining qualified employees.

Section 5 of your Quality Manual provides your organization with the opportunity to present the qualifications and responsibilities of your quality related personnel. Initially you should provide an overview of your company's personnel policies (selection, hiring, promotion, key characteristics, etc.).

5.2 Competence

Identify the competencies required for different positions and specifically identify quality related responsibilities.

Describe your company's policy regarding the core competencies needed by your quality personnel. Refer to the company's organization chart that provides responsibility outlines (job descriptions) for each of your key personnel primarily responsible for quality assurance/quality control. It is not necessary to include this in the Quality Plan because it changes frequently. Generic company job descriptions are often maintained by the Company's Human Resources Department. NRMCA has a compilation of typical job descriptions and required competencies for ready mixed concrete company personnel.

Identify who in your organization is responsible for the distribution and maintenance of your Quality Manual. Provide an overview of the importance of your quality assurance/quality control (Technical Services) activities to your company.

5.3 Quality Awareness

Describe the process and responsibility of dissemination of the QMS to Company employees.

How does your company make your employees aware of quality related information? Explain who is responsible for quality related communications and how that communication is disseminated.

5.4 Training and Career Enhancement

Describe personnel training and education and opportunities for career growth provided to all employees at different stages of their employment.

Discuss your company's personnel training procedures and stress the importance of your key quality personnel achieving industry recognized certification at the state or national level. Describe the quality related training of your employees beginning with the interview process and continuing throughout their career with your organization. Present training opportunities within your company which may include the initial interview process, introductory training, on-the-job training, and continuing education.

Does your company encourage employee career growth through participation in:

- *Industry Technical Committees: Membership in Industry Technical Committees provides the opportunity to participate in efforts to improve industry standards and technical specifications, including those of governmental agencies;*
- *Specification-Writing Groups: These offer a direct forum for presenting the industry point of view on existing and upcoming standards governing materials specifications and tests methods.*

- *Membership on ACI and ASTM Technical Committees and regular attendance at these Conventions. Generally these Societies meet twice a year. Participation in local ACI Chapters;*
- *Professional Associations: Personal involvement in Professional Associations, and the presentation of special programs, serve to advance the reliance by design professionals on concrete as a versatile and dependable building material;*
- *Membership on the technical committees of your state Ready Mixed Concrete Association;*
- *Membership on NRMCA Committees.*

Has your Company established the means to communicate and work on developing issues that could adversely affect the industry in general, not just your organization?

Appendix B list competencies for some ready mixed concrete company personnel illustrating the range of instruction subjects recommended.

Discuss who keeps employee training records and where these records are kept.

6. Facilities, Plant(s) and Equipment

6.1 General

Describe the overall infrastructure of your Company's production facilities.

Section 6 of your Quality Manual is where you describe your company's facilities, plant(s), and equipment and associated quality related procedures. In this section, summarize your company's primary equipment (plants, trucks, laboratory, etc.). Details can be referenced rather than including in the Quality Plan.

6.2 Infrastructure

Describe in more detail the overall infrastructure of your Company's production facilities and related quality initiatives in compliance with Company and industry standards.

Provide an overview of your concrete plant equipment and any applicable Plant Certifications. Describe quality related plant procedures and reference, or include, documented company standards.

Provide information on your company's truck fleet and any applicable Truck Certifications. Describe quality related truck procedures and reference, or include, documented company standards.

6.2.1 Ready Mixed Concrete Plants

Describe details of each production facility to include equipment and process used.

This can be included in the Quality Manual or referenced to a source of information. On separate consecutive pages include a fact sheet for each concrete plant location, including:

- *Plant manufacturer*
- *Rated capacity*
- *Concrete mixing method*
- *Component material storage capacities*
- *Number of trucks*
- *Description of the plant*
- *Certification(s) and Inspection(s) of the plant and trucks (if applicable)*

6.2.2 Laboratory Facilities

Describe details of quality testing resources to include equipment and process used.

The sampling and testing of concrete and concrete component materials are a critical aspect of your company's quality assurance and quality control. You should provide a detailed explanation of your company's sampling and testing resources, including:

- *Description of your (internal or external) laboratory facility(s);*
- *Summary of personnel assigned to the Technical Services Department, if any;*
- *Quality related publications available;*
- *Laboratory Accreditation(s), if applicable;*
- *List of equipment available in your laboratory.*

The details of these items do not need to be included in the Quality Manual and can be referenced to a source.

If your company operates a laboratory, your lab may be accredited or you may wish to seek

accreditation, to document your laboratory's qualifications. The NRMCA Concrete Laboratory Resource Guide, located in Appendix C, provides information regarding the competency, documentation, and inspection requirements for various Laboratory Accreditations.

If your company's laboratory is accredited, you should explain the type of accreditation and the requirements associated with your accreditation. If you do not have a laboratory or your laboratory is not accredited, you should explain the outside (Independent Testing Laboratory) resources available to your organization. If applicable, discuss your company's participation in a local or national proficiency sample testing program and laboratory inspection program, besides accreditation.

Briefly explain who keeps what quality records in the laboratory and where those records are located.

Laboratory testing priorities are generally directed at those tests that are most important to the acceptance of concrete by your customer. Having the capabilities of testing fresh concrete and the strength (and other properties) of hardened concrete, are extremely important to your operations. The NRMCA Concrete Laboratory Resource Guide (Appendix C) includes a list of the tests that may be performed in a concrete materials laboratory, the test method for each test, and the equipment that is used in conducting the test. Discuss testing of ingredient materials such as aggregates, cementitious materials monitoring and water (if recycled) tests and frequencies. Identify the laboratory equipment that your company has available for materials and concrete testing.

6.3 Control of Monitoring and Measurement Devices

Establish the process and frequencies for monitoring accuracy of measurement devices in production facilities and laboratories.

Describe your company's standards regarding the frequency of calibrating your batch plant scales, water meters, admixture dispensers, moisture meters, and laboratory equipment. If any equipment is found to be out of calibration, discuss your process for corrective action.

6.4 Equipment Maintenance

Establish the process and frequencies for maintenance of equipment in production facilities and those for delivery fleet.

Explain your company's maintenance facilities and procedures. Describe Preventive Maintenance processes for your concrete plants which may include, but are not limited to:

6.4.1 Silos for Cementitious Materials

- *Provide moisture proof storage and physical separation by means of double bin walls or separate silos. Check tightness of separation walls in multi-compartment silos by determining accumulation of cement or pozzolan in compartment left in "empty" condition.*
- *Check for accidental "cross-feed" in transfer devices.*
- *Monitor the high-bin indicators, anti-overfill devices and pressure sensors for correct operations.*
- *Inspect the Dust Collection systems in accordance with the manufacturer's recommendations.*

6.4.2 Aggregates

- *Provide physical separation of aggregates by type. Periodically empty and inspect the wear of the overhead aggregate bins.*
- *Monitor transfer devices, turnhead limit switches, and full-bin signals for correct operation.*

6.4.3 Chemical Admixtures

- *Confirm that admixture storage containers are properly identified with the chemicals stored*

within.

- *Provide protection against freezing, as required. Freezing of air-entraining agents may cause solids to settle out resulting in wide variations in air content.*
- *Inspect agitation devices as required to maintain uniform solution densities (e.g., standard calcium chloride solutions). Tanks, hoses, and dispensers for seasonal admixtures should be operated weekly.*
- *Insure that admixture dispensers are functioning correctly. Make sure that sight glasses are clean and are provided with legible graduations. Periodically check for tank integrity and for leaking hoses and faulty connections.*
- *The dispenser units should be visible from the batcher station for immediate detection of any malfunction.*

6.4.4 Batching Equipment

- *Make sure that weigh batchers remain freely suspended; the scale linkages clean; that wind protection is adequate for cement weigh batchers; there is no binding against the frame or other obstructions (check when weighing capacity loads); and there is no binding of scale cables (at entry port to control house).*

As a rapid means of checking batching accuracy, the truck mixer can be tared before hand on a truck scale and then weighed immediately after batching to check the weight of the batch.

- *Insure that the cement weigh batcher is properly vented and there is no back pressure on the scale system from pneumatically charging the cement or pozzolan silos (aerator; or from pneumatic unloading of transportation units).*
- *Monitor batching records for verification of batching accuracy.*
- *Rotate the sheaves or cable pulleys periodically for uniform wear.*
- *Discuss record maintenance policies relative to time and cross reference to delivery tickets.*
- *Make provision for periodically checking the actual admixture discharge into mixer.*

Obstructions at end of discharge line, or low air pressure in pneumatic discharge, may cause holdback which may enter next batch.

6.4.5 Central Mixer

- *Designate the frequency of checking for build-up of hardened concrete and blade wear.*
- *Define the frequency of performing mixer uniformity test, if conducted.*

6.4.6 Truck Mixers

- *Check for concrete build-up, blade wear, revolution counter in working condition, accuracy of water gauge or meter, and general condition of truck water system (legible quantity indications, clean gauge, water leaks).*
- *Verify the TMMB rating plate for mixing and agitation and the manufacturer's plate for operating details.*
- *On units with hydraulic slump meters, verify correlation of hydraulic pressure to slump of standard mixes and load size established.*

7. Materials Management

7.1 General

Indicate the component materials used and the Company's selection process.

Identify the component materials that your company uses in the manufacture of ready mixed concrete. Component materials may include, but are not limited to Portland Cement, Fly ash, Slag, Silica Fume, Chemical Admixtures, Fine Aggregates, Coarse Aggregates, Fibers, Color, and water.

Explain your organizations selection process for component materials. The specific materials required may be necessitated by the project specifications or the mix design selected. The selection of individual component materials strictly on the basis of economy may result in higher mix costs and/or increased quality control expense. A poor quality cement may produce highly variable concrete strengths and a fine aggregate subject to erratic changes in grading may cause unexplained water demand and a subsequent reduction in concrete strengths. While troubleshooting these problems, your Technical Services personnel may not be available for other critical assignments.

7.2 Supplier Qualifications and Selection

Discuss the Company's criteria, consistent with your Quality Policy for selecting component material suppliers.

Discuss your company's supplier relations (consistent with your Quality Policy) and identify your procedures for selecting concrete component material suppliers. Selection criteria may include:

- *previous experience with the supplier;*
- *component material availability;*
- *price;*
- *knowledge of the supplier's quality assurance/quality control program;*
- *State DOT Approved Materials;*
- *delivery; and*
- *support services available (training, safety, administrative, etc.).*

Does your company require your suppliers to have a Quality Assurance/Quality Control Plan (Quality Manual)? Are your company's suppliers required to have an accredited laboratory? Do you require your suppliers to employ a certified quality control technician(s)?

7.3 Supplier Requirements (Expectations)

Discuss the Company's requirements and expectations of component material suppliers those are consistent with the Quality Policy.

Identify your company's quality related requirements or expectations for each of your component material suppliers. Purchase Orders (specific and/or open-ended) should be issued for each component material purchase, in accordance with Section 9, Purchasing of this Quality Manual. For each component material specify the testing, documentation and reporting that your company requires of your suppliers. Establish and define office procedures to monitor regular receipt, review, and distribution of supplier provided quality control reports. Review each report for changes from previous reports. Requirements by component material may include:

7.3.1 Coarse Aggregates

For example, the Company may request that each coarse aggregate supplier should provide:

1. *Aggregates, as specified, meeting the requirements of ASTM C 33 for normal weight aggregates and ASTM C 330 for lightweight aggregates;*
2. *A monthly summary of their gradation representing a minimum of one (1) sieve analysis for every 400 tons shipped, or a minimum of one test per week for each product purchased;*
3. *Specific gravity, absorption, and petrographic analysis test results every 3 years or when there appears to be a change in the aggregate source, including a new lift or location within the quarry;*
4. *Tests results of the evaluation of the aggregate for potential alkali-silica or alkali-carbonate reactions;*
5. *Tests results for aggregates containing particles with an iron sulfide content that shows a stain index less than 20 when tested in accordance with ASTM C 641;*
6. *A visual check prior to shipment of aggregates for exposed surfaces, for general appearance against the approved sample;*
7. *Aggregate certification indicating compliance with ASTM or equivalent AASHTO specifications.*

7.3.2 Fine Aggregates

For example, the Company may request that each fine aggregate supplier should provide:

1. *Aggregates, as specified, meeting the requirements of ASTM C 33 for normal weight aggregates and C 330 for lightweight aggregates;*
2. *A monthly summary of their gradation and fineness modulus representing a minimum of one (1) sieve analysis for every 200 tons shipped, or a minimum of one test per week for each product purchased;*
3. *Specific gravity and absorption test results every 3 years or when there appears to be a change in the aggregate source;*
4. *Tests results for deleterious substances and organic impurities annually;*
5. *Tests results for materials finer than No. 200 sieve for new sources or any time variations are experienced;*
6. *An original notarized letter of the Producers Certification annually for each product purchased.*

7.3.3 Cement

For example, the Company may request that each cement supplier should provide:

1. *Cement, specified by Type, meeting the requirements of ASTM C 150, C 595 and C 1157;*
2. *Mill Tests Reports, with each shipment of cement or bill of lading, that certify conformance to ASTM or AASHTO specifications;*
3. *A monthly ASTM C-917 (Cement Strength Uniformity) report by the 15th of the month following the 28-day cube breaks. This report may only be available for a predominant product from a cement source (not available for all product) but provides an indication of the uniformity of product from the source;*
4. *An original notarized letter of the Manufacturer's Certification annually or more often for each product purchased.*

7.3.4 Fly Ash and Slag Cement

For example, the Company may request that every Fly Ash and Slag supplier should be required to

provide an original notarized letter of the Manufacturer's Certification annually, for each product purchased.

Each Fly Ash supplier should provide:

- 1. Fly Ash, specified by Class, meeting the requirements of ASTM C 618;*
- 2. Mill Tests Reports with each shipment or bill of lading of Fly Ash.*

Each Slag supplier should provide:

- 1. Ground Iron Blast-Furnace Slag meeting the requirements of ASTM C 989;*
- 2. Mill Tests Reports with each shipment or bill of lading of Slag.*

7.3.5 Chemical Admixtures

For example, the Company may request that each Chemical Admixture supplier(s) should provide:

- 1. Chemical Admixtures meeting the requirements of ASTM C 494 or C 260 for air entraining admixtures;*
- 2. Recommended dosages for various applications and placement conditions;*
- 3. Notarized statements on chloride content. Use of admixtures containing chlorides may be prohibited under certain conditions;*
- 4. An original notarized letter of the Manufacturer's Certification annually for each product purchased.*

7.4 Conformance Monitoring

Describe the Company's component materials testing and monitoring processes and responsibilities to verify compliance with purchase agreements and for quality of concrete.

Receiving and conformance testing are routine quality assurance/quality control functions. Through verification testing your company can monitor the quality of the products you receive and verify the creditability of the reports from each supplier. Discuss your process for the monitoring and measurement of ingredient materials. Identify the key ingredient material properties that you are monitoring which may include: cement strength, sand FM or percent passing No. 50 sieve, moisture, unit weight, etc.

Aggregate gradations should be reviewed for consistency and conformance to grading requirements. Control charts of representative sieves should be provided by the supplier or developed internally. Additional aggregate tests should be provided and evaluated, as required.

Cement Mill Tests Reports should be reviewed for changes from the previous reports and for the following:

- ASTM C 109 cube strength;*
- Fineness;*
- Compound composition;*
- Loss on ignition (LOI);*
- Total alkali, expressed as Na₂O equivalent.*

Fly Ash Mill Tests Reports should be reviewed for changes from the previous reports and for the following:

- Sum of SiO₂, Fe₂O₃, and Al₂O₃*
- Material Retained on No. 325 Sieve (C 430).*

- *Loss on Ignition (LOI)*
- *Strength Activity Index with Portland Cement*
- *Total Alkalis*

Slag Mill Tests Reports should be reviewed for changes from the previous reports and for the following:

- *Slag Activity Index (C 989)*

Conformance testing of your concrete making materials should be in accordance with the “NRMCA Guidelines for Conformance Testing of Concrete Component Materials” which is included as Appendix D in the Quality Manual.

7.5 Materials Handling and Stockpile Procedures

Describe the processes for materials receiving, handling and processes that support the quality initiatives of the Company.

Discuss your company’s procedures for the receiving, handling, and storing (stockpiling) of materials. Describe how your company insures that the proper materials are placed in the proper storage areas. Does your company;

- *Have all of your ground storage areas properly identified?*
- *Label your silo fill pipes?*
- *Require connection confirmation for unloading of cement and pozzolans?*
- *Train dump truck drivers (internal and/or external) on delivery procedures and the yard layout?*

Identify the method(s) used to deliver each component material to your plant(s), the method of storing each material, and how the material is transferred to the truck mounted or central mixer. The following Table may be used to summarize your company’s Material Handling.

MATERIAL HANDLING

<i>MATERIAL</i>	<i>DELIVERY TO PLANT</i>	<i>STORAGE TO MIXER</i>
<i>Cement</i>		
<i>Fly ash</i>		
<i>Slag</i>		
<i>Fine Aggregate</i>		
<i>Coarse Aggregate</i>		
<i>Chemical Admixtures</i>		

7.6 Customer Property

Describe the process for managing special materials that may be used for certain projects that might be required or purchased by Customers.

Occasionally on a large or unique project, your customer will specify a component material that you do not routinely inventory. This may be a non-standard chemical admixture, a larger than normal aggregate size, Type K Cement, steel fibers, etc. Identify your company’s procedures for isolating this customer purchased product and define how your organization preserves the quality of this product until use.

8. Concrete Mixture Development or Selection

8.1 General

Describe your overall process for design of concrete mixtures and selection process for projects.

Section 8 of your Quality Manual (QM) provides your organization with the opportunity to define how you design new concrete mixtures and select specific mixtures for a project or application. The quality of your ready mixed concrete is a function of the properties of the individual component materials as well as a function of the interaction of the selected materials in the composite mix. In Section 7 of this Manual you defined your company's methodology for selecting component material sources and your testing requirements for these materials. It should be stressed in this Section that new materials may not be used in your concrete until all initial testing is complete and the results have been analyzed.

The initial requirement for designing or selecting the proper concrete mix proportions is to determine the performance characteristics of the ready mixed concrete. Performance characteristics for concrete may include, but are not limited to:

- *Setting characteristics*
- *Material compatibility evaluation*
- *Workability;*
- *Placeability;*
- *Strength;*
- *Uniformity;*
- *Durability; and*
- *Aesthetics.*

8.2 Determination of Mixture Proportions and Selection of Component Materials

Describe the process and objective when designing and proportioning concrete mixtures.

The objective in designing your concrete mixes is to develop a workable, economical concrete mix that meets the performance criteria identified. Define specifically how your company proportions new concrete mixes including the criteria used for the component materials for different performance requirements for concrete mixtures. Do you design mixtures internally, request assistance from your supplier(s) or use an outside Engineer or Independent Testing Laboratory? Are mixtures proportioned in accordance with practices identified by ACI Committee 211? The ACI 211 Committee report provides practices for proportioning normalweight, lightweight, high strength, mass concrete, etc. mixtures.

Describe the qualifications that your company requires for individuals responsible for designing and proportioning concrete mixtures for various classes of concrete and in response to project specification requirements. Additional ACI publications (ACI 201, ACI 301, ACI 318, etc.) provide information, specifications and standards regarding concrete properties and the prequalification of concrete mixtures.

8.3 Evaluation of Mixture Development/Selection for Specification Criteria

Describe the process and objectives when designing and proportioning concrete mixtures. Include the communication process between sales, technical and operations.

In order to select the proper concrete mixture with the characteristics desired, it is important to obtain the following information:

- *Intended use of the concrete*
- *Method of placement*
- *Method of finishing*

For most major projects this information and additional details may be obtained by reviewing the job specifications, drawings, and structural notes. Project specifications and/or drawings may be obtained from Owners, Engineers, or General Contractors. The specifications should be maintained on file to evaluate any pre-qualification tests requirements prior to the bid or delivery date; evaluating durability requirements; determining the correct placement location within the structure; and verifying that the order has been correctly placed.

Sales personnel should communicate with operations and technical service personnel any applicable special project conditions.

Performance criteria for each proposed concrete mixture should be established and the methods used to verify the performance criteria should be documented. This may include some of the following:

- *Concrete strength data from previous job test records evaluated per ACI 214.*
- *Required average strength for each class of concrete established based on past test records as per ACI 318 and ACI 301 for the specified strength in the project specifications.*
- *Trial mixes either by the producer or Independent Testing Laboratory*
- *Prepare three (3) mixes with varying water-cement ratios and develop a three (3) point curve.*
- *Process of further optimizing of mixture proportions for economy for prescriptive and performance requirements*
- *Description of any other methods used to evaluate performance criteria of a proposed mix design.*

Section 15 of this QM will provide further details of your company's procedures for analyzing the data collected.

8.4 Validation of Mixture Selection and other specified Project Requirements

Describe the evaluation process of purchaser's requirements and project specifications, recording of mixture criteria and performance and compliance process.

Results of trial batches for new mixtures and the historical test data for established mixtures provide the basis for validating that the mixtures proposed for a project compare with the performance desired. Define your processes for recording the specified mixture performance criteria (form, checklist, etc.) and selecting your company's mixture that meets the project requirements.

It is vital that your company understand the needs of your customer or potential customer. Beyond reviewing the project specifications and drawings, what does your organization do to insure that the concrete mixtures selected for a project or application meets the defined needs of your customer? Do you contact the Architect or Engineer for clarification or recommendations regarding project specifications? Do you seek to have overly restrictive requirements (which do not diminish the performance criteria) removed from the specifications? Does your company require attendance at Pre-

Bid Conferences on major projects? By attending Pre-Bid Conferences your personnel may:

- *Determine A/E's or Contractor's points of emphasis in concrete control.*
- *Clarify unreasonable requirements and work toward realistic control standards.*
- *Explain importance of correct testing and employment of qualified testing agency and personnel.*
- *Arrange for concrete supplier to be put on distribution list of all concrete test reports.*

Other items to monitor in your specification review may include requirements for:

- *NRMCA Plant Certification (or others);*
- *Costs associated with unique test requirements;*
- *Specific types of production facilities and batching systems;*
- *Special types of component materials or concrete;*
- *Recording batch weights and reporting requirements on delivery tickets;*
- *Restrictions on concrete unloading times;*
- *Restrictions on type of water or jobsite water addition;*
- *Rate of concrete delivery;*
- *Limits on concrete temperature;*
- *No chute/truck rinsing permitted on site;*
- *Potential costs associated with improper sampling or testing;*
- *Safety training prior to going on site; and*
- *Back-up plant facilities.*

8.5 Concrete Mixture Verification and Submittal

Describe the process of documenting verification of mixture requirements to project specifications and developing the submittal package.

It is important that your organization has a process in place to verify that the concrete mixtures selected for projects or applications conform to the requirements specified. Explain your company's process developing a mix submittal package including the component materials, the component material sources, and the quantities of each material. Does your submittal information include all of the requirements identified in ACI 211.5, Guide for Submittal of Concrete Proportions? Identify differences in submittal documentation based on whether the mixtures are for prescriptive or performance-based specifications. Indicate the process of developing data and documentation of special concrete tests such as shrinkage, ASR, permeability, etc. Some of these tests may be outsourced, as needed.

8.6 Control of Changes to Designated Concrete Mixtures

Define the authority and responsibility of personnel charged with modifications to concrete mixtures during development and production. Describe the process used.

Identify who in your organization is authorized to make changes to established classes of concrete mixtures (other than minor moisture and admix adjustments). Define the process for changing designated concrete mixtures.

8.7 Concrete Mixture Summary

Establish process of establishing mixture designations, computer entry and evaluation of batch records.

Once you have selected the concrete mixture's component materials, developed the mixture proportions, tested the mixture, and evaluated the results, a unique mix number or designation needs to be assigned. Explain your company's methodology in assigning mix numbers and how you maintain the mix book or log. Who is responsible for maintaining your mix book and who determines the batch weights and enters the mixtures into your company's batch computer(s)?

Once a "Notice to Proceed" is issued for a project, who is responsible for providing a list of mixtures (including targets for slump and air) to the appropriate production, quality assurance, and administrative personnel?

9. Purchasing

9.1 Introduction

Describe your overall processes and objectives with purchasing component materials.

Purchasing is an important aspect of the quality process. In order to produce quality ready mixed concrete it is important that you purchase consistent reliable component materials. In this Section, define your company's purchasing procedures and identify what purchased products are covered.

9.2 Purchasing Process

Define the factors involved in the purchasing process and responsibilities of individual personnel.

The purchasing process begins once your company determines what product or service you need. Define the factors that influence your decision about source selection for concrete ingredient materials. These factors may include, but are not limited to:

- *availability;*
- *product quality;*
- *long term relationships;*
- *delivery;*
- *material costs;*
- *freight costs;*
- *quality control; and*
- *support.*

As discussed in Section 8, Concrete Mixture Development or Selection, the optimum individual component material may not provide the optimum concrete product. Does your company rely on Technical Services to evaluate each concrete component material prior to making a purchasing decision of that material? For example, a specific fine aggregate may be plentiful, close, of low cost, and meet specification requirements. It may not, however, perform well with the other raw materials available at the plant. Optimum concrete performance will be achieved through selecting the most effective combination or blend of component materials.

In order to document your company's purchasing process, you may find it beneficial to flow chart the process.

9.3 Purchase Agreements

Describe the process of developing and executing purchase agreements

Once your company has selected the optimum source for a component material a Purchase Agreement should be prepared. Purchase agreements are written contracts and should be prepared for each concrete making material. These are sometimes referred to as Purchase Orders. This section should describe the company's procedure for developing purchase agreements and the assigned responsibility and review/approval process used. The criteria for establishing purchase agreements may include technical requirements, price and supply and terms and conditions of these agreements.

Purchase agreements may include the following information:

- *Quantity of material or specific time period (It is recommended that time specific Purchase Orders not exceed one year)*

- *Material Pricing, Terms and Conditions.*
- *Specified method of delivery.*
- *The material description and any specified standard requirement.*
- *Testing documentation required and frequency of testing. This may be Mill Test Reports, supplier certifications, Sieve Analysis, or Chemical Analysis.*
- *Current Material Safety Data Sheets (MSDS).*
- *Detail of technical support required from the supplier.*
- *Supplier’s immediate disclosure of any non-conformance(s) of their product which may impact the quality of your company’s product.*
- *Acceptance testing procedures and methods of handling non-conforming materials.*
- *Other items to be addressed may include insurance certificates, specific operational requirements, or safety regulations that suppliers must follow.*

Authorized signatures should be obtained on the Purchase Agreement from the purchasing company and the supplier.

9.4 Purchasing Information

Describe the establishment of a Supplier list and recording process for purchased component materials

Suppliers of your company’s component materials for ready mixed concrete should be selected as discussed in Section 7.2 Supplier Qualifications and Selection, of this Quality Manual. Does your company have an approved supplier list? If so, is someone assigned the responsibility of maintaining and modifying the list as new products become available? Who is responsible for including new products in this list? Suppliers may be placed on an approved supplier list based on any of the following methods:

- *As of the effective date of this Quality Manual, all existing suppliers that have provided acceptable products and services should be included;*
- *Demonstration of the capabilities to provide the product and services required. This may include DOT Certification, past performance history, Quality Manual review, etc.;*
- *External Audit of the suppliers facilities and processes;*
- *Conditional approval based on the evaluation of future performance.*

It is recommended that no product be purchased from a supplier that is not on the approved supplier list. The approved supplier list should be reviewed and updated annually by the Quality Committee.

9.5 Verification of Purchased Product

Describe the process used to verify purchased products and documentation required and maintained.

Does your company require that delivery tickets be included with every component material shipment delivered to your plant(s)? Is each shipment verified and the delivery ticket or packing slip signed by the Plant Manager or delegate? What does your Plant Manager do with these documents?

Acceptance of the component material is based on receiving inspections, acceptance testing and the acceptable performance of the material. The quality testing and scrutiny that your company applies to your suppliers should be a function of the effect that their product has on your ready mixed concrete.

10. Order Processing and Dispatching Procedures

10.1 General

Describe the overall process of receiving orders for different types of projects and the communication and recording process.

Identify the types of orders that your company receives and the methods by which you receive these orders. Orders for ready mixed concrete vary significantly. For major and unique projects a Proposal from sales and/or a Purchase Agreement from the customer, generally specifies the anticipated quantity and class of concrete (by mix number). Established customers often use the same concrete mixtures day after day. Small contractors and individuals often describe their performance requirements and ask dispatch personnel what designated concrete mixture meets their criteria.

Orders for product should always be communicated between the customer and the appropriate order entry/dispatch personnel. Sales and management personnel may assist by facilitating communications between company dispatch personnel and the customer, however, the confirmation of the order and the time of delivery should be the responsibility of the order entry/dispatch personnel.

Explain your company's methods for receiving orders. Most orders are received by telephone, over a dedicated line, directly into the order entry/dispatch office. Some company's receive orders by fax and most recently by email. Often a customer or potential customer will come by the office to place an order.

10.2 Order Entry

Document the process and format of recording customer orders.

As orders are received, the orders are recorded on the appropriate order entry form or entered directly into the dispatch software. Your company may use the Checklist for Ordering and Scheduling Ready Mixed Concrete© or your own internal form. The Checklist was prepared by a Task Group of the National Ready Mixed Concrete Association (NRMCA) and the American Society of Concrete Contractors (ASCC). A copy of the Checklist is included in Appendix E. The minimum information required for entering an order is:

- *Name and address of the customer;*
- *Individual placing the order and contact information (particularly a cell phone number);*
- *Date and time the order was received;*
- *Customer number – all customers, except pre-paid and COD customers, should be assigned a customer number by the accounting department;*
- *Product and quantity desired – for ready mixed concrete the mix number and any additional requirements (fibers, color, etc.) should be identified. Other products to be delivered may include construction/expansion joint materials, finishing tools, etc.;*
- *Application that the concrete will be used for and method of placement;*
- *Address of the delivery and detailed directions to the site;*
- *Date and time of delivery;*
- *Special site conditions which may include; location of a septic tank, no truck rinse water permitted on site; Personal Protective Gear; etc.; and*
- *Individual receiving the order.*

Include or reference a copy of your Order Entry form or software input fields. Many companies record

orders on the Checklist or large index cards and input the data at a later time. These forms provide back-up documentation in case of a computer failure.

All orders should be verified to a Purchase Agreement or Proposal, where applicable.

Once orders are entered what additional contact does your order entry/dispatch personnel have with the customer? What steps are taken to ensure that an order is not skipped? Define your procedures for confirming orders placed a week in advance. What steps you take to ensure on-time delivery? What if there is inclement weather prior to or at the time of delivery for outdoor concrete placements? When do you notify the customer if you are unable to deliver the concrete at the agreed upon time?

10.3 The Dispatch Process

Describe systems used and processes for dispatch and scheduling of concrete deliveries.

Dispatching a fleet of ready mixed concrete trucks is one of the most challenging tasks in the ready mixed concrete industry. Describe your company's dispatch process. How do you determine the number of trucks required for a particular placement and the truck spacing (schedule)? If the process is not automated, what are the logistics associated with assigning and tracking your ready mixed concrete trucks. What checkpoints for delivery status are monitored and do you use specific terminology or color codes to identify the truck status.

If your Dispatch system is automated, provide an overview of the software that your company uses. Is your system linked to truck tracking software?

Are concrete orders for the following day reviewed for accuracy? Who reviews the orders? Are Technical Services personnel scheduled based on mixes and projects?

Does someone review at the end of day/week the delivery time compared to that ordered? If so what does your company do with that information?

10.4 Batch Instructions

Describe how orders from dispatch are incorporated in the batching processes.

Once the order is entered and the delivery schedule determined, batch instructions should be initiated for the concrete. Describe your company's procedure for entering the information necessary for concrete batching instructions. Do batch personnel receive Delivery Tickets (ticketing a truck)? If so, are Delivery Tickets received in the order to be batched? The concrete batching process is defined in Section 11, Concrete Production.

10.5 Recordkeeping

Define the record generation and retention process and responsibilities of personnel.

Explain where order entry and dispatch records are maintained and for how long. Who is responsible for keeping these records? Are the records readily retrievable?

11. Concrete Production

11.1 General

Describe the overall systems in place for production of ready mixed concrete.

The purpose of this section is to illustrate that the system is in place to control the production of ready mixed concrete. The equipment utilized in the production and control of ready mixed concrete is described in Section 6. Facilities, Plant(s), and Equipment. The component materials for the production of concrete are received, tested, and stored (stockpiled) in accordance with the procedures described in Section 7. Materials Management.

11.2 Production Planning

Describe the planning process required prior to production of ready mixed concrete and pertinent personnel responsibilities.

Describe your company's process for production planning. Prior to each production day, a plan must be developed for the allocation of resources. Materials should be inventoried and component material deliveries scheduled. Special material requirements for unique applications may necessitate that orders be placed months in advance.

Each evening drivers should be instructed of the time to report to work the following day. Drivers' hours should be regularly monitored during the work week to avoid fatigue and to operate in compliance with applicable regulations.

Scheduled maintenance of ready mixed concrete trucks and plant equipment should be anticipated to minimize the impact on production. Preventive maintenance is a critical function of plant operations. Ready mixed concrete trucks should be washed, fueled, and checked at the end of each day (pre-trip inspection) and ready to go the first thing each morning.

Production planning includes assigning Technical Services personnel plant and/or project responsibilities prior to the day of production.

Discuss who in your organization makes daily assignments of production (plant and drivers) and Technical Services personnel. How are these assignments communicated? Production planning continues throughout the production day since change is inevitable. Briefly discuss how change is incorporated into your daily operations.

11.3 Concrete Production

Outline the process steps and pertinent responsibilities of personnel for producing ready mixed concrete.

Prior to batching the first load of concrete each day, component materials must be loaded into the plant; trucks must be in place; and instructions must be communicated to the concrete batch personnel and/or computer. Once a day the Plant Manager, or delegate, should perform a walk through inspection of the concrete plant.

Discuss your company's production processes addressing the following activities:

- *The process by which materials loaded into the batch plant*
- *The communications process for batching concrete. Are delivery tickets forwarded to the plant (electronically, fax, etc.)? Are tickets stacked in the order to be batched? Are truck numbers specified on the ticket?*

- *The process by which trucks are instructed to enter the plant (pull into the hole) for loading. Is the truck loading position confirmed?*
- *Is your batching process manual or computerized? If automated, what back-up system do you have available?*
- *Duties of the driver doing while the truck is being loaded, such as filling the water tank. How is the driver notified when the truck is loaded?*
- *How does the driver receive the delivery ticket? How are directions confirmed? Are additional items to be delivered highlighted and reviewed?*
- *Once loaded, where does the truck go? Through a drive-through rinse area? To the slump rack? Is the truck rinsed?*
- *For dry batch plants, the process for mixing the concrete.*
- *Procedures for checking the concrete slump and mixture consistency before leaving the yard.*
- *Procedures for correcting slump and air content to required targets before leaving the yard.*
- *Identify additional loading procedures for special applications (steel fibers, ice, liquid nitrogen, etc.).*
- *Procedures for installing chute or rock guard, notifying dispatch, and leaving the yard.*

11.4 Production of Specialty Concrete

Define variations from standard process for production of special classes of ready mixed concrete by type.

Specialty concrete may include a number of different concrete applications. Identify your company's processes for the production of specialty concrete. These applications may include but are not limited to:

1. *Colored concrete*
2. *High strength concrete*
3. *Lightweight concrete*
4. *Heavyweight concrete*
5. *Mass concrete*
6. *Exposed aggregate concrete*
7. *Pervious concrete*

11.5 Production Environment

Define details of standard process to address how weather conditions impact production procedures.

The weather conditions within which your company operates can have a significant impact on the quality of your ready mixed concrete. Describe the general environment of your operations and your company's facilities, equipment, and procedures for minimizing the impact of weather conditions to your concrete production. During extreme weather conditions, your company may utilize hot and/or cold weather concrete practices.

The procedure for hot weather (ACI 305) concreting may include, but is not limited to:

1. *Loader operators are instructed in areas of materials management.*
2. *Overhead storage bins for aggregates are emptied at the end of each day.*
3. *Coarse aggregate stockpiles are continuously watered for cooling.*

4. *Delays in the ordering and delivery of concrete are minimized. All concrete is placed within 1 hour of the time the concrete was batched.*
5. *Random loads have temperatures checked throughout the day.*
6. *Various admixtures are used to avoid early setting of the concrete. Determination of the proper admixture and appropriate dosage rate is determined by the Technical Services Manager or qualified designated delegate.*
7. *Procedures to retain slump for prolonged delivery times in case of anticipated or unanticipated delays.*
8. *Ice can be added at the customer's expense with appropriate notification.*
9. *Re-tempered concrete where the mixing water content exceeds that for designated mixture is not used. During the placement of the concrete, if the concrete loses slump and requires the addition of water for workability in excess of what is permitted for that mixture class, it is disposed.*

The procedures for cold weather concreting (as defined by ACI 306) could include:

1. *Loader operators are instructed in areas of materials management.*
2. *Overhead storage bins for aggregates are emptied at the end of each day.*
3. *Heated mixing water is used. The concrete temperature is maintained in accordance with ACI 306.*
4. *Accelerating admixtures may be used to minimize the concrete set time. Determination of the proper admixture and appropriate dosage rate is determined by the Technical Services Manager or qualified designated delegate.*

11.6 Control of Plant Operations

Define the important procedures to monitor and control materials and plant operations and identify responsibilities to pertinent personnel.

It is important that your organization have adequate procedures in place to monitor concrete production on a daily basis. One method of control is NRMCA Plant Certification which requires monitoring for continued compliance with the NRMCA Checklist for Ready Mixed Concrete Production Facilities.

Specific controls may include, but are not limited to:

11.6.1 Materials Receiving

- *Materials are checked for conformance with the bills of lading or delivery ticket;*
- *Stockpiles are visually inspected for contaminants, deleterious materials (clay coal and lignite; off-color sand), woodsticks, excessive under/oversize coarse aggregate.*

11.6.2 Materials Storage and Handling

Cement, Slag and Pozzolan Silos

- *Confirm that the respective fill pipes are properly labeled and monitor tanker truck unloading.*

Aggregates

- *Monitor for proper storage (stockpile) procedures to prevent harmful segregation and degradation and to provide for uniform moisture as used.*
- *Sprinkle coarse aggregate stockpiles for cooling during hot weather concreting.*
- *Sprinkle lightweight aggregate stockpiles for saturation.*

- *Observe conveying processes to minimize or eliminate spillage or overflow into adjoining compartments.*
- *Empty multi-use compartment completely before filling with different aggregate types.*

Chemical Admixtures

- *Insure that admixtures are protected from contamination and dilution (rain water seepage; splash water from truck washdown; etc.).*
- *Monitor admixture deliveries for connections to the proper tanks and to insure the use of drip pans under each connection.*

11.6.3 Weighing and Batching

Measuring Accuracy

- *Perform a daily scale check, including zeroing of the dial scale, and zero balancing of the tare and weigh beams of beam scales.*
- *Confirm that the measuring devices are in compliance with the applicable accuracy requirements.*
- *Establish frequency for conducting verification checks and calibration of scales and volumetric measuring devices.*

Batching Accuracy

- *Monitor batching accuracy, specifically of automated units, at designated intervals. Controls of automated systems may require adjustments for the accurate discharge of materials during batching.*

Automatic plants should be provided with a basic troubleshooting guide, listing the most common malfunctions experienced at individual plants and the corrective action required.

- *Check readings of any remote or slave indicators to make sure they agree with the master.*
- *Monitor to make sure that batching stations are provided with current mix information and that invalid or obsolete information is promptly removed.*
- *Make sure the personnel at the batching station are provided with clear and unambiguous dosage instructions for the various admixtures handled at the plant.*

Mistakes in admixture use and batching are likely to cause serious performance problems in concrete.

- *Insure that the plant operator and substitute operator are thoroughly familiar with admixture dispenser operation, including the significance of measuring units (whether ounce units, or various cement weight equivalents for different dosage rates); and of the dosage setting and metering devices of automatic systems.*

Batching Procedures

- *Standardize sequence of charging materials into mixer.*

Incorrect procedure, such as charging of cement with water or wet aggregates into the head end of the drum can lead to formation of lumps.

- *Delivery tickets show required information including specified slump*
- *Company policy on small batches. Minimum batch size, procedures for batching, such as additional material to butter the mixer to ensure required properties are obtained.*

Small batches can lead to problems because batching errors are

magnified and any wash water left in the drum may produce a wet batch. Work with customers to avoid the necessity for small loads at the end of a placement.

- *Company policy on disposition of returned concrete is observed.*
- *Plant provided with guidelines on handling of mis-batched concrete.*

11.6.4 Mixer and mixer controls

Central Mixer

- *Insure that the minimum mixing time is observed.*
- *Train the batch plant operator and substitute operator on familiarity with the slump meter readings.*

Truck Mixers

- *Make sure that all drivers are aware of the required amount of mixing and of the standard mixing and agitating speeds.*

12. Concrete Testing

12.1 General

Describe the procedures, frequencies and purpose along with technical service responsibilities for testing and quality control of ready mixed concrete.

The purposes for testing concrete include the evaluation of component materials; concrete mix proportioning; and quality control of your ready mixed concrete production. This Section should describe your company's Technical Services or Quality Control /Quality Assurance organization and procedures for sampling and testing your concrete.

Ready mixed concrete is a simple, flexible, durable, and economical product with a multitude of applications. In order for your company's concrete to perform as specified, the concrete must possess certain properties which are necessary for the application intended. To confirm that the desired properties or performance criteria are (or will be) achieved, it is necessary to test the concrete in both a plastic and hardened state.

12.2 Concrete Tests Frequency and Mix Selection

Define the frequency and types of concrete tests that are required based on type of project and purpose for the tests.

The accuracy and reliability of the quality control tests results, in representing the concrete tested, is largely dependent upon the frequency of tests performed. The frequency of your company's quality control testing may be a function of many factors including, but not limited to:

- *Project requirements;*
- *Evaluation of testing by others;*
- *Component materials analysis;*
- *Mix consistency and performance;*
- *Plant standard deviation; and*
- *Weather considerations*

According to ASTM C 94,

strength tests as well as slump, density, temperature, and air content tests shall generally be made with a frequency of not less than one test for each 150 yd³. Each test shall be made on a separate batch. On each day concrete is delivered, at least one strength test shall be made for each class of concrete.

This frequency of testing is for acceptance testing only and should not control your company's internal quality control tests frequency.

Slump, air-content, density and temperature tests shall be made at the time of placement at the option of the inspector as often as is necessary for control checks. In addition, these tests shall be made when specified and always when strength specimens are made.

Describe your organization's testing frequency for specific plants and/or designated concrete mixtures (for example, one test per 200 cu. yd. of plant production or one test per 50 cu. yd. for a particular designated mixture).

Regular testing of a standard reference mixture can be a very useful indicator of mixture and plant

consistency. This can be supported by lab tests tied to incoming shipments of materials. If you regularly sample, test, and track specific mixes, discuss your mix selection methodology, where samples are taken, who is responsible for obtaining the samples, and the information you obtain. The analysis of the data obtained will be described in Section 15, Measurement, Analysis and Improvement.

12.3 Sampling and Testing of Freshly Mixed Concrete

Outline the Company's process and frequency for quality control tests of plastic concrete for product quality monitoring or for independent verification of acceptance testing.

Acceptance testing of ready mixed concrete requires sampling in accordance with ASTM C 172, Practice for Sampling Freshly Mixed Concrete. It is critical that sampling for acceptance testing be accomplished by the precise techniques specified in order for the sample to be representative of the concrete being tested.

For acceptance testing, samples should be taken in accordance with ASTM C 172; the sample(s) from stationary mixers and revolving drum truck mixers shall be taken during discharge from the middle portion of the batch. Samples for truck mixed concrete are generally taken at the job and samples from central mixed concrete may be taken at the plant and/or at the job site.

ASTM C 172 may not be appropriate for quality control tests conducted at the plant. If your company deviates from ASTM C 172 procedures for your internal quality control testing, it is important that you achieve consistency in your sampling process.

In some cases your company might chose to conduct independent tests to verify the results obtained by commercial testing laboratories. Establish the sampling procedure – independent sample from the same load or conduct tests on the same sample as obtained by the lab. The latter permits better comparison of testing practices. Alternatively, sample on a random basis. If detailed data are desired on concrete performance, test pre-selected loads where mixture prequalification test data exists for the mixture composition such aggregate grading; aggregate proportions; mixing water content; cement characteristics; etc.

The NRMCA Concrete Laboratory Resource Guide, illustrated as Appendix C, defines the tests on concrete that may be performed in the laboratory, the test method for each test, and the equipment that is used in conducting the test. The following standardized procedures are used for sampling and testing of the companies quality assurance purposes as identified in ASTM C 94:

- *Sampling Fresh Concrete – Practice C 172*
- *Slump – Test Method C 143*
- *Density and Yield – Test Method C 138 (calculate gravimetric air content)*
- *Air Content – Test Method C 173 or Test Method C 231*
- *Temperature – Test Method C 1064*
- *Compression Test Specimens – Practice C 31*

Discuss the decision process and responsibilities when dealing with non-conforming results either from the quality control tests or those conducted for acceptance by a testing laboratory. If the concrete slump is below the target slump range, can you add water to the concrete if a specified water/cement ratio will not be exceeded? Who is authorized to adjust the slump? Explain your company's procedures regarding jobsite adjustments and do your procedures require a quantified limit of jobsite water addition on a delivery ticket? Can the air content be increased on the job?

Also define your company's process for making adjustments in the batching process to compensate for adjustments being made in the field.

Jobsite quality control testing should be accomplished for routine mix or plant monitoring as well as for special mixes and applications. Discuss your company's process for controlling the yield of lightweight concrete. You may perform unit weight tests on the first load and every 100 cu. yd. thereafter. It may then be necessary to adjust the batch weights for correct yield. This is sometimes very critical for structural lightweight concrete. Check tests need to be performed to determine the adequacy of yield adjustments. The testing frequency is dependent upon the variability of unit weights. A history of yield information needs to be maintained for each designated concrete mixture.

For flexural strength it is important for your company to assure compliance with the narrow slump tolerances of low slump paving concrete. Implement strict adherence to conformance testing procedures including standard methods of making, curing, and testing beam specimens. Flexural strength tests (beam test) are highly sensitive to non-standard procedures. One approach is to develop a laboratory correlation between compressive and flexural strength and recommend that the engineer of record use compressive strength tests for field samples for better reliability of the acceptance testing.

For high strength concrete it is important to assure the use of concrete at a slump within the specified range; the prompt discharge of the concrete; the use of appropriate molds for test cylinders; and for strict adherence to curing and testing procedures.

12.4 Testing Hardened Concrete

Outline the Company's process and frequency for quality control tests of hardened concrete for product quality monitoring or for independent verification of acceptance testing.

Compression test specimens for monitoring ready mixed concrete quality control are cast and cured in accordance with Practice C 31. Cylinder specimens for strength tests are routinely made for 3, 7, 28, and 90 day breaks, with a minimum of 7 and 28 day breaks and a set of reserve cylinders. Three-day tests permit early recognition of variable strengths and a 90 day test history provides useful strength gain information, especially in the event of low 28 day test results.

According to ASTM C 94 paragraph 17.2, [for a strength test, at least two standard test specimens shall be made from a composite sample as required in Section 16].

Flexural strength testing of beams should be in accordance ASTM C 78 for third point loading and ASTM C 293 for center point loading.

In addition to strength test, additional hardened concrete tests which may be specified or used by your organization, include:

- *Air Content and air void system, ASTM C 457*
- *Cement content, ASTM C 1084*
- *Density and Specific Gravity, ASTM C 567*
- *Chloride Ion Content, ASTM C 1218*
- *Rapid indication or chloride ion penetrability (Permeability indication), ASTM C 1202*
- *Shrinkage, ASTM C 157*
- *Various durability characteristics – ASR, sulfate resistance, etc.*

Identify your company's procedures for evaluating hardened concrete in place which may include tests methods such as the rebound method (ASTM C 805), the penetration method (ASTM C 803), and/or core testing (ASTM C 42). In-place concrete strengths may be evaluated in accordance with ACI 228.1R In-Place Methods to Estimate Concrete Strength and ACI 228.1R Nondestructive Test Methods for Evaluation of Concrete in Structures.

13. Concrete Delivery and Site Control

13.1 General

Describe the general Company requirements for delivery of concrete starting at the plant.

The concrete delivery process begins when the ready mixed concrete truck leaves the yard and ends when the truck returns to the plant or other designated facility. Explain your company's policies regarding the use of rock guards; drum speed (agitation); stopping on the way to or from the job; spillage; etc. There are a number of safety issues associated with driving a ready mixed concrete truck. Reference your company Safety Manual or other documented safety procedures.

13.2 Truck Tracking

Outline the process and systems in place to track truck locations and contact with drivers

Explain your company's method of tracking your ready mixed concrete trucks. Your system may be as simple as moving magnetic markers around a board or as sophisticated as monitoring a communications center computer screen. Your drivers may be in constant radio contact with dispatch or may drive a truck equipped with a global positioning system (GPS) Locator System linked to your truck tracking software.

13.3 Jobsite Monitoring and Control

Describe the processes used to monitor and maintain control of the product at the jobsite, including responsibilities of the drivers.

The ready mixed concrete truck drivers are very important representatives of your organization. From a customer focus standpoint, many customers will never meet anyone else from your company except for your driver(s). From a product quality standpoint your drivers are often your company's jobsite liaison.

Explain how your company communicates with and trains your drivers in jobsite awareness, including but not limited to:

- *Unusual concrete appearance (under/over sanded mix, fluffy paste/excessive air, elongated aggregates, etc.)*
- *Observations of the sampling (middle of load) and testing procedures of the Owner's testing agency;*
- *Care and handling of concrete cylinders;*
- *Water added on the jobsite (requested and signed for by the customer);*
- *Other materials added by the customer;*
- *The slump as used;*
- *Method(s) of concrete placement;*
- *Check test requirement for non-conforming concrete test due to slump or air content;*
- *Weather conditions at time of placement;*
- *Location of concrete placement (on unstable base, on poly, on red clay, etc.);*
- *Recording necessary information on delivery tickets and obtaining purchasers signatures*

Certain jobsite conditions necessitate prompt notification of dispatch, batch plant, and/or Technical Services personnel. Describe the flow of communications within your organization and your response procedures.

On major and unique projects Technical Services personnel often visit the site to observe operations and monitor concrete sampling and testing. Specific areas observed include water demand, rate of slump loss, workability, bleeding rate, finishing characteristics, and time of set.

Review your company's controls and procedures regarding unique jobsite requirements. Do you add High Range Water Reducer (HRWR) on the job? Are your trucks equipped with tanks? Do you store product on site? Who is authorized to dispense the HRWR? How long do you mix the concrete (or how many drum revolutions) after introducing the HRWR? Do you provide contact personnel for the initial pumping of lightweight concrete on a job? Can you add fibers, air entraining agent or other admixtures on the job? What are your procedures for adding and recording water?

Prior to pump placements you may wish to address each of the details in the Checklist for Pumping Ready Mixed Concrete©. The Checklist was developed by the National Ready Mixed Concrete Association, the American Society of Concrete Contractors, and the American Concrete Pumping Association. A copy of the Checklist is illustrated in Appendix E.

Does your company have a policy regarding the practice of customers adding calcium chloride, fibers, or other additives to your concrete?

Jobsite quality control (verification) testing is addressed in Section 12, Concrete Testing.

Jobsite safety requirements may include the use of hard hats, safety glasses, ear plugs, safety vest, and/or uniforms. You may want to emphasize certain task such as the observance of jobsite speed limits and the use of proper backing procedures. Refer to your company's Safety Manual or include specific jobsite safety requirements, as you deem necessary.

Jobsite environmental concerns are adding increased responsibilities to the ready mixed concrete producers. Reference any specific guidelines regarding jobsite truck (chute) rinse procedures or restrictions that your organization may have. Discuss limitations regarding the uses of excess concrete and company requirements for the use of rock or chute guards, if applicable.

As discussed in Section 4, Customer Focus review your company's procedure for jobsite personnel (drivers, technicians, sales, or production) providing customer feedback. How are complaints recorded and communicated?

13.4 Identification and Traceability

Describe how products are identified and traced related to placement on projects.

The ready mixed concrete that you deliver to the jobsite must be identifiable and traceable. If you discover that a critical nonconforming mix component was used in batching concrete, it may be important to locate concrete used at other locations or projects with the same defective material. Your delivery ticket should identify the plant and time that the concrete was batched and the truck number of the truck delivering the concrete. From this information, the batch tickets at the plant can be reviewed and the component materials and proportions determined.

As previously discussed in Section 9, Purchasing, all component materials delivered to your plants should require the inclusion of a delivery ticket with each load. The delivery ticket illustrates the product received, the date the product was received, and the quantity of product received. The component material delivery ticket should make reference to the purchase order number for the product. The specific component materials used in a given load on a given day may be identified based on the receiving records and the production schedule of concrete using the same component materials (consumption). The production of concrete within the identifiable time constraints defines the usage of the product. All concrete related component materials should be inventoried on a monthly basis to

verify the accuracy and accountability of receiving and production records. Mill Test Reports should be required for the delivery of cement and fly ash. The testing of component materials should be in accordance with Section 7, Materials Management.

The preservation of ready mixed concrete is primarily limited to concrete in a plastic state and throughout the finishing and initial curing processes. As a ready mixed concrete producer, your primary preservation responsibility is preserving your concrete (in a plastic state) until it can be used for the purpose intended. In Section 11, Concrete Production, you identified your company's procedures for producing concrete during extreme work environments (hot and cold weather concreting). Discuss additional company policies regarding the preservation of your concrete, if any.

14. Concrete Troubleshooting

14.1 General

Outline the general processes used by the Company for troubleshooting concrete quality and customer reported problems

The production of ready mixed concrete is a complex process involving the proportioning, batching, and mixing of various component materials under constantly changing conditions. Regardless of the best efforts of the ready mixed concrete producer there will inevitably be a need for concrete troubleshooting. This section enables you to define your method(s) for responding to complaints (inquiries), tracking the complaint, investigating the cause, analyzing the data, and summarizing the findings.

14.2 Complaints and Inquiries

Establish the process of handling customer or other indication of non-conforming product.

The existence of nonconforming product is often communicated to the ready mixed concrete producer through a complaint or an inquiry. The origin of the complaint or inquiry may be from any number of sources including company personnel, the customer, the owner, an end user, an interested party, etc. It is important to view each legitimate complaint as an opportunity to evaluate and improve your operations. In Section 4, Customer Focus you identified your procedures for receiving and distributing customer complaints and inquiries. Define any additional procedures that your company may have for responding to complaints. Discuss any specific timelines identified and how you involve all the responsible parties.

In concrete troubleshooting it is extremely important to treat all complaints as valid until determined otherwise. It is equally important to emphasize to your company's employees the importance of listening to the customer. Through active listening you can specifically identify the problem and minimize your investigation and subsequent analysis.

14.3 The Investigation

Describe the Company's process of investigating non-conforming product or other customer complaints.

Discuss your company's procedure for investigating concrete problems and/or complaints. Who investigates complaints and what qualifications are required? Has your company established a methodical approach for investigations? Do you have a checklist?

ACI 201.1R, Guide for Making a Condition Survey of Concrete in Service is a guide which

“provides a system for reporting on the condition of concrete in service. It includes a check list of the many details that may be considered in making a report, and repeats the ACI standard definitions of terms associated with the durability of concrete. Its purpose is to establish a uniform system for evaluating the condition of concrete”.

The check list illustrated in ACI 201.1R encourages you to “select those items important to the specific concerns relating to the reasons for the survey”. Also included in ACI 201.1R are photographs illustrating the various types of distress associated with concrete in service.

NRMCA Publications 133 – In Place Concrete Strength Evaluation – A recommended practice and the Concrete in Practice (CIP) series are invaluable tools in investigating, analyzing, and reporting concrete conditions. The CIPs address the What, Why, and How? of concrete in practice. These are useful to inform a customer about the reason for a specific problem or to advise a contractor on proper procedures for handling and finishing concrete.

14.4 The Analysis

Outline the analysis process of evaluating the results of an investigation on non-conforming product or other customer complaints.

Your initial analysis should include securing relevant information from jobsite personnel, sales representatives, drivers, and/or independent testing laboratory personnel as soon as possible. It may be beneficial for you to take photographs of any defective concrete.

You should then obtain all records associated with the problem (or other reason for this investigation), which may include but are not limited to:

- *Customer complaint form;*
- *Independent testing laboratory report(s);*
- *The condition survey;*
- *Ordering information;*
- *Dispatch records;*
- *Driver log;*
- *Delivery ticket;*
- *Batch ticket;*
- *Records on the same class of concrete from the same plant tested elsewhere.*

Specific items addressed during the analysis may include the addition of water; the age of the concrete when discharged; materials added by the customer; unusual appearance of the concrete at the time of placing; concrete temperature; etc.

Your analysis may include hiring a consultant(s) for jobsite evaluation or more detailed concrete sample tests using chemistry, petrography, etc. and depends upon the financial implications of the initiating complaint. Your company may also have a position regarding the use of an arbitration process for dispute resolution.

It is important for your personnel to be objective in their analysis of all of the information available.

14.5 Summary Report

Define what needs to be recorded in a report resulting from troubleshooting a problem

The investigation and subsequent analysis of the concrete should be summarized in a report. This summary report should be fact-based with supporting documentation. The report should summarize the findings and present the conclusion(s) and recommendations, if appropriate.

Your company should maintain reference documents and files addressing the most frequent problems associated with concrete. Literature identifying methods of avoiding concrete defects should be provided to your customers prior to concrete placements.

Remedial actions recommended in a summary report should be supported by printed information originating from established authorities in the field. A disclaimer might be appropriate indicating that the concrete producer does not guarantee success of the remedial actions.

15. Measurement, Analysis and Improvement

15.1 General

Define the basic measurement processes and key indicators used to monitor quality of ready mixed concrete with the goal to improve processes.

In order to improve your company's operations it is important to measure key indicators of your performance. In this section, you should explain the activities that you have selected to measure; how you monitor these activities; your analysis process; and the method(s) that your company uses to review the measurement data. Through the process of measuring key indicators throughout your operations, monitoring those activities, and analyzing the results, you can:

- *Evaluate the batch to batch uniformity of ready mixed concrete;*
- *Improve processes; and*
- *Evaluate the effectiveness of your QMS in quantifiable measures.*

15.2 Monitoring and Measurement

Identify the monitoring and measurement processes

Selecting the proper activities or items to measure is critical in understanding and evaluating your company's performance.

Some sample forms for capturing information are provided in Appendix F.

15.2.1 Customer Satisfaction

Define measurement processes to evaluate and improve customer satisfaction

Customer satisfaction should be measured as discussed in Section 4, Customer Focus. Monitoring your company's customer satisfaction may include:

- *Reviewing customer satisfaction data at the Quarterly Quality Committee meetings. This data may include the results of customer surveys, Customer Advisory Committee minutes, complaint review, customer correspondence, and personal interactions;*
- *Management review of customer complaints and inquiries, including Summary Reports;*
- *Review of your company's customer focus at your weekly sales meetings.*

The goal in evaluating the level of customer satisfaction is to determine if your company is meeting your customer's requirements and what is your customer's perception of your organization?

When a metric for customer satisfaction is identified, improvement goals should be established.

15.2.2 Internal Audits

Outline the internal audit processes, audited items and internal audit schedules, including responsibility of personnel responsible for internal audits.

Internal Quality Audits should be conducted at each of your facilities at least semi-annually. These Audits should address multiple aspects of your organization and evaluate conformance to your company's QMS.

An initial Audit Checklist should be developed addressing items within each Section of your Quality Manual. This Checklist should be prepared based on the importance of the processes within the category being evaluated. The Audit Checklist should be reviewed and revised (if applicable) annually, based on the previous Audits and established corporate priorities. A copy of your initial Audit

Checklist should be included at the end of this Section.

The Quality Committee, at its initial meeting each year, schedules the first Quality Audit(s) of the year for each facility. The Audit Team assigned to conduct the Audit is identified and may consists of any of the following, or combination thereof:

- *Quality System Coordinator*
- *Production/Operations Manager*
- *Plant Manager (other than the facility being audited)*
- *Quality Committee member*
- *Specific employees designated by the Quality Committee*
- *Consultant*

Records of each Audit should be maintained by the Quality System Coordinator. The results of each Audit should be reviewed and discussed at the following Quality Committee meeting. Based on the results of the Audit, corrective actions should be defined and the responsible manager should be provided a list of corrective actions. The manager should subsequently be responsible for correcting any non-conformances within a reasonable period of time.

You should identify your company's follow-up procedure for confirming that the nonconformities have been corrected and identify the individual responsible for monitoring this process.

15.2.3 Monitoring and Measurement of Processes

Define the Company's internal auditing for monitoring and measuring of processes.

What methods does your company employ to monitor the critical tasks (key indicators) within your QMS? Are those processes performing as desired? Are there measurements associated with the monitoring of operations? If so, define those measurements.

Sample measurements of key indicators of production processes may include, but are not limited to:

- *Trips per truck per day*
- *Average cubic yards per load*
- *Cubic yards produced per hour*
- *Total concrete production per plant (per day, per week, per year)*

If monitored processes fail to achieve the desired results what is the procedure for implementing change?

15.2.4 Monitoring and Measurement of Product

Define the Company's internal auditing for monitoring and measuring of product quality.

Concrete sampling and testing should be performed as defined in Section 12, Concrete Testing. Concrete sampling. For the internal purpose of evaluating plant production and designated mixture performance, concrete from dry batch plants may be tested at the plant under the direction of Technical Services personnel. The primary concrete characteristics (conformance testing) monitored include:

- *Slump or slump flow;*
- *Temperature;*
- *Density;*
- *Air Content, and*
- *Compressive strength.*

Identify who is responsible for maintaining records of conformance testing and where these records

are maintained.

During everyday operations, the ready mixed truck driver is responsible for verifying the visual characteristics of the concrete and releasing the product. On critical placements Technical Services personnel may observe or test the product and subsequently accept responsibility for releasing the product.

15.3 Control of Non-conformances

Identify processes and criteria for establishing non-conformances and the resulting control or corrective action. Establish responsibilities for reporting/recording and disposition of non-conformances.

Non-conformances might be in the following areas:

- *Process, such as material receiving and storage, batching, mixing or delivery*
- *Product, such as type of materials or quantity batched, contamination, non-conforming tests or dispatch of incorrect designated mixture*
- *Quality system when items defined in the QMS are not followed.*

Non-conformances may be identified through observation, utilization, and/or conformance testing. Establish a reporting process. Reporting of non-conformances should be tasked to any employee of the company or from customers. Establish a standard non-conformance reporting form that includes space to record actions taken. Documentation should include as much information as possible.

Establish the company's disposition procedures for correcting or controlling non-conformances and identify the company personnel responsible for this process. This will vary depending on type or location of non-conformance.

Non-conformances should be documented by type and tracked for analysis.

15.4 Analysis of Data

Define the measurement tools used to document and analyze product quality data and criteria that establishes necessary action

Describe how your company determines what activities or items to monitor, measure, and track. Discuss how you collect data for analysis and the methods that your company uses to analyze the selected data. The analysis of your data should enable you to evaluate your operations and the effectiveness of your QMS.

Statistical Process Control provides an important method of evaluating and analyzing concrete component materials and concrete characteristics. ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete, states that "statistical procedures provide tools of considerable value in evaluating results of strength tests and information derived from such procedures is also of value in defining design criteria and specifications".

Define how your company monitors your processes and analyzes your data. NRMCA Publication 190 describes the use of statistically-based evaluations pertinent to the ready mixed concrete industry. Control charts may be prepared for each plant illustrating the characteristics of fresh concrete (slump, air, temperature, unit weight, and yield) and compressive strength of standard mixes. Establishing control limits, particularly for early ages, enables early detection of excess variations of the tracked property. Control charts including several selected characteristics of component materials, production conditions or tests of concrete can establish assignable causes for the variations.

15.5 Improvement

Outline the items and means by which the Company uses the measurement systems in place to ensure continuous improvements.

A primary goal of your organization should be to continuously improve your QMS. The methods that your company uses to seek improvement may include but are not limited to:

- *Defining and re-defining your Quality Policy*
- *Planning*
- *Management review*
- *Customer feedback*
- *Training*
- *Facilities, Plant, and Equipment improvements*
- *Materials management*
- *Purchasing*
- *Production and delivery*
- *Internal Audits*
- *The collection and analysis of data*
- *Corrective and preventive actions*

15.5.1 Corrective Action

Identify corrective actions towards improvement

Through monitoring and tracking nonconformities your company can minimize or eliminate the cause(s) that creates the respective nonconformity. As discussed earlier, each non-conformance should be evaluated to prevent or minimize recurrence and a Summary Report of findings should be prepared.

15.5.2 Preventive Action

Identify preventive actions towards improvement

Your company should be pro-active in anticipating non-conformances in situations where these have occurred in the past. Describe your methods of notifying and educating your customers about the preventive actions that they can take to minimize problems associated with the placement, finishing, and curing of concrete. Review your company's procedures for determining nonconformance or potential nonconformities and their causes. Determine the preventive actions required to eliminate non-conformances and to monitor the results after implementing those actions.

Appendix A - Reference Sources

AMERICAN SOCIETY OF QUALITY

ASQ
P.O. Box 3005
Milwaukee, Wisconsin 53201-3005
(800) 248-1946
www.asq.org

Resources on the ANSI/ISO/ASQ Q9000:2000 Standards

Quality management systems - Requirements©

Quality management systems – Guidelines for performance improvements©

Quality management systems – Fundamentals and vocabulary©

ASTM INTERNATIONAL

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
(610) 832-9585
www.astm.org

Annual Book of ASTM Standards, Volume 04.02 -- Concrete and Mineral Aggregate
Volume 04.01 -- Cement; Lime; Gypsum

ASTM C 29	Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C 31	Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 42	Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 70	Test Method for Surface Moisture in Fine Aggregate
ASTM C 78	Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 94	Specification for Ready Mixed Concrete
ASTM C 109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
ASTM C 114	Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C 115	Test Method for Fineness of Portland Cement by the Turbidimeter
ASTM C 117	Test Method for Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	Test Method for Lightweight Pieces in Aggregate
ASTM C 125	Terminology Relating to Concrete and Concrete Aggregates
ASTM C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	Test Method for Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 138	Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 142	Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143	Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 172	Practice for Sampling Freshly Mixed Concrete
ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 187	Test Method for Normal Consistency of Hydraulic Cement
ASTM C 191	Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C 192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 204	Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 266	Test Method for Time of Setting of Hydraulic-Cement by Gillmore Needles
ASTM C 294	Descriptive Nomenclature for Constituents for Constituents of Natural Mineral Aggregates
ASTM C 311	Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 330	Specification for Lightweight Aggregates for Structural Concrete
ASTM C 430	Test Method for Fineness of Hydraulic Cement by the 45 μ m (No. 325) Sieve
ASTM C 451	Test Method for Early Stiffening of Portland Cement (Paste Method)
ASTM C 470	Specification for Molds for Forming Concrete Test Cylinders Vertically
ASTM C 494	Specification for Chemical Admixtures for Concrete
ASTM C 511	Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
ASTM C 535	Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 566	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 595	Specification for Blended Hydraulic Cements
ASTM C 617	Practice for Capping Cylindrical Concrete Specimens
ASTM C 618	Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 702	Practice for Reducing Samples of Aggregate to Testing Size
ASTM C 803	Test Method for Penetration Resistance of Hardened Concrete
ASTM C 805	Test Method for Rebound Number of Hardened Concrete
ASTM C 900	Test Method for Pullout Strength of Hardened Concrete
ASTM C 917	Test Method for Evaluation of Cement Strength Uniformity from a Single Source
ASTM C 989	Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1012	Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
ASTM C 1017	Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1064	Test Method for Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1116	Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM C 1137	Test Method for Degradation of Fine Aggregate Due to Attrition
ASTM C 1152	Test Method for Acid-Soluble Chloride in Mortar and Concrete

ASTM C 1157	Performance Specification for Blended Hydraulic Cement
ASTM C 1202*	Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C 1218	Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C 1231	Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C 1240	Specification for Silica Fume for Use in Cementitious Mixtures
ASTM C 1252	Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM C 1260	Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 1293	Test Method for Concrete Aggregates by Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C 1399	Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
ASTM C 1437	Test Method for Flow of Hydraulic Cement Mortar
ASTM C 1451	Practice for Determining Uniformity of Ingredients of Concrete From a Single Source
ASTM C 1567	Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C 1543	Test Method for Determining the Penetration of Chloride Ion into Concrete by Ponding
ASTM C 1556	Test Method for Determining the Apparent Chloride Diffusion Coefficient of Cementitious Mixtures by Bulk Diffusion
ASTM C 1585	Test Method for Measurement of Rate of Absorption of Water by Hydraulic Cement Concretes
ASTM C 1602	Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C 1603	Test Method for Measurement of Solids in Water
ASTM D 75	Practice for Sampling Aggregates
ASTM D 98	Specification for Calcium Chloride
ASTM C1610	Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique
ASTM C1621	Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring
ASTM C1611	Test Method for Slump Flow of Self-Consolidating Concrete
STP-169D	Significance of Tests and Properties of Concrete and Concrete-Making Materials, ed. Joseph F. Lamond and James Pielert
MNL 49	User's Guide to ASTM Specification C 94 on Ready-Mixed Concrete, D. Gene Daniel and Colin L. Lobo (available from NRMCA)

AMERICAN CONCRETE INSTITUTE

ACI

38800 Country Club Drive
Farmington Hills, MI 48331
(248) 848-3700
www.concrete.org

ACI Manual of Concrete Practice

ACI 116R	Cement and Concrete Terminology
ACI 121	Quality Management System for Concrete Construction
ACI 201.1R	Guide for Making a Condition Survey of Concrete in Service
ACI 201.2R	Guide to Durable Concrete
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.5	Guide for Submittals of Concrete Proportions
ACI 212.3R	Chemical Admixtures for Concrete
ACI 213R	Guide for Structural Lightweight-Aggregate Concrete
ACI 214R	Evaluation of Strength Test Results of Concrete
ACI 214.4R	Guide for Obtaining Cores and Interpreting Compressive Strength Results
ACI 221R	Guide for Use of Normal Weight and Heavyweight Aggregates in Concrete
ACI 221.1R	State-of-the-Art Report on Alkali-Aggregate Reactivity
ACI 225R	Guide to Selection and Use of Hydraulic Cements
ACI 229R	Controlled Low Strength Materials (CLSM)
ACI 232.1R	Use of Raw and Processed natural Pozzolans in Concrete
ACI 232.2R	Use of Fly Ash in Concrete
ACI 233R	Slag Cement in Concrete and Mortar
ACI 234R	Guide for the Use of Silica Fume in Concrete
ACI 301	Specifications for Structural Concrete
ACI 302.1R	Guide to Concrete Floor and Slab Construction
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to Curing Concrete
ACI 318/318R	Building Code Requirements for Structural Concrete and Commentary
ACI 325.9R	Guide to Construction of Concrete Pavements and Concrete Bases
ACI 330	Guide for Design and Construction of Concrete Parking Lots
ACI 332R	Guide to Residential Cast-in-Place Concrete Construction
ACI 350/350R	Code Requirements for Environmental Engineering Concrete Structures
ACI 363R	State-of-the-Art Report on High-Strength Concrete
ACI 363.2R	Guide to Quality Control and Testing of High-Strength Concrete

NATIONAL READY MIXED CONCRETE ASSOCIATION

NRMCA

900 Spring Street

Silver Spring, Maryland 20910

(301) 587-1400

www.nrmca.org

Call for Publication List

- NRMCA 133 In-Place Concrete Strength Evaluation -- A Recommended Practice
NRMCA 154 Outline and Tables for Proportioning Normal Weight Concrete
NRMCA 159 Concrete Plant Operator's Manual
NRMCA 170 Compilation of ASTM Standards for Technician Certification
NRMCA 159 Concrete Plant Operators Manual
NRMCA 186 Ready Mixed Concrete
CONCRETE07 Standard for Ready Mixed Concrete
NRMCA 188 Truck Mixer Driver's Manual
NRMCA 190 Guideline Manual for Quality Control/Quality Assurance
2PMNL 49 User's Guide to ASTM Specification C 94 on Ready-Mixed Concrete, D. Gene Daniel and Colin L. Lobo (available from NRMCA)
2PPIG NRMCA Plant Inspectors Guide
CPMB 100 Concrete Plant Standards of the Concrete Plant Manufacturers Bureau
TMMB Truck Mixer, Agitator, and Front Discharge Concrete Carrier Standards of the Truck Mixer Manufacturers Bureau
NRMCA Concrete in Practice (CIP) Series of Information Sheets
NRMCA Technical Memo Series
Checklist for the Concrete Pre-Construction Conference
Checklist for Ordering and Scheduling Ready Mixed Concrete©
Checklist for Pumping Ready Mixed Concrete©
Certification programs:
Certification of Ready Mixed Concrete Production Facilities, QC Manual Section 3, Plant Certification Check List
Concrete Technologist Level 2 and Level 3 Certification
Concrete Plant Operator, Supervisor and Manager Certifications
Concrete Delivery Professional Certification
Certified Concrete Sales Professional Certification
Concrete Environmental Professional Certification
Concrete Safety Professional Certification
Pervious Concrete Contractor Certification

PORTLAND CEMENT ASSOCIATION

Portland Cement Association
5420 Old Orchard Road
Skokie, Illinois 60077
(847) 966-6200
www.cement.org

Call for Publication List

EB001 Design and Control of Concrete Mixtures

AMERICAN SOCIETY OF CONCRETE CONTRACTORS

ASCC
2024 S. Brentwood Blvd., Suite 105
St. Louis, MO 63114
(314) 962-0210
www.asconc.org

Checklist for the Concrete Pre-Construction Conference
Checklist for Ordering and Scheduling Ready Mixed Concrete©
Checklist for Pumping Ready Mixed Concrete©

AMERICAN CONCRETE PUMPING ASSOCIATION

ACPA
606 Enterprise Drive
Lewis Center, OH 43035
(614) 431-5618
www.concretepumpers.com

Checklist for Pumping Ready Mixed Concrete©

PERIODICALS

ACI Concrete International, Farmington Hills, MI, www.concrete.org (free to ACI Members)
Concrete Products Magazine, Prime Media, Chicago, IL, www.concreteproducts.com
The Concrete Producer Magazine, Hanley-Wood, Addison, IL, www.theconcreteproducer.com
Concrete Construction Magazine, Addison, IL, www.concreteconstruction.net

Appendix B: Competencies for Ready Mixed Concrete Personnel

Technical Services Staff	
<ul style="list-style-type: none"> • Sampling and testing of concrete and concrete materials • Batch data preparation • Mix design Submission • Batch plant and mixer inspection • Quality limits and action on non-compliance • Investigation of abnormal test results (in-house and other) • Statistical evaluation of strength data • Communications with customers • Job site control functions • Slump control procedures 	<ul style="list-style-type: none"> • Proportioning concrete mixes; trial batches • Laboratory procedures • Laboratory quality control • Trouble shooting and report writing • Schedule of testing and job priorities • Processing and filing of test reports • Specification review • Innovations in concrete technology • Safety procedures
<p style="text-align: center;">Plant Operators</p> <ul style="list-style-type: none"> • Basic concrete technology • Types of concrete and concrete materials • Aggregate moisture tests and adjustments • Effects of changes in materials (gradation; specific gravity) • Slump control procedures • Plant inspection (NRMCA Plant Check list) • Company policy on handling of returned concrete • Disposition of misbatched loads • Inventory taking and potential causes of inventory losses • Mechanics of scale train and other batching equipment • Yield adjustments on lightweight concrete • Quality control procedures by materials handlers • Response to rejection of concrete loads <p style="text-align: center;">SEE NRMCA PLANT OPERATOR MANUAL</p>	<p style="text-align: center;">Truck Mixer Operators</p> <ul style="list-style-type: none"> • Basic concrete technology • Types of concrete and concrete materials • Mixing requirements, initial and after water additions • Slump control procedures • Company policy on job site water additions • Mixer maintenance (NRMCA Plant Check list) • Testing methods and recognizing improper procedures • Company policies on handling of returned concrete of apparently misbatched loads • Correct practices in handling and finishing concrete • Handling of customer complaints about product quality • Response to rejection of concrete at the site <p style="text-align: center;">SEE NRMCA TRUCK MIXER DRIVER'S MANUAL</p>
<p style="text-align: center;">Dispatcher/Office Personnel</p> <ul style="list-style-type: none"> • Basic concrete technology • Types of concrete and concrete materials • Slump control procedures • Mix identification system • Handling of customer complaints and claims regarding product quality • Response to rejection of concrete at the site • Company policy on handling of returned concrete • Within-company communications 	<p style="text-align: center;">Sales Representatives</p> <ul style="list-style-type: none"> • Basic concrete technology • Types of concrete and concrete materials • Mix identification system • Specification review • Handling of customer complaints and claims regarding product quality • Response to rejection of concrete at site • Testing methods and recognizing improper procedures • Within-company communications • Slump control procedures • Strength test reports and promotional use • Innovations in concrete technology - selling added value

Appendix C: NRMCA Concrete Laboratory Resource Guide

Laboratory Inspection and Accreditation'

If your company operates a laboratory, your lab may be accredited or you may wish to seek accreditation, to document your laboratory's qualifications to the outside world. Documentation of this type is available by way of periodic inspections by the ASTM-sponsored Cement and Concrete Reference Laboratory (CCRL) of the National Institute of Standards and Technology (NIST), and through accreditation by the U.S. Department of Commerce through its National Voluntary Laboratory Accreditation Program (NVLAP), the AASHTO Accreditation Program (AAP), and the American Association for Laboratory Accreditation (A2LA).

- (1) *CCRL Inspection:* The CCRL representatives determine compliance of laboratory staffing, equipment and procedures with applicable standards and document the laboratory's compliance status in a summary report. The report gives no ratings and its contents are not to be used for general promotional purposes. It may, however, be shown to interested parties to substantiate the laboratory's qualifications. The fact that a producer laboratory is CCRL-inspected confers a certain reliability status to its data that may be important to the producer's dealings with customers and building officials. Information regarding this inspection program can be obtained by writing to

Cement and Concrete Reference Laboratory,
National Institute of Standards and Technology
Building 226, Room A 365
Gaithersburg, Maryland 20899.

- (2) *NVLAP Accreditation:* The competency of a laboratory in the most important tests on field concrete can be documented through accreditation by the U.S. Department of Commerce. Accreditation is given following successful completion of a process which involves submission of an application and payment of fees, followed by an on-site visit, proficiency testing, deficiency resolution, technical evaluation and administrative review. While NVLAP uses its own assessors for on-site visits, they accept assessments by the Cement and Concrete Reference Laboratory Program. NVLAP requires laboratories to participate in CCRL's cement and concrete proficiency sample programs. Accreditation confers a more visible degree of recognition of a laboratory's proficiency in the testing of concrete. A laboratory may publicize its accredited status and use NVLAP logos on test reports, stationery and in business and trade publications. Information on the accreditation process is summarized in the NVLAP Concrete LAP Handbook, which can be obtained by writing to:

National Voluntary Laboratory Accreditation Program
Construction Materials Testing,
National Institute of Standards and Technology
Gaithersburg, Maryland 20899.

- (3) *The AASHTO Accreditation Program (AAP):* The American Association of State Highway and Transportation Officials (AASHTO) established the AAP in June of 1988. The objective is to provide a mechanism for formally recognizing the competency of testing laboratories to perform specific tests on hydraulic cement and Portland cement concrete, besides other construction materials. AASHTO recognizes a laboratory's compliance to the requirements of ASTM Practice C 1077. AASHTO accreditation is available to all laboratories including independent laboratories, Manufacturers' in-house laboratories, university laboratories and governmental laboratories. Central laboratories of State Departments of Transportation will typically obtain AASHTO accreditation. The AAP utilizes laboratory inspection and proficiency sample services provided by the AASHTO Materials Reference Laboratory (AMRL) and the Cement and Concrete Reference Laboratory (CCRL). AMRL and CCRL are Research Associate programs located at the Building and Fire Research Laboratory of the National Institute of Standards and Technology (NIST). For more information on AAP write to:

AASHTO Material Reference Laboratory
National Institute of Standards and Technology
Building 226, Room A 365
Gaithersburg, Maryland 20899

- (4) *American Association for Laboratory Accreditation (A2LA):* is a nonprofit, scientific membership organization dedicated to the formal recognition of testing laboratories and related organizations

which have achieved a demonstrated level of competence. Accreditation is available to all laboratories regardless of whether they are owned by private companies or government bodies. On-site assessments of applicant labs are performed for conformity with equipment and procedures. Accreditation will list specific tests and types of tests for which the lab has been found competent. A2LA uses CCRL Proficiency Sample programs. For more information write to:

American Association for Laboratory Accreditation
656 Quince Orchard Road
Gaithersburg, Maryland 20878

Laboratory testing priorities are generally directed at those tests that are most important to the acceptance of concrete by your customer. Having the capabilities of testing fresh concrete and the strength (and other properties) of hardened concrete, are extremely important to your operations. Additional laboratory testing may include certain tests for significant properties of aggregates and other concrete materials, which have a bearing on your concrete's performance.

Basic Laboratory Testing Capabilities

The following is a summary of the tests that can be performed in a concrete laboratory, the method for each test, and the equipment that may be found in a laboratory for quality assurance and quality control testing of concrete. The italicized numbers in parentheses refer to the applicable ASTM standard test method(s).

Tests on Concrete

- (1) *Accessory equipment*: Wheelbarrow (4 cu. ft.); No. 1 or 2 metallic scoop; tamping rod; mallets with a rubber or rawhide head, for consolidating test samples, wood or magnesium float; steel trowel; 10 quart bucket; short-handled square-end shovel; box of clean rags; work gloves; rubber gloves (neoprene); 6 ft. ruler; 100 ft. tape (for measuring form dimensions); magnifying glass or loupe (10×) to inspect hardened concrete for amount of air or water voids and other characteristics; plywood boards (for providing firm base for molding test cylinders and setting up other equipment on a level base in the field); pocket calculator.
- (2) *Slump test (C 143)*: Cone Mold.
- (3) *Air content - volumetric (C 173)*: Roll-A-Meter, furnished with accessory equipment; isopropyl alcohol, for dispelling surface foam. Can be used for accurate air content determination on all types of concrete, including lightweight concrete and normal weight concrete with porous aggregates. High cement factor concrete may need a longer testing duration before a stable air content reading is obtained.
- (4) *Air content - pressure method (C 231)*: Various types of pressure meters are available. Furnished with calibration and other accessory equipment. Measuring bowls having capacity of 0.2 cu. ft. and more. These containers may be usable for unit weight tests (see C 138). Pressure air meters are not for use with lightweight aggregate concrete, or with high porosity aggregates. Aggregate correction factor should be applied to the measured air content.
- (5) *Unit weight and yield (C 138 and C 29)*: Unit weight bucket (½ cu.ft.); strike-off plate – ¼ in. thick metal plate, ½ in. thick glass or acrylic plate; ¼ in. thick glass plate, water pump, and chassis grease for calibration procedure. Platform scale, capacity depending on size of unit weight measure and expected weight range of concrete.
- (6) *Concrete temperature (C 1064)*: A good quality bi-metal thermometer with large dial face readable and accurate to within ±1°F. Liquid-in-glass thermometer accurate to within ±0.5°F for calibration of bi-metallic field thermometers.
- (7) *Cylinder molds (C 470)* various types as follows (in order of frequency of use):

Plastic, single use - permit easy stripping; attention required to possible deformation from squeezing if cylinders are moved while concrete is plastic; must be set on firm base to prevent downward bulging of bottoms and resultant convexity of cylinder ends, which causes lower measured strength.

Heavy Plastic, multiple use - removed by controlled air pressure through hole in the base. Caution should be used when removing concrete test specimens from these molds. Repeated use results in outward bulge of cylinder bottoms and convexity of cylinder ends leading to lower measured strengths.

Waxed cardboard, with metal base - provide better rigidity and resistance to deformation than plastic molds. Wax coating may melt under exposure to heat or sun, with wax penetrating concrete, thereby

causing difficulty in stripping molds. Erratic strengths were recorded when cylinders using these molds were placed in steam curing environment. Outside surfaces of molds should not be allowed to become wet as the expansion of cardboard fibers may damage the concrete cylinder. Some types of molds have plastic inside coating. Scuffing the lining during rodding operation allows water to penetrate paper fibers causing swelling and deformation of plastic concrete in the mold. Accidental striking of metal base with the tamping rod causes protrusions in cylinder bottoms which necessitate thick caps for strength testing. These result in lower measured strengths.

Tin molds, single use - of the various mold types, these are reported to produce cylinder strengths nearest to those obtained from cylinders molded in reusable steel molds (see below). However, they are easily deformed out of roundness from careless handling. Bottoms are easily damaged by accidental striking with tamping rod. Tin molds may also leak water from crimps in joints.

Steel molds, reusable - provide highest cylinder strengths of various types of molds. Involve extra labor cost from time-consuming cleaning and re-assembly to ensure water tightness. No capping is required if machined end plates are used and cylinders are stored horizontally. However, horizontally-stored cylinders produce 5 to 10 percent lower strengths.

- (8) *Flexural strength test (C 31, C 192, C 78)*: Beam molds are usually of 6 × 6 × 21 in. dimensions. Consideration should be given to ease of handling (low weight), cleaning and assembly when selecting type of mold. If large number of tests are involved, use a vibrator, 1 in. maximum diameter; minimum 7000 vibrations per minute, for consolidation of low slump concrete. The vibrator may have to be powered by portable generator if operated away from regular power source. Wood or magnesium float for finishing beam surface. Use a trowel to space the sides. Load application apparatus (single-point or third-point).

- (9) *Curing facilities (C 511)*:

Low volume operation for strength testing - Use a curing tank filled with saturated lime water (calcium hydroxide). Galvanized steel cattle trough, or equal, with temperature recording device inserted in water for control of 73.4±3°F temperature requirement. Unless located in temperature-controlled environment, provide for automatic temperature adjustment by means of heating/cooling elements.

High volume operation for strength testing - Moist room capable of maintaining free moisture on specimen surface at controlled temperature of 73.4±3°F. This condition can be obtained by various methods, including combination of heating/cooling air conditioner and humidifier; or A/C unit with a water atomizer using compressed air from plant air compressor and water from available source.

Flexural strength tests - Curing tank filled with saturated lime water (calcium hydroxide) for curing a minimum of 20 hours before the flexure test. Note that without this final curing phase and immediate testing after removal from water, the measured flexural strength of test beams may be reduced by as much as 10 percent and more.

- (10) *Cylinder capping (C 617 and C 1231)*: Most practical and economic method is that using sulfur capping compound. The method involves use of the following items:

Capping fixture or jig -- With machined steel base plate, min. 5/8 in. thick. Note that the ASTM Standard permits ½ in. thick plates. However, plates of this thickness with welded-on retaining rings deform from the heat of capping compound and cause convexity of cap surfaces and lower measured strength. Use of a two-piece metal plate permits re-machining of the base plate to eliminate gouges or dents from continued use.

Compound melting pot - Size depends on testing volume. For high volume, use automatic roaster ovens available at kitchen supply houses and discount stores.

Capping compound - For optimum strength use commercial high-strength compound and limit re-use of reclaimed material. For additional precautions see Manual of Aggregate and Concrete Testing, Appendix to Part 04.02, Annual ASTM Book of Standards. Strength of the compound should be periodically verified by means of 2 in. cubes prepared in accordance with C 617.

Neoprene pad capping (Unbonded) -- Retaining ring system to hold neoprene rubber pad; durometer hardness of pads varies from 50 to 70, depending on strength of concrete tested. Pad caps may not be appropriate for concrete strengths below 2000 psi or higher than 7000 psi. Maximum number of reuses may be limited to about 100. The pad cap system should be qualified by correlating with sulfur-capped cylinders. Number of reuses needs to be verified with companion sulfur capped cylinders.

- (11) *Testing machine (C 39)*: Must be power-operated and have controlled rate of loading to conform with C 39. Therefore, small manually-operated machines may not be a sound investment for a producer laboratory if the strength test data should carry any weight in disputes over strength test results obtained by an outside agency. For greater accuracy in higher load range, allow for capacity well in excess of the highest anticipated loads. Select machine with more than one load range if testing of other than structural concrete cylinders is expected (flexural or tensile splitting strength; 2 in. mortar cube tests).

Special accessory tools may be required for testing of specimens other than 6 × 12 in. cylinders.

- (12) *Rebound hammer test (C 805)*: Several sizes and types of rebound hammers are available. Useful for determination of approximate in-place strengths of concrete.

Tests on Aggregates

- (1) *Aggregate moisture*:

Aggregate drying method (C 566) -- Usable for fine and coarse aggregate; hot plate or drying oven (230°F); drying pans (size depending on sample size required by C 566); scales accurate to at least 1 gram, capacity according to required sample size. Aggregate absorption required for determination of aggregate surface moisture.

Chapman Flask or Pycnometer (C 70) -- Chapman Flask or other graduated flask; or pycnometer; scale. Primarily for determination of fine aggregate surface moisture. Aggregate specific gravity required for result determination.

Speedy Moisture test: Self-contained unit; moisture readout on pressure gauge actuated by gas pressure developed from aggregate surface moisture which reacts with calcium carbide powder which is also placed in the pressure vessel.

- (2) *Fine aggregate gradation (C 136)*: Sample splitter of appropriate size; hot plate or drying oven (230°F); scale; mechanical sieve shaker with horizontal and vertical movement and tapping action ("Ro-Tap" or equal); nest of sieves, 8 in. diameter, having screen sizes of 3/8 in., No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200, cover and pan.
- (3) *Coarse aggregate gradation (C 136)*: Sample splitter of appropriate size or means for hand-quartering down to sample size; drying at 230°F (not mandatory for rapid control tests); mechanical screen shaker; set of screens for most frequently used coarse aggregate sizes, usually 1½ in., 1 in., ¾ in., ½ in., 3/8 in., No. 4 and No. 8.

- (4) *Other basic aggregate tests*:

Materials finer than No. 200 sieve (C 117) -- Fine aggregate sieves No. 16 and No. 200; drying oven (230°F); container or vessel for aggregate washing; scale.

Specific gravity and absorption of coarse aggregate (C 127) -- Wire basket; scale; hot plate or drying oven (230°F); apparatus for suspending sample container (wire basket) in water under scale; box of clean rags or towels (terry cloth or equal).

Unit weight and voids content in aggregate (C 29) -- Unit weight container (½ cu. ft.); platform scale, min. 100 lb. capacity; drying oven (230°F); thermometer; glass plate (the last two items required for calibration of unit weight measure).

NOTE: Test for specific gravity of fine aggregate (C 128) requires operator dexterity and is not very frequently done because fine aggregate deposits show fairly uniform specific gravity. It is therefore omitted from this list. Consider using an experienced commercial laboratory if this test is required.

Advanced Testing Capabilities

Equipment includes that for basic QC functions and equipment listed below.

Tests on Concrete

- (1) *Trial batches (C 192)*: Laboratory mixer (revolving drum type) with capacity for making a minimum of six 6×12 in. cylinders per batch and sufficient concrete for slump, air, unit weight tests, typically about 2 cu.ft.. Bunkers for holding different aggregate types and sizes. Facilities for pre-soaking of coarse aggregate. Large size aggregate shaker for separating and accurate recombining of aggregate size groups for controlled comparison testing for effects of various mix variables on strength and other

concrete properties. Batch scale, preferably dial type, 100 lb capacity. Pipettes and graduates for accurate measuring of admixture quantities. Special laboratory operating practices for uniformity and consistency in trial batch preparation.

- (2) *Setting time of concrete (C 403)*: Proctor penetration resistance apparatus; rigid, nonabsorbent containers of 6×6×6 in. minimum size; pipette. Effect of hardening rate of concrete of variables such as different cements, admixtures, mix proportions, and concrete temperatures are determined with this method.
- (3) *Splitting tensile strength (C 496)*: Supplementary bearing plate or bar for the testing machine; special jig for aligning concrete cylinders and bearing strips. Test used for determination of design coefficients applicable to various lightweight aggregates and lightweight concrete mix compositions. Also used in place of flexural strength tests after strength correlation have been established, although not qualified as acceptance test.
- (4) *Core testing C 42*: Core drill. Drill bits for various core diameters, typically 3 to 4 inch. Portable generator, if electric power is unavailable. Concrete saw for preparation of core ends. Capping rig for core diameter less than 6 in.
- (5) *Penetration resistance test (C 803)*: Windsor probe unit. Measures resistance of concrete to penetration by a steel projectile propelled by a measured powder charge. Usually considered a more reliable indicator of in-place concrete strength than the rebound hammer.
- (6) *Petrographic examination (C 856)*: Loupe for 10x magnification. Stereomicroscope to 70× magnification. Diamond saw; polisher; abrasives of various fineness; resin or wax for impregnating surface to be polished; hot plate or oven for impregnating and drying of specimens. Basic defects in hardened concrete (high air content; excessive water voids) can be rapidly identified with this equipment. More detailed examination requires services of skilled petrographer and specialized equipment. See C 856 for additional information.

Tests on Aggregates

- (1) *Specific gravity and absorption of fine aggregate (C 128)*: Balance of 1 kg min. capacity; pycnometer; metal cone mold; tamper.
- (2) *Sand equivalent test (D 2419)*: Check the ASTM Method for equipment requirements. Method measures quantity of detrimental fine dust and clay in fine aggregate.
- (3) *Organic impurities (C 40)*: Graduated glass bottles; reagent sodium hydroxide solution; reference color standard solution (potassium dichromate dissolved in sulfuric acid), or color reference plates.
- (4) *Resistance to Degradation by Abrasion and Impact in Los Angeles machine (C 131 and C 535)*: Los Angeles abrasion machine; abrasive charge. Measures the degradation of coarse aggregate from impact and abrasive wear.

Tests on Cement

Testing of cement is advisable if strength fluctuations are experienced for which no assignable causes in properties of concrete or concrete materials can be determined. With a moderate expense in labor and equipment, basic information on cement performance can be obtained including compressive strength of cement mortar cubes, time of set, early stiffening (false set; flash set), and water demand. Note that equipment for strength tests of cement mortar cubes is usable for determining uniformity and strength contribution of fly ash, blast-furnace slag and other pozzolans; for strength tests of capping compound; and effects on mortar strength of non-potable mix water, recycled wash water, and of organic matter in fine aggregate. The reliability of test results is gauged by running replicate tests and between-laboratory tests for degree of compliance with the precision statement applicable to the specific method of test. The success of a cement testing program requires that sampling is done in strict compliance with applicable standards (C 183; C 917) and is handled by responsible personnel.

Listed below are basic equipment requirements for various tests on cement.

- (1) *Compressive strength of cement mortars C 109*: 2 in cube molds; graded Ottawa sand (C 778); 4 quart mixer (C 305); glass graduates; scale; tamper; trowel; flow table, flow mold and caliper (C 230); moist cabinet or curing room; testing machine with 0 to 60,000 lbs. load range; testing machine with attachments for testing 2 in. cubes. Note that flow test is required in testing blended cements (C 595). Flow of portland cement mortars is a useful indicator of the mix water demand of a cement.

- (2) *Time of setting by Vicat Needle (C 191)*: Vicat apparatus with 300 g plunger with steel needle, 1 mm dia.; glass graduates; scale; conical ring mold; glass plate; mixer (C 305). Initial set is attained when needle penetrates 25 mm into cement paste sample (at normal consistency) having a depth of 40 mm; final set when no visible sinking of needle into sample is observed.
- (3) *Time of setting by Gillmore Needles (C 266)*: Gillmore Needles, consisting of one "initial set" needle, 1/12 in. dia., 1/4 lb. weight, and one "final set" needle, 1/24 in. dia., 1 lb. weight; glass graduates; scales; mixer (C 305); glass plate. Initial set is attained when a cement paste pat will bear initial set needle without appreciable indentation by the final set needle.
- (4) *Normal consistency C 187*: Vicat apparatus with 300 g plunger, and plunger end having 10 mm dia., conical ring mold; glass graduates; scales; mixer (C 305); non-absorptive plate. The determination of normal consistency provides information on quantity of mixing water to be used in time of setting tests by Vicat and Gillmore Needles. Normal consistency of a cement paste is attained with that amount of mix water which will cause the plunger to settle at a point 10 ± 1 mm below the surface 30 seconds after release of the plunger. The test provides supplementary information on the mix water demand of cement in concrete.
- (5) *Early stiffening of portland cement (mortar method) (C 359)*: Modified Vicat apparatus with 400 g plunger with plunger end of 10 mm. dia.; containers, 50×50×150 mm, for holding mortar samples; graded Ottawa sand and 20/30 standard Ottawa sand (C 778); graduates; scale; mixer (C 305); interval timer. Rate of plunger penetration is measured for initial, 5 min., 8 min., 11 min., and remix penetration. If remix penetration is appreciably greater than earlier penetration rates, the cement may have false set tendencies.
- (6) *Early stiffening of portland cement (paste method) (C 451)*: Vicat apparatus as used in the normal consistency test (C 187); graduates; scale; mixer (C 305); conical ring mold; glass plate; interval timer. Initial, final (5 minute), and remix penetration are measured. If remix penetration is appreciably greater than the final penetration, the cement may have false set tendencies.

NOTE: A cement with severe false set characteristics may adversely affect the performance of concrete to a greater extent than is normally assumed. Even after mixing through the early stiffening phase and restoring the plasticity of the concrete, it may exhibit abnormal bleeding, poor workability, erratic strengths, and variable air content, if the concrete is air-entrained. A high degree of batch-to-batch variability has also been observed when a false setting cement is used in laboratory trial batches of concrete.

Additional physical tests on cement may be found to be useful, including tests for fineness, or loss on ignition. These require more sophisticated equipment and additional operator training in following prescribed testing procedures. See methods of test as described in Part 04.01 of the Annual Book of ASTM Standards.

Supplementary Cementitious Material -- Fly ash:

Being a by-product of power plant operation, its properties may change depending on type and origin of coal used, varying levels of power generation, and other factors. Uniformity of a fly ash can be monitored by various tests, including: color comparison, the simple foam index test for effect on air entrainment; material retained on the No. 325 sieve for amount of large particles (C 430); loss on ignition for carbon content and moisture (C 311); and for pozzolanic activity index (C 311). See the individual methods for equipment required in these tests.

- (1) *Foam Index* -- Not a standardized test. Place 16 grams cement + 4 grams fly ash in a wide mouth glass bottle. Add 50 mL water, cap bottle and shake for 1 minute. Add air-entraining agent (diluted 1:20 with water) in measured increments using an accurate pipette. After each addition, cap and shake vigorously for 15 seconds. Remove cap and observe the stability of the foam. The amount of diluted air-entraining agent needed to produce a stable foam that just covers the surface is the foam index of the fly ash. If too much foam is produced, repeat the test with less admixture. The test measures rapidly the effect of a fly ash lot on the required air-entraining admixture dosage to obtain the required entrained air content and air-void system in concrete, and will help detect a change in fly ash properties from previous deliveries.

Supplementary Cementitious Material – Slag cement:

When used in combination with portland cement in suitable amounts, ground granulated blast-furnace slag (GGBFS) is capable of substantial strength contributions to concrete. Slag is rated by different grades as defined in the Specification C 989. Generally, the strength contribution of a slag increases with its fineness of grind and the content of non crystalline or amorphous minerals (glass). Due to the uniformity of slag from a

given source, control testing may not be necessary or only at considerable intervals. The most practical method for testing the quality and uniformity of slag is the strength test of 2 in. mortar cubes in accordance with a modification of the C 109 test for strength of portland cement mortar. The procedure is described in C 989.

Tests on Chemical Admixtures

Performance of admixtures in concrete, including air-entraining, is usually evaluated by means of trial batches in which characteristics of concrete containing admixtures are compared to those of a plain reference concrete. Equipment for these is as listed in Tests on Concrete. The procedure applies to new materials, to new cement-admixture combinations, and to admixture stock with suspected abnormal performance in the field.

Due to highly controlled manufacturing processes, they show good lot-to-lot uniformity. Freezing may cause a settling out of solids. Homogeneity can usually be restored by mechanical agitation and can be determined by density measurements with a hydrometer. (NOTE: Remixing should never be done by sparging with compressed air. Carbon dioxide in the air may change the admixture pH and destabilize the admixture chemistry.)

Appendix D: NRMCA Guidelines for Conformance Testing of Concrete Component Materials

Coarse Aggregates

Coarse aggregate sampling should be in accordance with ASTM D 75 and C 702. One (1) sample should be collected for every ____ cu. yds. of concrete production per source. The frequency of testing is dictated by the variability of supply.

Coarse Aggregate conformance testing includes:

- **Sieve Analysis** (C 136). Retain failing sample(s) for check test by supplier.
Excessive undersize causes increased water demand, low strength, higher shrinkage rate. Oversize impairs workability and placeability.
- **Specific Gravity and Absorption** (C 127). For material of fluctuating specific gravity or where variation of the amount of porous material may affect mixing water control or concrete quality.
- **Materials Finer than 75 μm (No. 200) Sieve** (C 117).
Excessive amounts in the form of clay may increase mix water demand and reduce strength.
- **Resistance to Degradation in the Los Angeles Machine** (C 131, C 535). Normally not required regularly.
Increase of loss due to degradation in the test may cause lower strengths or be an indicator of potential degradation problems during aggregate handling operation.
- **Unit Weight** (C 29). Dry-rodded unit weight of coarse aggregate determined in 0.5 cu. ft. unit weight bucket.
Important for mix design and can be useful for QC Variations may indicate a change in gradation, specific gravity, or particle shape.

Other tests as warranted by properties of local materials or as required by specification requirements. Check listing of tests in C 33 (paragraph on Methods of Sampling and Testing).

Lightweight Aggregate (ASTM C 330)

Samples should be collected for every shipment received. Properties of Lightweight aggregates may vary from shipment to shipment due to changes in raw material processing. Tests reports should be requested for each shipment to show unit weight, gradation, percent moisture (at time of test), absorption, and specific gravity, if available (pycnometer method). Timely receipt of test data provides an early warning of changes in aggregate properties.

Lightweight Aggregate tests include:

- **Unit Weight** (loose; shoveling procedure) (C 29). Test in oven-dry condition for determination of shipment to shipment uniformity. Test in "as is" condition for batch weight adjustment of lightweight concrete; also as a check on adequate pre-wetting and saturation if to be used in pumping lightweight concrete.
Maximum 10% change in unit weight of successive shipments from sample submitted for acceptance tests. Develop and use batch weight factor (i.e., multiple of cu. ft. weight) for yield adjustment of lightweight concrete. Maintain unit weight history for uniformity evaluation.
- **Sieve Analysis** (C 136, as modified in C 330)

Frequency dependent on aggregate variability. Oversize reduces concrete unit weight and strength; undersize increases concrete unit weight and causes underyield.

- **Specific Gravity Factor** (ACI 211.2, "Recommended Practice for Selecting Proportions for Structural Lightweight Concrete," Appendix A - Pycnometer Method). For some relatively smooth surfaced, lightweight coarse aggregates, regular specific gravity and absorption procedures by C 127 can be used; however, a lid is needed on the basket to confine floating pieces.

Fine Aggregates

Fine aggregate sampling should be in accordance with ASTM D 75 and C 702. One (1) sample should be collected for every ____ cu. yds. of concrete production per source. The frequency of testing is dictated by the variability of supply.

Fine Aggregate conformance testing includes:

- **Sieve Analysis** (C 136). Retain failing sample(s) for check test by supplier. Compute FM from the sieve analysis.
- **Fineness Modulus (FM)** (C 136). Computed from the sieve analysis.
Finer sand means increase in mix water demand and possible strength reduction if mixture is not adjusted. Coarser sand increases bleeding and may impair finishing. FM change by more than 0.20 may require change in mix design.
- **Materials Finer than 75-um (No. 200) Sieve** (C 117)
Excessive amounts of fines in the form of clay may increase mix water demand and reduce strength. It is particularly harmful in high-strength concrete.
- **Organic Material in Fine Aggregate by Color Comparison** (C 40). This is a colorimetric check test to see if organic matter may be present in the sand. Probably only necessary if there is some past history of organic matter in the sand.
Strength reduction of concrete and erratic air content or setting may result if sand fails limit. Additional tests are necessary in that case.
- **Clay Lumps and Friable Particles** (C 142). Make test if these materials are observed in significant amounts in sieve analysis.
Excessive amounts may cause strength reduction from increased fines due to degradation or may leave voids in the concrete due to deterioration.
- **Uncompacted Void Content of Fine Aggregate** (C 1252). Use a standard grading and track changes in the void content, which gives an indication of particle shape and surface texture. Specific gravity of the aggregate needs to be known.
Excessive changes will indicate changes in mix water demand of concrete. Sands producing higher void contents are more angular.

Other tests as indicated by fine aggregate properties or specification requirements.

Cement

One (1) cement sample should be obtained for every _____ cu. yds. of production (per cement source). See ASTM C 917 for correct sampling procedure. A composite sample should be taken from 2 or 3 sub-samples and the sample size should be 10 to 15 pounds. Store the sample in an airtight, moist-proof container with minimum air space over the sample. Maintain a portion of each sample in case of a possible future need for analysis.

Cement tests should include:

- **Color Comparison.** Visual check of cement compared to previous samples.
Helpful in verifying that cement is from a standard mill source. Unannounced changes in mill sources may result in variable concrete properties, such as: air, strength, setting, and color.
- **Bottle Shake Test.** Place cement in the bottom of a jar filled half-full with water; shake; observe stability of the foam produced.
Could identify whether air-entraining or masonry cement was shipped by accident. A stable foam indicates an air-entraining agent may be included in the cement.
- **Cement Temperature Measured at Time of Delivery.**
Important for temperature controlled concrete. Concrete temperature will change 1°F with each ± 9°F change in cement temperature. False set may be associated with high cement temperature.

Additional conformance tests which may be accomplished through your company's cement testing program or by using a reputable independent testing laboratory may include:

- **Cube strength** of cement mortar (C 109) at 3, 7, 28, and 90 days
Check on strength performance of cement. Twenty-eight and 90-day tests indicate strength gain potential of cement at later ages. Data provide basis for in-house evaluation of cement strength uniformity by means of control charts and C 917 procedure.
- **Percent flow** of C 109 mortar; should be measured when mortars are prepared.
Check on mix water demand of cement.
- **Time of Set** (C 266 or C 191).
Useful for estimating time of set of concrete and detecting potential changes.
- **Normal Consistency** (C 187); needed for time of set determination.
- **Fineness** (C 204 or C 115). Blaine air permeability fineness is a fairly rapid test which can be run on cement or mineral admixtures.
Coarser grind may indicate lower strength, more bleeding, or poor finishing. Finer grind can result in higher strength, higher water demand, and increased drying shrinkage.
- **Material Retained on No. 325 Sieve** (C 430).
Check on amount of large cement particles which do not contribute to concrete strength and possible contamination.
- **False Set Ratio** (C 415).

False set: ratio of less than 50% may cause excessive bleeding, poor finishing, lower strength.

- **Loss on Ignition (LOI)** (C 114).

Cement may be partly hydrated if LOI is above normal; possibly weathered clinker; leads to lower concrete strength.

Fly Ash and Ground Granulated Blast-Furnace Slag

One (1) Fly Ash sample should be obtained for every _____ cu. yds. of production (per fly ash source). Sampling frequency should be dictated by the fly ash variability. Store the sample in an airtight, moist-proof container with minimum air space over the sample. Maintain a portion of each sample in case of a possible future need for analysis.

Fly Ash tests should include:

- **Color Comparison.** Visual check of fly ash compared to previous samples.

Darker color may indicate higher carbon content which will reduce air content of concrete.

- **Foam Index** -- Not a standardized test. Place 16 grams cement + 4 grams fly ash in a wide mouth glass bottle. Add 50 mL water, cap bottle and shake for 1 minute. Add air-entraining agent (diluted 1:20 with water) in measured increments using an accurate pipette. After each addition, cap and shake vigorously for 15 seconds. Remove cap and observe the stability of the foam. The amount of diluted air-entraining agent needed to produce a stable foam that just covers the surface is the foam index of the fly ash. If too much foam is produced, repeat the test with less admixture.

The test measures rapidly the effect of a fly ash lot on the required air-entraining admixture dosage to obtain the required entrained air content and air-void system in concrete, and will help detect a change in fly ash properties from previous deliveries.

- **Materials Retained on No. 325 Sieve** (C 430)
- **Loss on Ignition** (C 114)
- **Strength Activity Index with Portland Cement** (C 311)

Other tests as indicated by properties of available fly ash.

Note that chemicals may be added at the power plant to enhance precipitator efficiency. These include ammonia compounds, which do not generally impair concrete performance, and soda ash, which may cause abnormal setting of concrete and increase the total alkali content.

One (1) Slag sample should be obtained for every _____ cu. yds. of production (per slag source). Sampling frequency should be dictated by the slag variability. Store the sample in an airtight, moist-proof container with minimum air space over the sample. Maintain a portion of each sample in case of a possible future need for analysis.

Slag tests should include:

- **Material Retained on No. 325 Sieve** (C 430)

Increase could result in lower strength contribution.

- **Cube strength** of 50/50 slag-plus-portland cement mortar (C 109).

Strength ratio to plain portland cement mortar provides Slag Activity Index information.

Chemical Admixtures

Sampling frequency _____, as warranted by dependability of performance; and emergency sampling in the event of unusual performance in concrete (delayed set; flash set; extremes in air content). Sample size one quart.

Chemical Admixture testing includes:

Air-Entraining Agent: (C 260)

For control and reference purposes determine:

- Air-entraining efficiency for various local material combinations;
- Effects of various overdosages on air content and strength.

Chemical Admixtures: (C 494)

For control of lot-to-lot uniformity determine:

- pH level;
- Percent solids;
- Specific gravity using hydrometer.

When using new cement-admixture combination, determine:

- Cement-admixture compatibility;
- Effects of various overdosages on setting time and strength.
Certain cement-admixture combinations may cause rapid slump loss, rapid set, delayed set, low concrete strength.
- Semi-adiabatic heat signature testing and setting time evaluation using ASTM C 403
To evaluate changes in rates of cement hydration, heat generation and impacts on setting time

Calcium Chloride (Standard Solution): (D 98)

- Check for correct density with hydrometer, using manufacturer's density charts, each fresh batch, and at weekly intervals to assure predictable performance in concrete.

Water

City water will not be tested.

Questionable sources of mixing water or ice (such as well water, ponds or streams) should be tested to meet the requirements of ASTM C 1602 - Table 1 for strength and setting characteristics.

Chemical characteristics for determine compliance with the optional requirements of C 1603 – Table 2 for Chlorides, Sulfates, Alkalis as Na₂O eq., and Total Solids.

Other testing as required by codes of local jurisdictions (health, environmental, highway departments) or project specifications.

Re-Used Wash Water -- Sampling and Testing:

At prescribed intervals, based on the density of mixing water, should be tested to meet the requirements of ASTM C 1602 - Table 1 for strength and setting characteristics.

Chemical characteristics for determine compliance with the optional requirements of C 1603 – Table 2 for Chlorides, Sulfates, Alkalis as Na₂O eq., and Total Solids.

Recycled wash water may affect rate of setting, hardening, strength gain, and other characteristics.

Appendix E: Project Checklists

1. Checklist for Concrete Pre-Construction Conference, NRMCA and ASCC
2. Checklist for Ordering and Scheduling Ready Mixed Concrete, NRMCA and ASCC
3. Checklist for Pumping Ready Mixed Concrete, NRMCA, ASCC and ACPA

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National Ready Mixed Concrete Association
American Society of Concrete Contractors
American Concrete Pumping Association



*Checklist for the Concrete
Pre-Construction
Conference*

Introduction

Pre-construction meetings are of prime importance in planning concrete construction work because many potential problems can be avoided at the right time – before the start of the project when the cost impact is relatively low.

In 1999, the National Ready Mixed Concrete Association (NRMCA) and the American Society of Concrete Contractors (ASCC) joined in a partnership to enhance the quality of concrete construction. This checklist is one of the ongoing initiatives of the partnership.

NRMCA and ASCC recognize the benefits resulting from participating in these pre-construction meetings and have prepared this **Checklist for the Concrete Pre-construction Conference** to assist the decision makers and participants on a project - representing the owner, specifier, general contractor, concrete contractor, concrete producer, other material suppliers and testing agency – in planning quality concrete construction work.

The checklist allocates responsibilities and establishes procedures related to concrete construction – subgrade preparation, forming, concrete mixture proportioning (mix design), necessary equipment, ordering and scheduling materials and operations, placing, consolidating, finishing, jointing, curing and protection, testing and acceptance as well safety and environmental issues.

The checklist covers some of the issues that need to be discussed at a pre-construction meeting and is not intended to be all-inclusive.

Sample Checklist for the Concrete Pre-Construction Conference

A. Project Information

- 1. Project name _____
- 2. Location _____
- 3. Project start date _____
- 4. Project completion date _____

5. Project participants	Contact
• Owner _____	_____
• Architect _____	_____
• Structural engineer _____	_____
• Construction manager or General contractor _____	_____
• Concrete contractor _____	_____
• Concrete producer _____	_____
• Admixture supplier _____	_____
• Concrete pumping contractor _____	_____
• Concrete finisher _____	_____
• Testing laboratory _____	_____
• Inspection agency _____	_____
• Other _____	_____

6. Background information about the project

7. Unique features of the project

8. Distribution of completed checklist
- Project Participants
 - Others: _____

B. Construction Process

- 1. Review notes and changes on drawings that may affect construction process

- 2. Sequence of construction and milestones dates

- a. Foundations _____
- b. Walls _____
- c. Structural slabs _____
- d. Slab-on-grade interior _____
- e. Slab-on-grade exterior _____

- 3. Construction/Acceptance of base/subgrade, compaction, elevation. Responsibility for:

- a. Providing base and subgrade elevations to contractors

- b. Stability of the base and or subgrade under construction traffic

- c. Protecting the base and/or subgrade from water damage

- d. Compacting and final grading of the base and subgrade after all plumbing installations are complete

- e. Location of electrical lines (conduit)

- In subgrade trenched and backfilled with rock _____
- In rock subgrade _____
- Protection from truck traffic if required _____

- 4. Responsibility for site access roads and their maintenance

- 5. Responsibility for available space for pumping operations if required

- Access for two trucks to pump, one on each side _____
- Staging area for testing and slump adjustment _____

- 6. Person responsible for directing trucks to pump or placement area _____

- 7. Responsibility for directing/backing up trucks _____

- 8. Responsibility for power, lighting, water, and water pressure during placing and finishing

- 9. Responsibility for controlling the ambient temperatures (subgrade, forms, and air)

10. Forms

- a. Form sizes, types _____
- b. Lifting equipment required _____
- c. Form materials, accessories _____
- d. Review location of reinforcement, embedded items, waterstops, drains, openings, openings for frames, etc. _____

- e. Scheduling form erection and removal correlated to reinforcing and concreting operations _____
- f. Responsibility for installation and inspection
 - i. Reinforcement _____
 - ii. Embedded items _____
 - iii. Waterstops _____
 - iv. Drains _____
 - v. Opening Frames _____
- g. Responsibility for form inspections
 - i. Preliminary – prior to rebar placement _____
 - ii. Semifinal – with rebars, embedded items, waterstops and drains: _____
Note: Reinforcement inspection must include
 - Location and spacing to allow access for vibration equipment and proper coverage
 - Spacing of reinforcement in relation to aggregate size
 - iii. Final – before placing concrete _____

11. Vapor retarder or vapor barrier membrane

- a. Type of membrane _____
- b. Location of membrane relative to subgrade _____

- c. Effect on curling _____
- d. Effect on bonding of applied floor coverings _____

- e. Basis of acceptance for installation of moisture sensitive flooring materials (wood, carpet, tiles) on the slab
 - i. Moisture emission requirements for flooring materials to be installed _____

 - ii. Responsibility for
 - Testing and reporting of the test results _____
 - Acceptance of the slab _____

12. Placing Concrete: equipment and procedures

- a. Deposit from truck _____

- b. Buggy _____

- c. Belt conveyor _____

- d. Bucket placement _____

e. Pumping _____

f. Other _____

13. Consolidation of concrete: equipment and procedures

a. Vibrators _____

b. Vibratory screeds (surface vibrators) _____

c. Back up equipment _____

d. Power source _____

e. Other _____

14. Responsibility for inspection of placing and consolidation of concrete

15. Ventilation in enclosed spaces

a. Type of test required _____

b. Responsibility for ventilation:

i. During placement _____

ii. During finishing _____

16. Strike off technique

Hand strike off _____

Vibratory screed _____

Laser screed _____

Other _____

17. Finishing

a. Types of finishes

• Area 1 _____

• Area 2 _____

• Area 3 _____

• Area 4 _____

b. Special materials for finishes _____

Dry-shake hardener

• Rate of application _____

• Procedure to install _____

c. Tools and equipment required _____

d. Back up tools and equipment required _____

18. Specified tolerances for

a. Vertical concrete surfaces:

- Plumbness _____
- Dimensions _____
- Thickness _____
- Texture _____
- Color _____

- Acceptable variances _____

- Surface defects _____
- Others _____

Note. Refer to ASCC Guide for Surface Finish of Formed Concrete

b. Slabs-on-grade and floors

- Flatness/levelness _____
- Dimensions _____
- Thickness _____

- How it will be determined _____

- Texture _____
- Color _____

- Acceptable variances _____

- Surface defects _____
- Joint spacing _____
- Others _____

c. Elevated slabs

- Flatness/levelness _____
- Dimensions _____
- Thickness _____

- How it will be determined _____

- Texture _____
- Color _____

- Acceptable variances _____

- Surface defects _____
- Others _____

d. Procedures for measuring tolerances (when and how)

e. Review specifications for possible conflict between the concrete installer and other trades

- f. Review specifications for conflict between the surface profile provided by the concrete installer and the surface profile required by installer of finish material

- g. Responsibility for

- i. Reporting F-numbers to concrete contractor _____
- ii. Accepting floors _____
- iii. Measuring tolerances _____
- iv. Repairing "air or bug holes" in vertical surfaces _____
- v. Removing curing compounds prior to application of sealers _____

19. Jointing

- a. Review/verification of contraction, isolation, expansion, and construction joint layout plans

- Structures (walls) Yes No
 Comments (number, location, spacing, details) _____
- Slabs-on-grade Yes No
 Comments (number, location, spacing, details) _____

- b. Type of joints contraction isolation expansion

- 1. Formed joints _____
- 2. Tooled joints _____
- 3. Early entry saw-cut
 - Timing _____
 - Depth of cut _____
 - Joint spacing _____
 - Equipment _____
- 4. Conventional saw-cut
 - Timing _____
 - Depth of cut _____
 - Joint spacing _____
 - Equipment _____

- c. Slabs-on-grade

- i. Joints Yes No
- ii. Reinforcement Yes No
 - Position of reinforcement in slab _____
 - Method of supporting reinforcement at specified elevation _____
 - Termination at joints _____

- iii. Load transfer devices (e.g. dowel bars)
 - Type, size, and location _____
 - Check for specified alignment _____
- iv. Define unacceptable cracks (see surface defects in tolerances) _____

- v. Method of repair of unacceptable cracks _____
- vi. Responsibility for repair of unacceptable cracks _____
- vii. Sealing (Filling) Joints Yes No
 - Epoxy joint filler Yes No
 - Elastomeric sealant Yes No
 - Timing (review product directions and ACI Guidelines) _____

 - Depth of filling _____
 - Procedure (flush or a slightly crowned for epoxy joint or concave for elastomeric sealant)

 - Responsibility for future touch up _____

20. Curing and Sealing

- a. Curing methods _____
- b. Curing periods _____
- c. Responsibility for curing floors placed prior to erection of roof, walls

- d. Temperature Control Yes No
 - Specify _____
 - If temporary heaters are used, responsibility for venting to prevent concrete dusting

- e. Excessive evaporation control
Specify _____
- f. Evaporation retarder Yes No
Specify _____
- g. Fogging Yes No
Specify _____
- h. Other _____
- i. Responsibility for inspection of curing operations/timing

- j. Responsibility for removing curing compounds _____

- k. Applying sealers _____
 - Types _____
 - Locations _____

21. Protection of concrete

- a. Roof and Walls Yes No

Specify _____

- b. Floors coverings Yes No

Specify _____

- c. Floor Protection Yes No

i. Specify age/strength of floor prior to the use of floor by:

- Foot traffic _____
- Pneumatic tire traffic _____
- Hard wheel traffic _____
- Construction traffic _____

ii. Specify age/strength of floor when

- Equipment is installed _____
- Racks are erected _____

22. Responsibility for storage areas and site security

23. Form removal

- a. What is the minimum strength requirement for form removal? _____ psi.

- b. What formal report is required before form removal? _____

- c. Type of field or in-place strength tests if used and evaluation criteria? _____

- d. Name(s) of personnel authorized to approve form removal _____

24. Procedures for hot weather concreting

25. Procedures for cold weather concreting

C. Concrete Materials and Required Mixture Proportioning (Mix Design)

1. Concrete Mixtures (Mix Design)

List of Mixture (Mix Design) Designations	Mixture (Mix Design) Codes	Location	Approximate Volumes

2. Mixtures (Mix designs) acceptance

a. Have mixtures (mix designs) been approved Yes No

b. Responsibility for mixture (mix design) approval _____

Comments: _____

c. Copies of the approved mixtures (mix designs) provided to

- Owner Yes No
- Architect Yes No
- Structural engineer Yes No
- Construction manager or general contractor Yes No
- Concrete contractor Yes No
- Concrete pumping contractor Yes No
- Concrete finisher Yes No
- Testing laboratory Yes No
- Inspection agency Yes No

3. Additional mixtures (mix designs) required Yes No

• Specify _____

• Approved Yes No

4. Consideration for aggregates

a. Gradation _____

b. Sand requirements _____

5. Pumped concrete Yes No

6. High early strength Yes No Strength required _____ psi at age _____

7. Lightweight concrete Yes No

8. Other _____ Yes No

Comments: _____

9. Concrete batch plant

Central-mixed Shrink-mixed Truck-mixed

a. Primary plant: _____ Backup plant: _____

b. NRMCA Production Facility Certification Required Yes No

c. Inspection requirements

- Full time
- Part time
- Not required

d. Revolutions or time limits for mixing concrete _____

Note: Refer to ASTM C 94

10. Review project specifications for conflicts in performance requirements (compressive/flexural strength, durability, shrinkage, curling and water-cementitious materials ratio, water content, slump, air content)

11. Other value-added ingredient materials required

- Mid range water reducing admixture Yes No
- High range water reducing admixture Yes No
- Non-chloride accelerator Yes No
- Corrosion inhibitors Yes No
- Fly Ash ASTM Class C Yes No
- Fly Ash ASTM Class F Yes No
- GGBF Slag Yes No
- Silica fume Yes No
- Type K cement Yes No
- Component expansion admixture Yes No
- Fibers Yes No
- Color Yes No
- Other _____ Yes No

Comments (specify type and quantity of ingredient, etc.) _____

Note 1. Batching all ingredient materials at the plant ensures best quality control of concrete. Jobsite modifications to mixture should be communicated to the concrete producer.

Note 2. Add appendices for requirements of ingredient materials

12. Project specification requirements for air content

- Normal weight air-entrained concrete (not recommended if floors require a machine troweled finish but recommended for all exterior work)

Comments _____

- Are adjustments to air content allowed on the jobsite Yes No

Comments _____

- Air-entrained lightweight concrete for interior slabs

Comments _____

- Other requirements: _____

Comments _____

13. Project specification requirements for slump limits

- Conventional concrete Max _____ Min _____
- Pumped concrete Max _____ Min. _____

Comments: _____

- Plasticized concrete Max _____ Min. _____

Comments: _____

- Other: Max _____ Min. _____

Comments: _____

14. Jobsite slump adjustments

a. Responsibility for:

- i. Making/Permitting jobsite slump adjustments _____
- ii. Recording of adjusted batch _____

b. Materials permitted to adjust the slump

- Water _____
- Mid-range water reducer _____
- High-range water reducer _____

c. Procedure to be followed and limitations that apply to jobsite slump adjustment (maximum amount, subsequent mixing, sampling of the load) _____

15. Project specification requirements for temperature

a. Required temperature of concrete as delivered: Max _____ °C/°F Min _____ °C/°F

b. Responsible person for requiring and approving special measures to meet concrete temperatures such as hot water, heated aggregate, cold water, ice, liquid nitrogen _____

c. Outline procedure to be followed and limitations that apply for measurement of concrete temperature and acceptance of concrete at the jobsite: _____

16. Project specification requirements for concrete delivery time

- ASTM C 94
- Other _____

17. Project specification requirements for lightweight concrete

- Maximum unit weight _____
- Slump _____
- Air content _____
- Pumping operations _____

18. Architectural concrete

a. Finish details

Location

- Exposed aggregate _____
- Smooth finish _____
- Rubbed finish _____
- Colored _____
- Imprinted _____
- Details (grouted joints, textured) _____

b. Special materials

- Cement _____
- Aggregates _____
- Water _____
- Admixtures _____
- Sealers _____
- Release agents _____

c. Architectural samples or mockups

- Location _____
- Preservation _____
- Responsibility for acceptance _____

d. Repair methods _____

D. Ordering and Scheduling Concrete

1. Person(s) responsible for ordering concrete (Concrete must be ordered by mixture (mix design) code)

2. Minimum time notice required for most placements _____
3. Define large and specialty orders _____
4. Minimum notice required for large and specialty placements _____
5. Procedure for handling will call orders _____
6. Procedure for handling revised orders _____
7. Contact name(s) and phone number(s) for last-minute cancellations
 - Producer _____
 - Concrete contractor _____
 - Construction manager or general contractor _____

- 8. Person on jobsite responsible for reviewing delivery ticket prior to placement

- 9. Regular hours are between _____ A.M. and _____ P.M.
Regular workdays are _____ through _____ not including designated holidays
- 10. Are there any anticipated holiday and/or overtime placements? Yes No
Comments _____
- 11. Delivery schedules
 - a. Location of placement _____
 - b. Anticipated placement sizes _____ cubic yards
 - c. Minimum load size _____ cubic yards
 - d. What are anticipated placement rates _____ cubic yards/hour
 - e. Approximate placements dates _____
 - f. Inclement weather plant capability _____
- 12. Concrete delivery
 - a. Any traffic restrictions at or near the jobsite Yes No
Comments _____
 - b. Any restrictions on entrance to or exits from jobsite Yes No
Comments _____
 - c. Other Items _____
Comments _____
- 13. Trucks:
 - a. Number of trucks _____
 - b. Type of trucks _____
 - c. Interval Schedule (Turn around time) _____

E. Environmental Aspects

- 1. Environmentally sensitive areas around the project Yes No
Comments: _____
- 2. Responsibility for providing a concrete wash out area at the jobsite _____

- 3. Responsibility for clean up of the wash out areas _____
- 4. Person responsible for directing trucks to the wash out area _____

- 5. Are spill response kits available on site? Yes No
Comments _____
- 6. On site emergency contact person _____

7. Responsibility for disposal of curing compounds _____

8. Other Items _____

F. Quality Control/Assurance

1. Accreditation requirements for laboratory _____

2. Certification requirements for

a. Laboratory testing technicians

Name

ACI Concrete Laboratory Testing Technician Grade I _____

ACI Concrete Laboratory Testing Technician Grade II _____

Equivalent _____

b. Field testing technicians

Name

ACI Grade I Certified _____

Equivalent _____

3. Advance notice for scheduling testing personnel _____

4. Procedures for verification of specified requirements

Batch Records

Strength Tests

Other _____

F.1 Concrete Sampling and Testing Requirements

1. Sampling frequency _____

2. Sampling location

Point of discharge

Point of placement

Comments (agreement on sampling location) _____

3. Tests performed on each sample

Slump

Temperature

Density (unit weight)

Air content

Compressive strength

Flexural strength

Other _____

4. Cylinder size for compressive strength test
 - o 4x8 inch o 6x12 inch
5. Beam size for flexural strength test
 - o 6x6 inch o Length: refer to ASTM C31
 - Other size _____

Note. If beam breaks are low, compare acceptable concrete with suspect concrete by coring
6. Number of cylinders per sample _____
(hardened cylinder weight must be recorded on concrete strength reports)
7. Number of beams per sample _____
8. Number of cylinders/beams to be cured _____ Field? _____ Lab? _____
9. At what ages are cylinders/beams to be tested? _____
10. Number of cylinders/beams per test (minimum 2) _____
11. Are reserve cylinders/beams required? o Yes o No How many? _____
12. Frequency of yield tests and compliance checks (three-load average of unit weight)

F.2 Test Cylinder Storage and Transportation:

1. Initial curing (up to _____ hours)
 - Immersed in water-controlled temperature
 - Storage box-controlled temperature - record daily minimum and maximum temperature
 - Exposed to the environment - record daily minimum and maximum temperature

Note. In the absence of cylinder storage with daily record of minimum/maximum temperatures, cylinders shall be immersed in water immediately after molding

 - Storage at jobsite under conditions consistent with concrete in structure

Note: Field-cured cylinders are used to determine the appropriate time for form removal or post-tensioning
2. Responsibility for providing cylinder storage box _____
Note: Refer to ACI 301
3. Responsibility for maintaining temperature in storage box between 60-80°F (16 to 27°C) during first 16-48 hours after molding _____

4. Describe how storage box temperature will be maintained _____

5. When will cylinders made on days preceding non-work days be transported to the laboratory?

6. Describe arrangements for access to construction site on non-work days

7. Responsibility for final curing as per ASTM C 31 _____

F.3 Acceptance/Rejection of Fresh Concrete:

1. Who has the authority to reject a concrete delivery? _____

Note: A second person may be designated as having the authority for FINAL rejection of a concrete delivery

2. What criteria will be used to reject concrete

- Slump _____
- Air content _____
- Unit weight _____
- Temperature _____
- Time limit _____
- Other _____

3. Are re-tests allowed before rejection? Yes No

Procedure _____

F.4 Acceptance Criteria for Hardened Concrete

1. Review Acceptance Criteria

- ACI 301/318
- ASTM C 94
- Other _____

2. Distribution of test reports (to all participants)

- Owner _____
- Architect _____
- Structural engineer _____
- Construction manager or
General contractor _____
- Concrete contractor _____
- Concrete producer _____
- Admixture supplier _____
- Concrete pumping contractor _____
- Concrete finisher _____
- Testing laboratory _____
- Inspector _____
- Jobsite testing technicians _____

Note. Concrete producer and concrete contractor must receive reports directly and immediately from the laboratory to allow timely response to any deficiencies.

3. Potential concrete deficiencies

- Target cylinder strength for earlier ages than 28 days (at 3-7 days) _____

- Procedure for timely reporting results to concrete producer and concrete contractor before the 28-day strength tests (density, 3-7 day strength, etc.) _____

F.5 Testing of Hardened In-Place Concrete

1. In what situations will additional (or referee) testing be required?
 - Running average of three consecutive strength tests is less than specified – ACI 318
 - Individual strength test is 500 psi less than specified – ACI 318
 - Other _____
2. Procedure(s) to be followed for evaluation of low-strength tests
 - Evaluation of test results and testing procedures – including laboratory operations
Comments _____

 - Non-destructive testing
 - Penetration probe in accordance with ASTM C 803
 - Rebound hammer in accordance with ASTM C 805
 - Other (combined method) _____

Note. Refer to ACI 228.1R
 - Evaluation of structural adequacy of questionable sections by the structural engineer

 - Core testing and evaluation in accordance with ACI 318
 - Procedure for conditioning cores prior to testing _____

 - Load testing in accordance with
 - ACI 318
 - Other _____
 - Remove and replace
Comments: _____

3. How do the project specifications handle additional testing? _____

If additional testing is required, _____ will notify the following parties _____

4. What investigative procedures will be used?

5. Who will be employed to conduct additional testing and who employs them?

6. How will the test results be evaluated?

7. Who will pay the costs of additional testing?

- Specified strength confirmed _____
- Specified strength not confirmed _____

G. Safety

1. Personal protective equipment required

- Hard hats
- Safety boots
- Eye protection
- Safety vests
- Specific protective clothing
- Respirators
- Other _____

2. Responsibility for:

- a. First aid supplies _____
- b. Providing and maintaining Material Safety Data Sheets (MSDS) at the jobsite _____
- c. Fall protection _____
- d. Safety Inspections _____
- e. Safety meetings _____

3. Emergency Contacts

The National Ready Mixed Concrete Association is a trade association representing producers of ready mixed concrete and those companies that provide materials and support to the industry. The primary goal of NRMCA is to increase the professionalism of the industry. NRMCA provides its members with education, training, product promotion assistance, information on research and technology and representation before Congress and regulatory bodies.

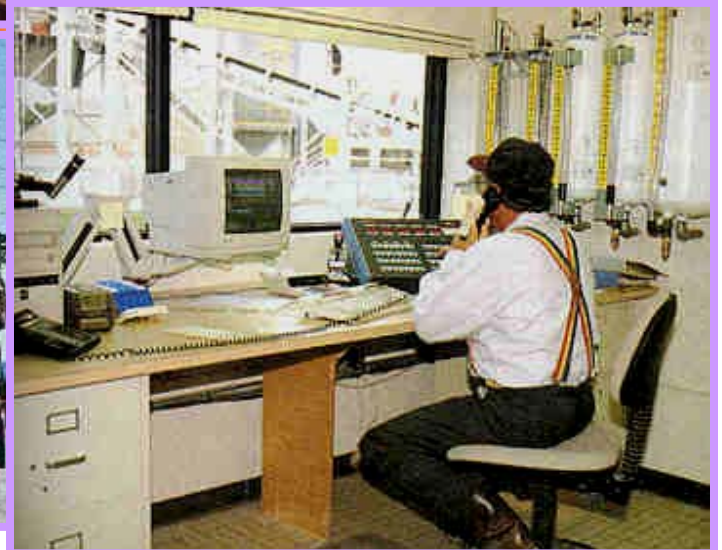
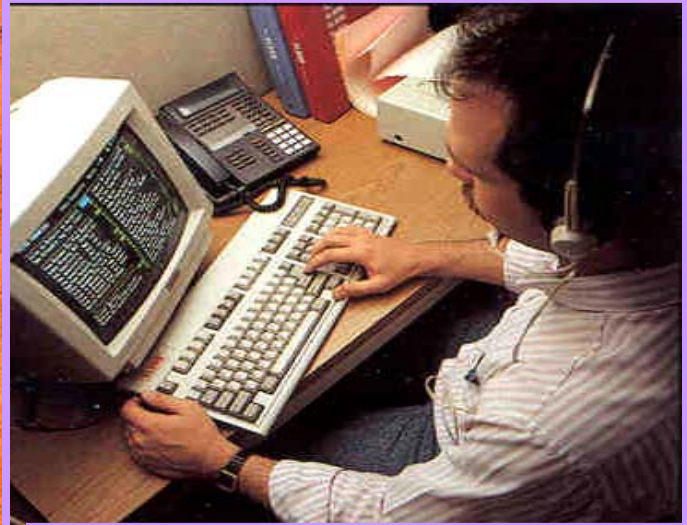
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*Checklist for Ordering and
Scheduling Ready Mixed
Concrete* ©

Introduction

A Task Group of the National Ready Mixed Concrete Association (NRMCA) and the American Society of Concrete Contractors (ASCC) has developed this checklist for Ordering and Scheduling Ready Mixed Concrete. The intent is to simplify the ordering process through a logical approach while establishing the necessary information from the supplier's and the purchaser's perspective, especially on smaller projects. The presumption is that on larger projects the concrete construction team has been through a pre-construction conference and has addressed the pertinent items in the **NRMCA/ASCC Checklist for Concrete Pre-Construction Conference** and those items are excluded from this document. The ordering requirements of ASTM C 94 *The Specification for Ready Mixed Concrete* generally govern unless over-ridden by the purchaser.

Besides items covered in this checklist other items that need to be defined and clarified between the supplier and purchaser include:

- **Advance notice for concrete orders**
- **Add-on orders**
- **Change orders**
- **Will call orders and advance confirmation**
- **After hours placements and charges,**
- **Week end/holiday orders and charges**
- **Cancellation of orders**
- **Clean-up load estimates and advance notice**
- **Additional charges for items like returned concrete, short loads, etc.**
- **Requirements for personnel and plant certification**

This checklist will facilitate the **person taking the order** to assist the **person placing the order** by walking him through these items and documenting the order.

The section on type of construction is to facilitate tracking changes in concrete market segments for promotion activities.



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CHECKLIST FOR ORDERING AND SCHEDULING READY MIXED CONCRETE

Project: _____

Location: _____

	Name	Phone	Mobile	Fax
Order taken by				
Ordered by				
Purchased by				

Time/Date Called		Quantity, cy	
Date Required		Truck Spacing/Duration	
Start time		Placement Rate, cy/hr.	

Location	Mix Code	Strength, psi	Min. cement content			Slump, in.		Air Content		
			No	Yes		±	No	Yes		%

Concrete Temperature Limits No Yes _____

Admixtures or other ingredients	No	Plant-added	Jobsite added	Admixtures or other ingredients	No	Plant added	Jobsite-added
Synthetic fibers				High range water reducer			
Steel fibers				Accelerator	Chloride		
High early strength					Non-chloride		
Mid-range water reducer				Other			

Directions to the jobsite _____

Site access _____

Transportation units access _____

Safety info to drivers _____

Wash-out areas _____ **Other** _____

Placement Method Pumping Conveyor Bucket Other _____

Emergency Contacts for schedule changes, equipment breakdown, plant/truck breakdown, mixture adjustments

	Contact	Phone	Mobile	Home Phone
Producer				
Contractor				
General Contractor				

Type of Project

- | | | |
|--|---|---|
| <input type="checkbox"/> Highway | <input type="checkbox"/> Streets and local roads | <input type="checkbox"/> Recreational paving |
| <input type="checkbox"/> Airports | <input type="checkbox"/> Parking garages | <input type="checkbox"/> Tilt-up construction |
| <input type="checkbox"/> Bridges | <input type="checkbox"/> Transit | <input type="checkbox"/> Buildings |
| <input type="checkbox"/> Water resource structures | <input type="checkbox"/> Waste management structures | <input type="checkbox"/> Flowable fill |
| <input type="checkbox"/> Parking areas | <input type="checkbox"/> Driveways/residential flatwork | <input type="checkbox"/> Basement walls |
| <input type="checkbox"/> Residential walls (ICFs) | <input type="checkbox"/> Other _____ | |

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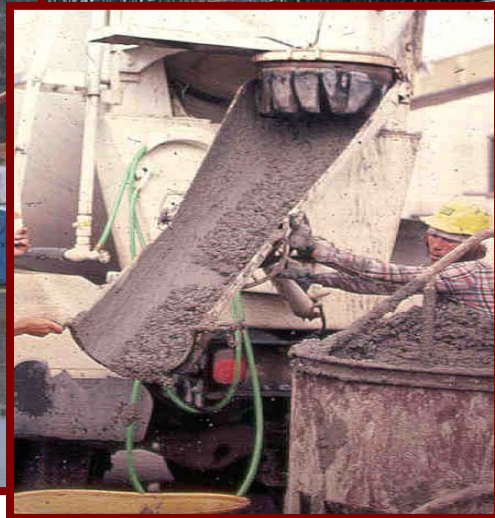
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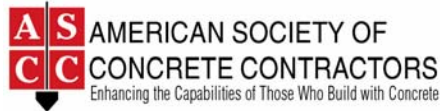


Checklist for Pumping Ready Mixed

Introduction

This short Checklist for Pumping Concrete was developed by National Ready Mixed Concrete Association (NRMCA), American Society of Concrete Contractors (ASCC) and the American Concrete Pumping Association (ACPA). The intent is to identify details of the process of pumping concrete prior to the start of the placement so that all impacted parties are aware of the issues related to the construction specification, equipment and schedules, responsible persons and jobsite safety. The presumption is that on larger projects the concrete construction team has been through a pre-construction conference and has addressed the pertinent items in the **NRMCA/ASCC Checklist for Concrete Pre-Construction Conference** and those items are excluded from this document. This document can be used included in a broader preconstruction conference agenda.

This Checklist is not intended to be all inclusive of the items that need to be considered and depending on a specific project many item regarding specification requirements, testing details, construction logistics and jobsite safety may need to be addressed in greater detail than outlined in this document. Many of these items will be critical to the success of the project and should be discussed and agreed upon prior to the placement of concrete with appropriate notification to the owner and his representative.



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CHECKLIST FOR PUMPING READY MIXED CONCRETE

Project: _____

Location: _____

Directions: _____

(Map on back) _____

1. Contacts

Who	Name	Phone	Mobile	Fax	E-Mail
C. Contractor					
RMC Producer					
Pump Contractor					

2. General Conditions

Start time	Pump:	am/pm	Concrete:	am/pm
Placement Location	<input type="checkbox"/> Slabs	<input type="checkbox"/> Walls	<input type="checkbox"/> Footings	Other
Placement Rate, cy/hr.	Volume, cy			
Type of pump	<input type="checkbox"/> Regular	<input type="checkbox"/> Z-Boom	<input type="checkbox"/> Telescoping	<input type="checkbox"/> Trailer
Size of Pump, m	Pipeline dia, in.			
Pumping Distance, ft.	Vertical		Horizontal	
Slump/Air Spec	<input type="checkbox"/> Point of Discharge		<input type="checkbox"/> Point of Placement	
Testing	<input type="checkbox"/> Point of Discharge		<input type="checkbox"/> Point of Placement	
Priming Agent	<input type="checkbox"/> Grout		<input type="checkbox"/> Slick Pack	

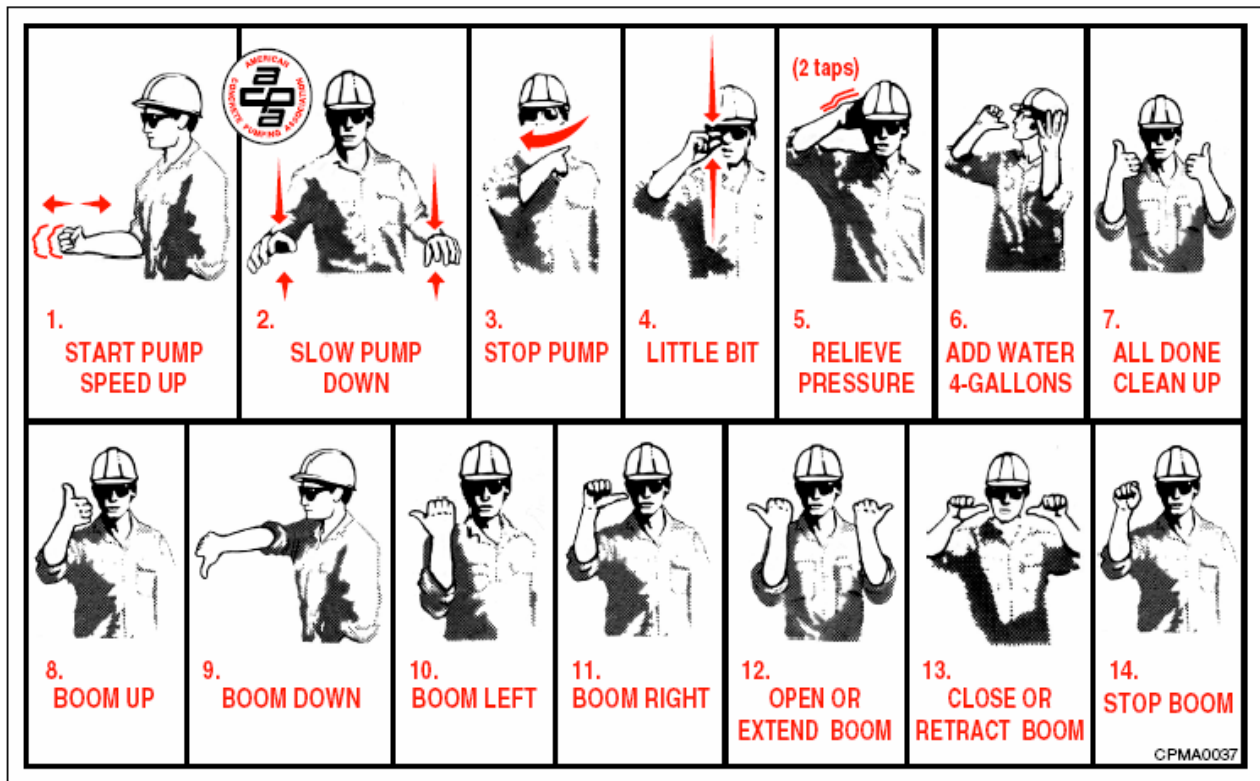
3. Concrete Mixture

Strength, psi	28 days:		Other _____:	
Max Size of aggregate	(no larger than 1/3 pipeline diameter)			
Density, (UW), pcf		Lightweight	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Slump, in.		Air, %		
Water Reducer	<input type="checkbox"/> Regular	<input type="checkbox"/> MRWR	<input type="checkbox"/> HRWR	
Fibers	<input type="checkbox"/> Yes	<input type="checkbox"/> No		
Special Requirements				
Set time requirements	Initial:		Final:	
Water Permitted at job	<input type="checkbox"/> Yes	<input type="checkbox"/> No		

4. Jobsite / Safety

Wash out area	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Power Lines	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Safe Set up Area	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Clean Water available for washout	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

5. Notes



Courtesy ACPA

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The American Concrete Pumping Association was founded in 1974 with the objectives to promote concrete pumping as the choice method of placing concrete, and to encourage and educate the concrete pumping industry on safe concrete pumping procedures. The ACPA Operator Certification Program is the only industry-recognized certification program for testing concrete pump operators on safe concrete pumping practices. Members of ACPA include owners of concrete pumps, manufacturers of concrete pumps, and distributors of concrete pumps and accessories.



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Appendix F: Sample Forms

1. Sample Mix Design Report
2. Sample Report Of Concrete Mix Design - Laboratory Trial Batch Data
3. Sample Submittal For Strength According To ACI 318 Requirements
4. Sample Report Of Plant And Truck Inspection
5. Sample Quality Control Report - Aggregate Grading
6. Sample Quality Control Report - Concrete Tests
7. Sample Report Of Truck Delivery Analysis
8. Sample Report Of Weather Data
9. Sample Report of Jobsite Analysis
10. Sample Report of Material Inventory

SAMPLE MIX DESIGN REPORT

Concrete Supplier _____

Project _____ Contractor _____

Mixture Identification _____ Specified Strength, f'_c _____ psi

Specified Slump: _____ inches Specified Air Content: _____ %

Required average strength, f'_{cr}

Based on past performance records (report attached) _____ psi

New mix (trial batch report attached) _____ psi

MATERIAL PROPERTIES AND SOURCE

Cementitious Material	Type	Source	Specific Gravity
Cement			
Pozzolan/Slag			

Admixtures	Name	Source	Dosage, fl.oz.

Aggregate	Type	Source	Sp. Gr. SSD	Abs., %	Fine - FM	Coarse - DRUW, pcf
No. 1						
No. 2						
No. 3						

BATCH QUANTITIES

Material	Quantities per cu.yd.	Abs. Volume, cu.ft.
Cement, lb.		
Mixing water, gal (or lb.)		
Pozzolan/Slag, lb.		
SSD Aggregate 1, lb.		
SSD Aggregate 2, lb.		
SSD Aggregate 3, lb.		
Air, percent		
TOTAL		

Comments: _____

Signature: _____ Date: _____

Title: _____

Organization: _____

SAMPLE REPORT OF CONCRETE MIX DESIGN - LABORATORY TRIAL BATCH DATA

Laboratory _____ Date _____

Address _____

For Company _____

Project _____

SOURCE OF MATERIALS

Cement _____ Type _____

Pozzolan/Slag _____ Type _____

Fine Aggregate _____ Type _____

Coarse Aggregate _____ Max. Size _____

Admixtures _____

QUANTITIES FOR 1 CUBIC YARD

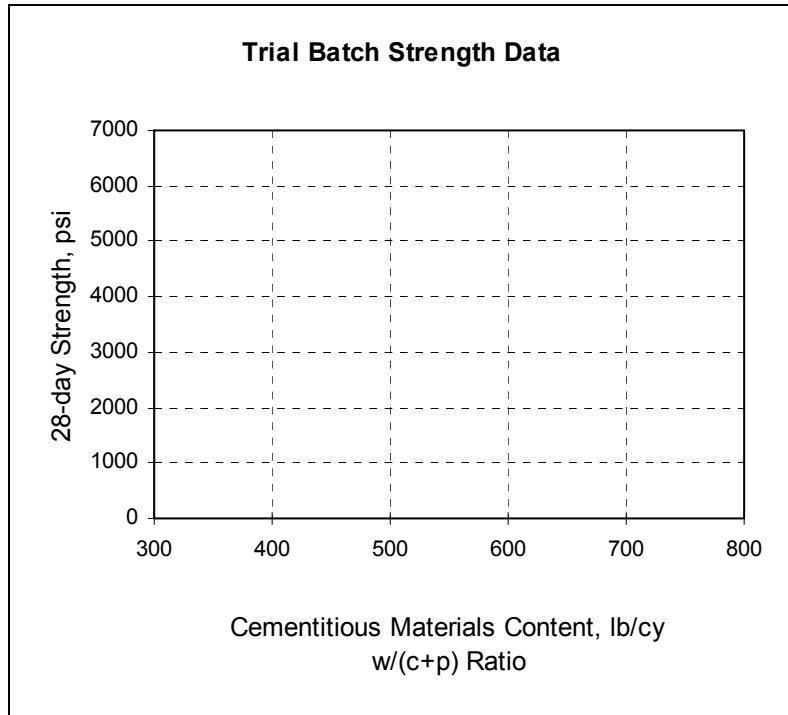
Material	No. 1	No. 2	No. 3	No. 4
Cement, lb.				
Fly Ash, lb.				
Mixing water, lb.				
SSD Sand, lb.				
SSD Gravel, lb.				
AEA, oz.				
Water reducer, oz				
w/cm ratio				

FRESH CONCRETE PROPERTIES

Batch Size, cu.ft.				
Air Temp., °F				
Concrete Temp., °F.				
Slump, inches				
Air Content, %				
Unit Weight, lb./cu.ft.				
Design Yield, cu.ft.				
Actual Yield, cu.ft.				

CONCRETE STRENGTH RESULTS, psi

7 day No. 1				
No. 2				
7-day Average				
28-day No. 1				
No. 2				
No. 3				
28-day Average				



Specified Strength, f'_c _____ psi

Specified Slump: _____ inches

Specified Air Content: _____ %

Required average strength, f'_{cr} _____ psi

Recommended cementitious materials content _____ lb./cu.yd.

Recommended w/cm ratio _____

Comments: _____

Signature: _____

Date: _____

Title: _____

SAMPLE SUBMITTAL FOR STRENGTH ACCORDING TO ACI 318 REQUIREMENTS

Company _____

Past Project _____

Mixture Identification _____ Specified Strength, f'_c _____ psi

Specified Slump: _____ inches Specified Air Content: _____ %

Testing Period _____

SOURCE OF MATERIALS

Cement _____ Type _____

Fine Aggregate _____ Type _____

Coarse Aggregate _____ Max. Size _____

Admixtures _____

SUMMARY OF STRENGTH TEST RESULTS (see over for test results)

Number of tests (n) _____

Average 28-day Strength (\bar{X}) _____ psi

Standard Deviation (S) _____ psi

Coefficient of Variation (V) _____ %

CALCULATION OF REQUIRED AVERAGE STRENGTH

New Project _____

Mixture Identification _____

Specified Strength, f'_c _____ psi

Specified Slump: _____ inches Specified Air Content: _____ %

Required Average Strength, f'_{cr} according to ACI 318

$$\text{Eqn. 5.1} \quad f'_{cr} = f'_c + 1.34.S = \text{_____ psi}$$

$$\text{Eqn. 5.2} \quad f'_{cr} = f'_c + 2.33.S - 500 = \text{_____ psi}$$

Signature: _____

Date: _____

Title: _____

DOCUMENTATION OF STRENGTH TEST RESULTS

Test No.	Date Tested	28-day Strength Test Results, psi			
		Cyl. 1	Cyl. 2	Cyl. 3	Average
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
Average 28-day Strength, psi					
Standard Deviation, psi					

SAMPLE REPORT OF PLANT AND TRUCK INSPECTION

Company _____

Plant _____ Inspection Date _____

ITEMS INSPECTED	CHECK	BY	COMMENTS OR CORRECTIVE ACTIONS
CEMENTITIOUS MATERIALS SCALES			
Calibration	<input type="checkbox"/>		
Maintenance tolerance	<input type="checkbox"/>		
Visual inspection	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
AGGREGATE SCALES			
Calibration	<input type="checkbox"/>		
Maintenance tolerance	<input type="checkbox"/>		
Visual inspection	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
WATER BATCHING DEVICES			
Calibration	<input type="checkbox"/>		
Batching accuracy	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
ADMIXTURE DISPENSERS			
Calibration	<input type="checkbox"/>		
Batching accuracy and leaks	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
CENTRAL MIXER			
Visual inspection	<input type="checkbox"/>		
Uniformity Tests	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
AGGREGATE STOCKPILES			
Visual inspection	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
CEMENTITIOUS MATERIAL BINS OR SILOS			
Visual inspection	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
CONVEYOR BELTS AND ROLLERS			
Visual inspection	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		
AGGREGATE MOISTURE METERS			
Calibration	<input type="checkbox"/>		
TRUCK BARRELS (LIST TRUCK NUMBERS)			
Visual inspection	<input type="checkbox"/>		
Other _____	<input type="checkbox"/>		

Signature: _____ Title: _____

SAMPLE QUALITY CONTROL REPORT - AGGREGATE GRADING

Company _____

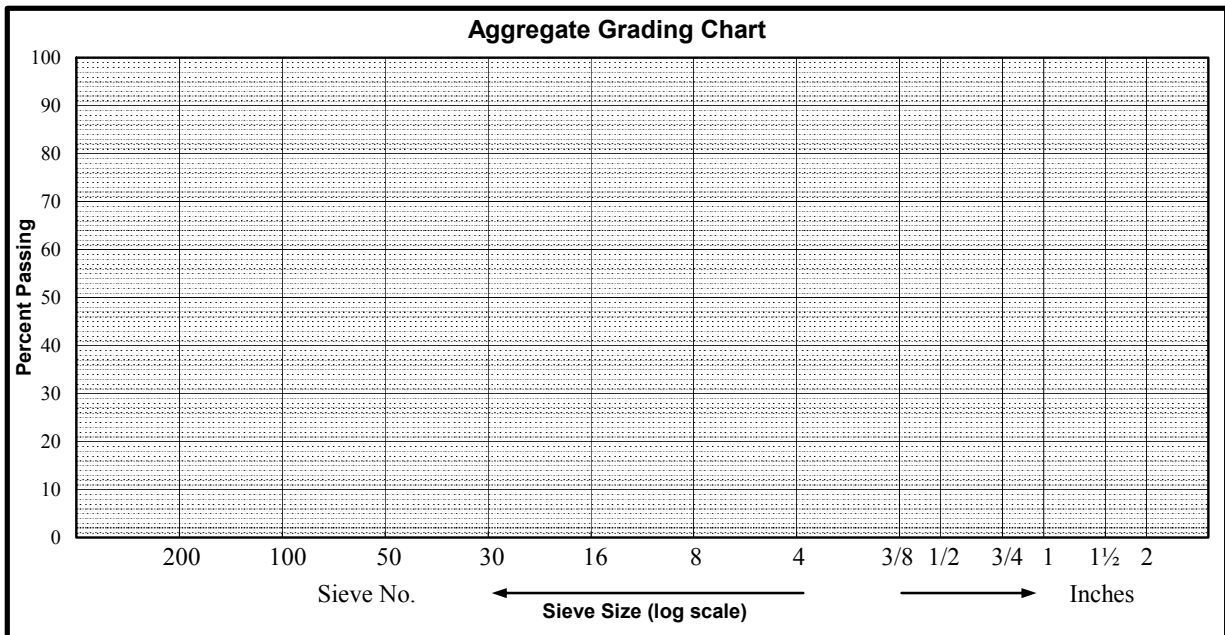
Project _____

Fine Aggregate Sample

Original Weight						
Sieves		Individual		Pass Sieve	% Pass	% Ret.
Pass	Ret. on	Wt.	%			
3/8 in.	No. 4			3/8 in.		
No. 4	8			No. 4		
8	16			8		
16	30			16		
30	50			30		
50	100			50		
100	200			100		
200	Pan			200		
Total					FM	
No. 200 wash						
Wt. before		_____				
Wt. after		_____				
Difference		_____ Minus No. 200 (wet), % _____				
Aggregate Source _____						
Aggregate Type _____						
Sampled by _____			Date _____			
Sampling Location _____						
Tested by _____			Date _____			
Quantity represented _____						
Comments _____						

Coarse Aggregate Sample

Original Weight						
Sieves		Individual		Pass Sieve	% Pass	% Ret.
Pass	Ret. on	Wt.	%			
				2 in.		
				1 1/2 in.		
				1 in.		
				3/4 in.		
				1/2 in.		
				3/8 in.		
				No. 4		
				No. 8		
Total					FM	
No. 200 wash						
Wt. before		_____				
Wt. after		_____				
Difference		_____ Minus No. 200 (wet), % _____				
Aggregate Source _____						
Aggregate Type _____						
Sampled by _____			Date _____			
Sampling Location _____						
Tested by _____			Date _____			
Quantity represented _____						
Comments _____						



Signature: _____

Date: _____

Title: _____

SAMPLE QUALITY CONTROL REPORT - CONCRETE TESTS

Company _____

Project _____

Mixture Identification _____

Specified Strength, f'_c _____ psi

Required Average Strength, f'_{cr} _____ psi

Specified Slump: _____ inches

Specified Air Content: _____ %

Sampled by _____

Date Sampled _____

Truck No: _____

Location _____

FRESH CONCRETE PROPERTIES:

Slump _____ in.

Yield Calculations:

Air Content _____ %

Weight of Batch _____ lb.

Concrete Temperature _____ °F

Concrete Unit Weight _____ lb.

Ambient Temperature _____ °F

Yield _____ yd³

STRENGTH TEST RESULTS

AGE	CYLINDER 1	CYLINDER 2	CYLINDER 3	AVERAGE
1 day				
3 day				
7 day				
14 day				
28 day				

OTHER TEST DATA

OBSERVATIONS AND COMMENTS

Signature: _____ Title: _____

SAMPLE REPORT OF TRUCK DELIVERY ANALYSIS

Project _____ Date _____

Ticket No. _____ Truck. No. _____ Total Cubic Yards _____

Time Batched _____ Time Arrival at Job _____ Time Discharged _____

Time Sampled _____ Time Tested _____

Sampled at End of Chute End of Pump Hose Other _____

Ambient Temp	Concrete Temp.	Air	Slump	Unit Weight

Number of Cylinders made _____ Stored at _____

Notes and Comments _____

Signature _____

Ticket No. _____ Truck. No. _____ Total Cubic Yards _____

Time Batched _____ Time Arrival at Job _____ Time Discharged _____

Time Sampled _____ Time Tested _____

Sampled at End of Chute End of Pump Hose Other _____

Ambient Temp	Concrete Temp.	Air	Slump	Unit Weight

Number of Cylinders made _____ Stored at _____

Notes and Comments _____

Signature _____

SAMPLE REPORT OF WEATHER DATA

Project _____ Date _____

Project Location _____

Number of cubic yards _____ Time of Placement _____

TEMPERATURE RECORD

Midnt. _____	6 a.m. _____	Noon _____	6 p.m. _____
1 a.m. _____	7 a.m. _____	1 p.m. _____	7 p.m. _____
2 a.m. _____	8 a.m. _____	2 p.m. _____	8 p.m. _____
3 a.m. _____	9 a.m. _____	3 p.m. _____	9 p.m. _____
4 a.m. _____	10 a.m. _____	4 p.m. _____	10 p.m. _____
5 a.m. _____	11 a.m. _____	5 p.m. _____	11 p.m. _____

High Temperature _____

Sunny

Windy

Low Temperature _____

P. Cloudy

Calm

Precipitation _____

Cloudy

Forms for concrete placed on this date was stripped on _____ at _____

Curing for concrete placed on this date was stopped on _____ at _____

Other Information _____

Signature _____

Quality Management System For Ready Mixed Concrete Companies

Part B: Sample Quality Manual: Global Ready Mixed Company

February 2008

Prepared by:

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Consulting Engineer, Greenville, South Carolina

RMC Research & Education Foundation

Reviewed and Approved by the NRMCA P2P Steering Committee



Sample Quality Manual

Global Ready Mixed Company

Foreword

This Quality Manual (QM) has been prepared based on the “Preparation Guidelines for Quality Manual for Ready Mixed Concrete Companies”. This Quality Manual is for example purposes only.

The Manual has been prepared for the fictitious organization, Global Ready Mixed Company (Global) and the fictitious certification organization, Ready Mixed Concrete Certification Organization (RMCCO). The Global Quality Manual is for illustration purposes only and does not serve to establish standard practices or even minimum requirements for a Quality Manual. The Quality Manual for an individual company will vary significantly based on the size and capability of the organization and the geographic distribution of their plants, including market served.

The elements of this example Quality Manual do not represent recommendations of the National Ready Mixed Concrete Association.



Global Ready Mixed Company™



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Fax: (155) 385-6691

Quality Manual

Revision: Original 0307

This Manual is an example of a Quality Plan of a fictitious ready mixed concrete company to serve as an illustration of the Guidelines for Development of a Quality Manual for Ready Mixed Concrete Companies
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Global Ready Mixed Company™



Quality Manual

Revision: Original 0307

Controlled Copy Number: 1

Issued to: _____ Title: _____

Company: _____

If there is a controlled copy number (not N/A) for this Manual, it is a controlled document. The unique copy number assigned to this Manual and the recipient of the Manual are recorded in a Manual Distribution log maintained by the Quality System Coordinator.

The manufacture and delivery of ready mixed concrete at: All Active Plant Locations

This Manual has been reviewed and approved.

N Sevier

(Signature)

Nathan Sevier

(Name)

President

(Title)

April 5, 2007

(Date)



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Hard Copy Distribution

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3. Senior Vice President of Plant and Fleet Operations
4. Vice President of Sales
5. Technical Services Manager
6. Plant Managers at all plant locations

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Quality Manual

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1. Introduction

1.1. General

The purpose of this Quality Manual (QM) is to provide documentation of the quality processes employed by Global Ready Mixed Company to insure the quality of our products. This QM meets the quality system documentation requirements for Certification by the Ready Mixed Concrete Certification Organization (RMCCO). An abbreviated version of this Quality Manual has been prepared for project submittals and general distribution.

Global Ready Mixed is one of the largest ready mixed concrete producers in upstate South Carolina. Global was founded in 1954, primarily to serve clients in the rural and residential markets. Since those early years, Global's growth and product diversity have mirrored the rapid growth and industrialization of the Piedmont area. Today Global has ready mixed concrete plants in the state of South Carolina at Silver Creek, Madison, Golden, Andover, and Portland, and a portable plant for use on major projects, as needed. Each of our concrete plants has the capability of producing ready mixed concrete for the simplest of projects to the most complex, high volume applications. All of our ready mixed concrete plants are included within the Global QMS. We have over 50 ready mixed concrete trucks available to serve this dynamic market. At our headquarters location in Silver Creek, we have administrative offices, a central maintenance facility, and a central laboratory.

The Quality Policy in Section 1.2 reflects the principles that have endured at Global Ready Mixed Company. This Quality Policy identifies what is important to us and is signed by our President and posted throughout our organization.

The intent of this Manual is to provide detailed, concise documentation of the Global Ready Mixed comprehensive QMS. This Quality Manual does not provide detailed work instructions. The Manual references but does not duplicate other industry standards or company programs (ASTM Standards, Safety Manual, etc.). This Quality Manual has been endorsed and approved by our chief executive and is the responsibility of the Quality System Coordinator.

The unit of measure in this Quality Manual is expressed in inch-pound (US Customary) unless otherwise noted.

1.2. Quality Policy

At Global Ready Mixed, providing quality products and services means delivering to the customer the quantity and quality of concrete desired within a mutually acceptable time frame. The concrete, upon delivery, must have been designed, proportioned, and mixed to meet the performance criteria specified. In order to achieve our policy objectives Global Ready Mixed:

- hires the most qualified individuals available for the positions to be filled;
- understands the importance of delivering our concrete in a professional, courteous manner;
- strives to continuously improve our operations;
- purchases and maintains the best equipment available for the tasks required;





- maintains NRMCA Plant Certifications for each of our ready mixed concrete plants;
- appreciates our employees as the “driving force” of our business;
- maintains clean and well-serviced delivery fleet;
- recognizes our suppliers as partners and a valuable, integral part of our business;
- understands the importance of personnel qualifications and certification and the benefits of providing career enhancement opportunities for our employees;
- is responsive to the needs of our customers;
- manufactures and delivers consistent ready mixed concrete;
- delivers concrete safely;
- takes pride in our business.

Global Ready Mixed has made a firm commitment to quality. It is our policy to produce products and services that competitively meet our customer’s quality requirements and conform to the guidelines of the Ready Mixed Concrete Certification Organization (RMCCO).

1.3. Terms and Definitions

Definitions of terms used in this Quality Plan.

QUALITY CONTROL - also called **PROCESS CONTROL** - Actions taken by an organization to provide control and documentation over what is being done and what is being provided so that the applicable standard of good practice and the contract documents for the work are

QUALITY ASSURANCE (QA) - Actions taken by an organization to provide and document assurance that what is being done and what is being provided are in accordance with the contract documents and standards of good practice for the work.

QUALITY CONTROL PLAN is utilized within the context of quality manual as the overview document that our company will produce to describe its Quality Management System (QMS)

QUALITY MANAGEMENT SYSTEM (QMS) – see Section 2.1





2. Quality Management System (QMS)

2.1. General

Global Ready Mixed has defined and documented our Quality Management System in this Quality Manual. Our Quality Management System consists of those processes, resources, policies, materials and activities that influence our product and service quality. It is important to us that we maintain and continuously improve our QMS.

2.2. Documentation Requirements

Documentation of our Quality Management System is not our goal, but instead is a means of achieving our goal. The purpose of documenting our QMS is to:

1. demonstrate to our customers our ability to consistently provide ready mixed concrete that meets their performance requirements;
2. achieve and maintain RMCCO Certification;
3. provide continuity and uniformity of processes;
4. enhance training and provide career enhancement to our employees;
5. improve customer satisfaction; and
6. establish a measurement system to facilitate continuous improvement through statistically-based concepts, when applicable.

2.2.1. Quality Manual (QM)

Defining and documenting our QMS is a part of our company-wide quality initiative. This Quality Manual addresses multiple functions which not only include the design and control of our company's product, but a number of activities indirectly related to the control of quality. Quality activities addressed in this Manual include, but are not limited to:

- sampling and testing of concrete and concrete materials;
- identifying the testing and evaluations conducted by Global and those services that we outsource, primarily for mixture performance for specification qualification;
- plant and field control of concrete production;
- personnel qualifications and training;
- facilities, plants, and equipment;
- purchasing;
- customer focus;
- order processing and dispatching procedures;
- concrete delivery and site control;
- concrete troubleshooting; and
- measurement, analysis, and improvement.





2.2.2. Responsibility and Authority

The documentation for our QMS is the responsibility of the Quality System (QS) Coordinator and the QMS is monitored by the company Quality Committee, as discussed in Section 3 Management Responsibility. Each documented Section and all revisions to the Quality Manual must be approved by the manager(s) responsible for the tasks identified within the Section. The Quality Committee is responsible for assigning the Quality Manuals. Revisions to the Manual are approved only by the Quality Committee. Suggested revisions may be submitted by any employee of the company. Revisions to the Manual may be submitted in writing or verbally communicated to the Quality System Coordinator or any Committee member at least three days prior to a scheduled meeting of the Quality Committee. The Quality Committee also evaluates quality improvements, determines if the improvements are achievable, and determines the costs/benefit of the improvement.

The Global Ready Mixed Quality Committee consists of the following members:

- President and Chief Executive Officer
- Senior Vice President of Plant and Fleet Operations
- Technical Services Manager (Quality System Coordinator)
- Two (2) Plant Managers and two (2) rotating members – the Plant Managers and rotating members are assigned to the Committee for two (2) year terms

The Quality Committee meets quarterly. The QS Coordinator is responsible for preparing meeting Agendas and recording Minutes of the meetings. The Agenda must be prepared and distributed to each Committee member two (2) business days prior to the meeting.

2.2.3. Control of Documents

Distribution of the Quality Manual is the responsibility of the Quality System Coordinator as directed by the Quality Committee. Two master lists of the Quality Manual are maintained. One list contains the listing of all persons with a Controlled (assigned) Manual. This list contains the Manual number (for controlled documents), initials of the person receiving the manual, and the date reviewed. All subsequent revisions of pages or sections are made with a revision summary, which is initialed by the receiving person at the time that the Manual revision is delivered. The QS Coordinator maintains these initialed revision summaries as the control record of each Manual's status.

Major revisions to this Manual are submitted to the Ready Mixed Concrete Certification Organization (RMCCO) for review and approval. The numbering scheme for the Manual facilitates revisions by page as needed. The Manual is numbered by sections so that a whole section may be changed without affecting the numbers of adjacent sections.

Routine updates to the Manual are accumulated on location until a significant revision exists. Tacit acceptance is concluded for routine updates and the company is only notified if the review is found to be unacceptable.

The second list kept by the QS Coordinator is a listing of the Quality Manual by page with the date of the latest revision of the page. This provides a listing of the most recent copy of the Quality Manual.





2.2.4. Control of Quality Records

Quality Manual administrative records are maintained by the Quality System Coordinator. These records include Manual correspondence; Quality Manual Distribution, Revision(s), and Page Reference; and the Quality Committee meeting Agendas and Minutes.

Additional records are prepared within each department of our organization. It is the policy of Global Ready Mixed to maintain complete and accurate quality records. These records meet the requirements of RMCCO.

Selected company records are illustrated within the various sections of this Manual. The record location and position (or person) responsible for maintaining the record are identified within each section of the Manual. Contact information for the responsible individual is available in the company directory. Many of our documents are scanned and retained electronically on our main computer server with appropriate backup procedures.

Samples of the types of records maintained include, but are not limited to:

- Approved Concrete Mix Designs
- Project/DOT Specifications
- Plant Information and Certification
- Batch records indicating actual batch weights
- Scale Calibration Records
- Plant Inspection Reports
- Truck Inspection Reports
- Personnel Certification
- Laboratory Accreditation
- Material Certifications
- Delivery Tickets
- Reports of QC Test Results
- Statistical data and control charts for the following QC data
 - * Fine aggregate grading
 - * Coarse aggregate grading
 - * Air content
 - * Slump
 - * Compressive strength
 - * Other tests required by specification

To provide retrievable records, the project documents are stored in the Corporate Laboratory by job name and numbered in chronological order.

General quality records are retained for a minimum of 3 years and project specific records are retained for a minimum of 7 years, in accordance with the RMCCO record retention requirements.





3. Management Responsibility

3.1. General

The senior management of Global Ready Mixed has established the significance of quality in our organization and demonstrated their **commitment** to our company's quality initiative. They are committed to the development and implementation of our QMS and to the continuous improvement of our quality processes.

The **Quality Policy** illustrated in Section 1 of this Quality Manual reflects the quality principles important to our senior management and subsequently to Global Ready Mixed. The level of our management commitment to quality is a reflection of our desired level of product quality. Although our Technical Service capabilities provide a high level of quality assurance and control, the overall (quality related) decision-making process addresses many other important aspects of our business.

3.2. Planning

The senior management of Global Ready Mixed understands the importance of business, financial, and quality planning. It is equally important to our organization to implement, monitor, and revise our plans, as needed. We conduct in-depth planning each fall for the following calendar year. Throughout the year, we review our performance compared to our goals and modify our expectations as required.

3.2.1. Quality Objectives

Before we fully develop our quality plans, we identify and/or review our quality objectives, which must be consistent with our Quality Policy. Our quality objectives are identified by the responsible manager and frequently change as we continuously improve our processes. Our quality objectives are measurable and the method of measurement is defined. Examples of our corporate quality objectives may include:

- achieving and maintaining RMCCO Certification;
- achieving and maintaining NRMCA Plant Certification for each of our ready mixed concrete plants;
- requiring all employees with one year of service to obtain industry certifications pertinent to their job functions;
- ACI Certification for all of our Concrete and Laboratory Technicians;
- achieving 90 percent on-time delivery;
- having an average fleet age of our ready mixed concrete trucks of not more than four (4) years old;
- achieving 95 percent customer satisfaction;
- maintaining all plant standard deviations for strength tests to less than 500 psi;





3.2.2. Quality Management System Planning

The senior management of Global Ready Mixed is responsible for identifying and subsequently allocating the resources necessary for the on-going implementation and continuous improvement of our company's QMS. Although many of our quality initiatives actually reduce operating costs over time, initial quality expenditures are often budgeted for the following year.

Our senior managers participate as members of the Quality Committee and meet quarterly to review the status of the company QMS.

3.2.3. Product Realization

In order to manufacture and deliver the products and services we provide, we have identified and continuously monitor the sequence of processes (and sub-processes) that we employ. We have prepared detailed descriptions of the process steps and/or process flow charts for designated procedures. The interaction of individual and departmental processes is periodically reviewed for effectiveness and improvement.

3.2.3.1 Planning

Based on input from sales, operations, and technical services, the senior management of Global Ready Mixed ultimately determines the products that we provide. In general, we provide ready mixed concrete products for residential, commercial and public sectors. We also develop concrete mixtures for high performance applications such as self consolidating and high strength concrete and pervious concrete.

As new products are evaluated for inclusion, the product planning includes identifying the materials and equipment requirements; determining the process sequence; and preparing a cost analysis.

3.3. Responsibility and Authority

The President of Global Ready Mixed is responsible for approving and signing our Quality Manual. The documentation of our QMS is the responsibility of our Quality System (QS) Coordinator, who is the **management representative** for our company's QMS. Implementation and monitoring of our QMS is the responsibility of our Quality Committee.

3.4. Internal Communications

We consider it extremely important to address the methods that we use to communicate our QMS. Communication of the Global Ready Mixed QMS begins with introductory training of newly hired personnel and continues with on-going awareness training.

Methods used to communicate our QMS include:

1. Discussion and review of our QMS at our weekly managers meeting which includes, the President, the Senior Vice President of Plant and Fleet Operations, the Sales Manager, the Technical Services Manager, and the Purchasing Manager. Participation in these meetings is encouraged and expected.





2. Distribution of Sections of the Quality Manual to those individuals affected by that portion of the Manual.
3. Encouraging the review of and strategically placing Sections of the Manual for the convenience of our employees.
4. Including the maximum number of employees in the review process of RMCCO Audits and Internal Quality Audits.
5. Including different employees as rotating members of the Quality Committee.
6. Distribution of revisions to the Manual.
7. The Operations Manager meets periodically with each Plant Manager to review QMS and safety issues.
8. Annual quality training for all production employees. This meeting provides the opportunity to insure that the production employees are familiar with the provisions and content of this Quality Manual. The meeting is conducted by the QS Coordinator and each person attending signs a sheet indicating their attendance. This record of the attendance is maintained by the QS Coordinator.

3.5. Management Review

As previously discussed, our senior management is responsible for establishing our Quality Committee to implement and maintain our QMS. The role and composition of the Committee are as defined in Section 2, *Quality Management System*. The Committee meets four times per year based on the RMCCO audit and internal audit schedules. The anticipated meeting dates and tasks (**inputs**) would be as follows:

1st Quarter

- a. Review the Minutes of the previous meeting and any follow-up actions required;
- b. Assign the Audit Team and schedule the performance of the two Internal Quality Audits for the year. Review and modify as required the Internal Audit report form;
- c. Review recommendations and departmental responses to the first external (RMCCO) Audit. Each department is required to respond within two weeks of receiving Internal or External Audit reports;
- d. Evaluate ingredient materials consistency and the subsequent impact on purchasing decisions;
- e. Review concrete non-conformities and corrective actions;
- f. Discuss customer focus activities and customer satisfaction;
- g. Evaluate changes to the Quality Manual;
- h. Discuss opportunities for improvement.

2nd Quarter

- a. Review the Minutes of the previous meeting and any follow-up actions required;
- b. Review recommendations and departmental responses to the first Internal Quality Audit. Each department is required to respond within two weeks of receiving Internal or External Audit reports;
- c. Review concrete non-conformities and corrective actions;





- d. Discuss customer focus activities and customer satisfaction;
- e. Evaluate changes to the Quality Manual;
- f. Discuss opportunities for improvement.

3rd Quarter

- a. Review the Minutes of the previous meeting and any follow-up actions required;
- b. Review recommendations and departmental responses to the second external Quality Audit. Each department is required to respond within two weeks of receiving Internal or External Audit reports;
- c. Review concrete non-conformities and corrective actions;
- d. Discuss customer focus activities and customer satisfaction;
- e. Evaluate changes to the Quality Manual;
- f. Discuss opportunities for improvement.

4th Quarter

- a. Review the Minutes of the previous meeting and any follow-up actions required;
- b. Review recommendations and departmental responses to the second internal Quality Audit. Each department is required to respond within two weeks of receiving Internal or External Audit reports;
- c. Review concrete non-conformities and corrective actions;
- d. Discuss customer focus activities and customer satisfaction;
- e. Evaluate changes to the Quality Manual and confirm the relevancy of the Quality Policy;
- f. Evaluate opportunities for improvement and the costs/benefit of those improvements;
- g. Establish QMS budget requirements;
- h. Appoint Committee members to serve on the Quality Committee to replace any members who have their terms expiring.

Accomplishments (**outputs**) of the management review process may include, but are not limited to:

- Improvements in the production and/or delivery of ready mixed concrete;
- Reduction in nonconforming concrete and subsequent concrete troubleshooting;
- Improved inventory control
- Improved purchasing decisions;
- Improved customer satisfaction;
- Identification of adjustments to resource needs.

3.6. Work Environment

Global Ready Mixed ensures that the infrastructure of our work environment including production facilities provides a safe and healthy environment for our employees. Facilities are provided with the necessary safety provisions for minimizing the risk for injury and ensuring compliance with OSHA standards.





Global Ready Mixed establishes a computerized network system with adequate protective measures but allows for the smooth transition of information flow within the organization. Information systems and computer software is kept up-to-date with current technology.

The established systems in place ensure for creating a participative work environment that encourages communication between various divisions and production facilities. We realize that this is important to our overall QMS. We will continuously strive to provide a comfortable, safe, and efficient work environment, operating in harmony with nature and the communities within which we reside.

Factors that need to be addressed to ensure maintaining a work environment that is conducive to efficient employee work processes and ensuring optimum product quality are addressed on a quarterly basis by the management team with appropriate follow up tracked.





4. Customer Focus

4.1. General

At Global Ready Mixed we understand and appreciate the importance of customer satisfaction. We have many capable competitors in our market area and we know that our customers must constantly make choices regarding their purchases of ready mixed concrete. In order to better understand the needs and desires of our customers, we:

- conduct periodic customer satisfaction surveys;
- maintain an active customer advisory committee; and
- capture, centralize, monitor, respond, and value customer inquiries and complaints.

4.2. Customer Satisfaction

Although many of our customer requirements are documented in the project specifications, many of their needs and inherent requirements are not specifically stated. On-time delivery is a customer expectation that is usually not specified. Our senior management continuously strives to identify, understand, and meet all of our customer's requirements. We conduct annual Customer Satisfaction Surveys that target our broad customer base. We conduct post project Surveys on major and unique projects and we listen to our customers.

All proposals and quotations to current and potential customers contain Global Ready Mixed standard figures and language or are pre-approved by the Sales Manager. Input from operations and Technical Services personnel are a critical aspect for estimating costs and bid pricing for major projects. All purchase orders and contracts are reviewed for content prior to acceptance.

At Global Ready Mixed, our customer focus is internal as well as external. We train our employees to understand how their work impacts the work of others throughout our organization. The customer of a driver is the dispatcher and a customer of the dispatcher is the driver. Both are dependent upon the other in the performance of their duties. A customer of both the driver and the dispatcher is the accounting person responsible for invoicing.

4.3. Customer Input

The Global Ready Mixed Customer Advisory Committee is one method used to provide customer input. This Committee is comprised of key customers to our organization. Each Committee member is asked to serve a two (2) year term and to attend two (2) Committee (lunch) meetings per year. An Agenda is prepared before each meeting and Minutes of the meeting are documented. The composition of the Committee reflects our diverse customer base and may include General Contractors, concrete finishers, Public Works Directors, owners, and other customers.

The input of our Customer Advisory Committee has been so appreciated that we have established regional Advisory Committees at our Madison and Portland facilities. It is important to recognize that through participation in our organization, each of our customers on the Advisory Committee develops a closer relationship with our personnel. It is equally important that Advisory Committee recommendations are acted upon.





Additional customer input is received through periodic surveys, customer inquiries, and complaints.

4.4. Complaint Management

At Global Ready Mixed we find that complaint management is especially challenging for our industry since complaints may be received by virtually any employee. In order to capture these complaints we have centralized responsibility for monitoring complaints with our Customer Service Representative. We have a “Complaint” form on a small pad which we provide to all employees. Our Customer Service Representative receives the completed “Complaint” forms and immediately directs a copy of the form to the proper individual for resolution. We emphasize the importance of promptly acting on even the smallest of complaints.

Our Customer Service Representative tabulates all complaint(s) and prepares a summary report for management. The report is factual and objective. We support any opinions presented in the report with reference to printed materials, if possible. The Customer Service Representative distributes the summary report as necessary. Depending upon the circumstances, it may be appropriate to forward a copy of the report or a letter of explanation to the customer.

4.5. Customer Connections

At Global Ready Mixed we are constantly seeking opportunities to connect with our customers. We encourage our sales personnel to frequent the Dodge™ and AGC™ plan rooms but we prefer that they review plans and specifications at customer’s offices. This gives our sales personnel the opportunity to have one-on-one dialog with our customer regarding a project that we are both interested in. It also gives us the opportunity to promote performance based specifications, when appropriate.

We, as a company, spend a considerable amount of resources promoting our business to current and prospective clients. With the capable assistance of our Technical Services staff, our sales personnel are able to demonstrate to our customers our technical understanding and knowledge of our products and can quickly respond to their particular needs.

Representative promotional activities include:

- Maintain a website that documents our company’s history and commitment to the local community, provide the appropriate contact information and products we typically produce, provide general information on ready mixed concrete and the benefits it provides to sustainability and long life structures.
- Presentations to customers of our performance records on previous major or special projects, including records of dependable early strengths of concrete (as required in high-rise construction). We also document this on our monthly company newsletters.
- Demonstration of the scope and qualifications of our company's Technical Services organization, including reference to its participation in inspection and accreditation programs of outside agencies.
- Expanding markets and applications of ready mixed concrete, to include a wider use of concrete by owners, designers, and builders.





- Distribution of technical literature including NRMCA “Concrete in Practice” (CIP) brochures and other publications with the company imprint, as applicable to various job situations.
- Suggested standard practices for ordering concrete which will help ensure that concrete of the proper quality level will be provided for typical local uses in commercial and residential construction.

As an active member of the Carolinas Ready Mixed Concrete Association (CRMCA), we work with the Association to promote the uses of concrete and realism in concrete specifications. Industry presentations may include:

- Presentations explaining the advantages and efficiencies of using concrete in various applications including tilt-up construction; city street and parking lot pavements; thermal insulation value due to concrete mass factor; etc.
- Sponsor manufacturers' presentations on innovations in the use of various chemical and supplementary cementitious materials and benefits imparted to handling characteristics; hot weather performance of concrete; and durability of concrete. These presentations are designed to demonstrate the versatility of concrete as a construction material.
- Panel discussions on realism in concrete specifications, including the cost-effective use of local materials; the need for appropriate tolerances in strength, slump and air-entrainment; reduction in job mix variables for optimum plant control of concrete; limitations of the water-cement ratio concept in mix design and field control of concrete; and sampling and testing of concrete -- the right way. We stress the importance of receiving copies of acceptance test reports to facilitate further product quality monitoring and improvements.

Many of our joint presentations and demonstrations are lunch meetings with us providing the box lunches. Professionals attending our seminars and demonstrations can obtain Professional Development Hours (PDH) for their attendance.

One critical forum for our customer focus is the pre-bid, pre-construction, and/or pre-pour conference. We appreciate the importance of these conferences and consider attendance by our Sales and Technical Services staff mandatory. For major and unique projects we are often the driving force in encouraging the General Contractor and/or owner to schedule and implement a conference.

We use the *Checklist for the Concrete Pre-Construction Conference*, developed jointly by the National Ready Mixed Concrete Association (NRMCA) and the American Society of Concrete Contractors (ASCC), to assist in planning on major and unique concrete projects.





5. Human Resources

5.1. General

At Global Ready Mixed we know that our people are our most important asset. We appreciate the work of every individual in our company and we consider it extremely important that our employees be challenged and have the opportunity to grow within our organization. We make every effort to select the most qualified applicants for all job functions.

We realize that the selection of our operations and delivery personnel has a considerable impact on our ability to provide dependable, timely, quality products and services. Our plant operators are capable of operating with a minimum number of errors regardless of outside interferences and distractions. They have the ability to comprehend the effects of various factors on concrete quality and are able to make the right decisions in stressful situations.

A higher than average degree of alertness, and concern for product quality, is required of our ready mixed truck drivers, particularly when working at our dry-batch plants. It is their job to take the materials weighed into their trucks and produce well-mixed concrete. They are able to use judgment in adjusting the consistency of the concrete to meet the job specifications. On the job site they protect our company's interests by carefully recording additions of water and other materials to the concrete, and noting any observed malpractice in sampling, placing, handling, and testing.

We believe that good people must be attracted to Global Ready Mixed and trained in our QMS and how our system effects their various job assignments. Training sessions and seminars are necessary to ensure that each person gets the information needed to perform his or her job effectively.

5.2. Competence

The organization of management of Global Ready Mixed is illustrated in Appendix A. This chart is intended to provide a general overview of the organizational structure of the management team of Global Ready Mixed. Revisions, regarding the organization of management, will be made to this Manual when and if, there is a change in the management structure of our organization.

It is the policy of Global Ready to hire the most competent personnel available for the positions we have available. Responsibility outlines for each of our key personnel primarily responsible for quality assurance/quality control are outlined in Appendix B.

The Technical Services Manager is the Global Ready Mixed Quality System Coordinator and is responsible for the distribution of the Quality Manual as directed by the Quality Committee. The Coordinator reports to our President and is responsible for maintaining all administrative documentation for the QMS. The Technical Services Manager works with the production department to develop means of maintaining and improving our quality level and cost efficiency of production, and monitors their successful implementation.

Quality control activities are coordinated with our production and sales departments. In turn, our quality control personnel depend on these departments for information that will result in an optimum contribution by the Technical Services organization to our company's business





objectives. This communication becomes especially important when considering jobs with specifications using statistically-based acceptance criteria with penalty clauses, since knowledge of the level of production variability is critical to the decision to bid. The usefulness of our Technical Services Department depends to a large extent upon its participation in the flow of communications within our organization

5.3. Quality Awareness

It is the responsibility of our management personnel to insure that all employees are aware of, and comply with, the provisions of this Quality Manual. Communication of our QMS begins with each employee's initial training and continues throughout their employment with Global.

Subsequent employee awareness consists of:

- every employee understands our company's intention to produce, deliver, and service quality ready mixed concrete;
- we continuously educate and train our employees on their role in maintaining our Quality Management System.

The Quality Manual is one method utilized by Global Ready Mixed to create customer awareness of our shared standard of quality. The Manual or portions thereof are frequently provided to customers as a demonstration of our commitment to quality.

Details of the process of communicating awareness of our QMS internally within the company are addressed in Section 3.4

5.4. Training

Training of personnel is an important part of the Global Ready Mixed QSM. Training and career development of our employees begins with the interview process and continues throughout their career with Global. The following outline provides an overview of our training process.

A. Interview Process

The interview process gives our managers the opportunity to evaluate applicants and inform the applicants about Global Ready Mixed. Specific items addressed during the interview process include:

1. Global Ready Mixed Drug and Alcohol policy (zero tolerance). All applicants are required to take a pre-employment physical which includes drug and alcohol testing.
2. Global Ready Mixed Safety Policy. A copy of our Employee Handbook is reviewed with all new employees during introductory training.
3. Global Ready Mixed Quality Policy.
4. Opportunities and requirements for advancement.
5. Expectations regarding responsibilities, dependability, working conditions, etc.

B. Introductory Training

All new employees receive introductory training once hired by Global Ready Mixed. Introductory training includes:





1. Global Ready Mixed orientation. This consists of a general discussion about the history and evolution of our company.
2. An in-depth review of our Safety and Quality policies particularly as each pertains to the position being filled.
3. Fundamentals of concrete and the ready mixed concrete business.
4. A tour of the Global facilities. This gives each new employee the opportunity to see how his or her work interfaces with the other activities within our company.
5. A review of major Company policies including benefits, work schedules, standard plant practices, etc.
6. Employees hired through unions and staffing services may receive their introductory training through the Union or Employment Agency utilized.

C. On-the-job Training

Upon completion of introductory training, each employee meets with his or her immediate supervisor to begin their on-the-job training. This training may be conducted by the supervisor or by a qualified individual designated by the supervisor. Although on-the-job training is specific for the position being filled, the following items are common to all positions:

1. Safety – Review general safety information (building exits, fire extinguisher locations, emergency numbers, etc.) and specific hazards to the job.
2. Quality – Review specific sections of this Manual and other applicable publications which relate to the performance of the position being filled.
3. Work procedures – The sequence and performance of each task in the work process is clearly explained and demonstrated. Each employee is informed about how the quality of their work impacts the overall product quality (quality is everyone's responsibility).
4. Job specific responsibilities – Equipment operation, batching procedures, sales reporting procedures, etc.

D. Continuing Education

All employees receive on-going training in various aspects of our business. We consider it important that our key quality personnel achieve and maintain industry recognized certification at the state and/or national levels. The types of training received are dependent upon the position held by the employee. Examples of continuing education and training include:

1. Weekly tool box safety and quality meetings for all production personnel. Each tool box meeting participant is required to sign an attendance sheet which is kept on file by the Plant Manager.
2. Weekly quality meetings for supervisory personnel.
3. Preparation training for Certification.
4. First aid training for designated supervisory and production personnel.
5. Mandatory annual safety training for all Company personnel.
6. Professional training for management, sales, and administrative personnel.





7. On-going quality training - The Global Ready Mixed Technical Services Department provides us with the technical and teaching resources for advancing the professionalism of our company personnel. We believe that a basic understanding of concrete technology and of our quality standards fosters personal involvement in our product quality and will lead our employees to make informed decisions in difficult situations. The teaching qualifications of our quality control personnel are enhanced through attendance at industry seminars and short courses. We encourage our Technical Services personnel to subscribe to and review pertinent industry publications. Training aids, either prepared in-house or obtained from outside sources, are used to lend substance to our training sessions and make them interesting. The effectiveness of our training sessions is enhanced by scheduling a quiz at the beginning and again at the end of each session. The quiz provides a means for gauging the success of our teaching efforts.
8. Certifications – All Global employees are encouraged to obtain available national or state industry certifications that are pertinent to their job functions. Global will facilitate their pre-course training and fund their attendance to industry courses and certification programs that will improve their ability to understand their jobs better. These industry certifications are important to establish the knowledge base and quality focus of our company in the eyes of our customers. Some of the industry certifications are:
 - a. Field and Laboratory Testing Technician Certification
 - b. Concrete Technologist Certification
 - c. Plant Operator and Plant Manager Certification
 - d. Sales Professional and Manager Certification
 - e. Delivery Professional Certification for drivers
 - f. Safety Certification
 - g. Environmental Certification
 - h. Dispatcher Training
 - i. Leadership Training
 - j. Supervisor Training

Training records of significant internal and external training are maintained in the personnel department so that employee qualifications remain current and appropriate sessions may be scheduled based on training needs. Certificates of completion for outside training are turned in by employees to the personnel department.

Global Ready Mixed believes in the continued growth of our organization and employees. We have a comprehensive policy offering continuing education opportunities to all of our employees. We encourage company representation in many industry and professional groups, including but not limited to:

- Membership on committees of the Carolinas Ready Mixed Concrete Association;
- Membership on NRMCA committees;
- Professional Association memberships, examples of which include: American Society for Quality; Women in Construction; S.C. Society of Professional Engineers; Silver Creek Home Builders Association, etc.; and





- Membership on ACI and ASTM Technical Committees.

Global Ready Mixed, through active Association participation, has established the means to communicate and work on developing issues that could adversely affect or provide opportunities for our industry, not just our company.





6. Facilities, Plant(s) and Equipment

6.1. General

Global Ready Mixed is a multi-plant ready mixed concrete producer located in upstate South Carolina. We have five (5) stationary ready mixed concrete plants and one (1) portable concrete plant. Two (2) of our plants are central mix plants and the remaining plants are dry batch plants. We operate a fleet of over 50 ready mixed concrete trucks. Our main office is located at the Silver Creek Plant where we have a central laboratory, central truck maintenance facility, and our administrative offices.

6.2. Infrastructure

All of our ready mixed concrete plants are certified through NRMCA's Plant Certification Program. The Plant Certification Check List used for the inspection of ready mixed concrete production facilities provides a comprehensive evaluation of each of our ready mixed concrete plants. The requirements of the checklist meet or exceed the provisions in Standard Specifications for Ready Mixed Concrete, such as ASTM C 94 and AASHTO M 157, and the Concrete Plant Manufacturers Bureau. Once each plant is inspected and qualified, the plant received a certificate of conformance. The South Carolina Department of Transportation (DOT) accepts the NRMCA certification of our production facilities to bid on state work.

Our ready mixed concrete plants have automatic batching controls. Cement and supplementary cementitious material silos are equipped with high bin indicators and acceptable dust collection systems. The silo fill pipes are clearly and properly labeled according to the product stored within. Company policy requires tanker/rail car unloading connection confirmation by either the Plant Manager or delegate. Cement and cement supplement silos are inspected annually for wear. Particular emphasis is placed on split silos to insure complete physical separation of cement and cement supplement storage, to prevent accidental leakage of fly ash or slag into the adjoining cement silo. Overhead aggregate bins for fine aggregates are equipped with moisture probes.

Global Ready Mixed ready mixed concrete trucks are inspected as part of the NRMCA Plant Certification process and over 90% of our fleet is acceptable for Certification. All of our certified trucks are equipped with a counter which is maintained in working condition to indicate the number of revolutions of the drum. Each certified truck is also equipped with a pressurized admixture tank for the jobsite addition of High Range Water Reducer. The truck mounted water tank, admixture dispenser, and drum counter are inspected each time the truck is serviced. Our ready mixed concrete trucks are equipped with global positioning system (GPS) sensors which are addressed in Section 10, *Order Processing and Dispatch Procedures*.

The central maintenance facility includes a four (4) bay truck shop. Fleet maintenance is managed through the use of our Fleet Maintenance Software. Global Ready Mixed's current goal is to maintain a six (6) year replacement schedule for the ready mixed concrete trucks in our fleet. Operation and Maintenance (O&M) Manuals are available for each piece of equipment and copies of the Manuals are located in the Maintenance Manager's office.





Administrative offices include management, accounting, sales, information systems, safety, and environmental.

6.2.1. Ready Mixed Concrete Plants

Descriptions for each of our ready mixed concrete production facilities are detailed in Appendix C.

6.2.2. Laboratory Facilities

The Global Ready Mixed central laboratory is located in a free standing 2000 square foot single story precast building on the Silver Creek Plant site. The lab includes offices for the Technical Services Manager, the Laboratory Technician, the Administrative Assistant, and work stations for the Field Technicians. There is also a small office set aside for our supplier personnel and South Carolina DOT inspectors. The majority of the space in the lab is dedicated to the testing of concrete and component materials. The central laboratory maintains copies (printed and/or electronic) of concrete and component material guidelines, specifications and regulations including, but not limited to:

- ACI Manual of Concrete Practice;
- ASTM and Other Standards Related to Ready-Mixed Concrete;
- ASTM Volume 04.01 Cement; Lime; Gypsum;
- Design and Control of Concrete Mixtures, Portland Cement Association;
- The State of South Carolina, Department of Transportation, Standard Specifications for Highway Construction;
- AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing;
- NRMCA Plant Operator's Manual; and
- NRMCA "Concrete in Practice" (CIPs).

Company policy requires that laboratory copies of these documents must be current within the previous five (5) years.

The Global Ready Mixed central laboratory is Cement and Concrete Reference Laboratory (CCRL) inspected. The CCRL inspection process consists of CCRL representatives determining the compliance of the laboratory staff, equipment and procedures with applicable standards and documenting the laboratory's compliance status in a summary report. The report gives us no ratings and its contents are not to be used for our general promotional purposes. The report may, however, be shown to interested parties to substantiate our laboratory's qualifications. The fact that our laboratory is CCRL-inspected confers a certain reliability status to our data that we consider important in demonstrating our qualifications to our customers and building officials. Global Ready Mixed participates round robin sampling and testing administered by the CRMCA to compare various laboratory tests results.

Quality assurance/quality control records are assembled and stored in the Technical Services Manager's office and the maintenance of these records is the responsibility of the Technical Services Manager.





Our laboratory testing priorities are primarily directed at those tests that are most important to the acceptance of our concrete by our customer. Having the capabilities of testing fresh concrete and the strength (and other properties) of hardened concrete, are extremely important to our concrete operations. Additional laboratory testing includes certain tests for significant properties of aggregates, recycled rinse/wash water, and other concrete materials which have a bearing on our company's concrete performance.

A list of equipment in the Laboratory is provided in Appendix D.

Tests which cannot be performed in our laboratory are outsourced, as required.

6.3. Control of Monitoring and Measurement Devices

It is the policy of Global Ready Mixed to have our concrete plant scales calibrated every six (6) months and water meters are validated every three (3) months. As defined in our Purchase Order for concrete admixtures, we require our admixture supplier(s) to calibrate admixture dispensers quarterly and provide the appropriate documentation. Plant related Equipment Calibration Records are maintained by the Plant Manager at the Plant. If any equipment is found to be out of calibration, the reason is determined, and the cause corrected immediately.

The hydraulic testing (compression) machine in the central laboratory is calibrated annually. Laboratory Bench and Gram scales are calibrated every six (6) months. Impact Hammers, Thermometers, and Air Meters are calibrated in accordance with manufacturer recommendations. All records of laboratory equipment certifications are maintained by the Technical Services Manager at our central laboratory.

Calibrations are performed at any time the equipment indicates erratic results, and in any case at intervals not greater than the aforementioned calibration frequency. Calibrations comply with ASTM C 1077 requirements.

6.4. Equipment Maintenance

Global Ready Mixed has a structured preventive maintenance program which includes all production equipment. Equipment is inspected, and repaired if necessary, at predetermined intervals based on the importance and condition of the equipment. Preventive Maintenance processes for our concrete plants include, but are not limited to:

6.4.1. Silos for Cementitious Materials

- Providing moisture proof storage and physical separation by means of double bin walls or separate silos. Checking for tightness of separation walls in multi-compartment silos by determining accumulation of cement in compartment left in "empty" condition.
- Checking for accidental "cross-feed" in transfer devices.
- Monitoring the high-bin indicators, anti-overfill devices and pressure sensors for correct operations.
- Inspecting the Dust Collection systems in accordance with the manufacturer's recommendations.





6.4.2. Aggregates

- Providing physical separation of aggregates by type. Periodically emptying and inspecting the wear of the overhead aggregate bins.
- Monitoring transfer devices, turnhead limit switches, and full-bin signals for correct operation.

6.4.3. Chemical Admixtures

- Confirming that admixture storage containers are properly identified with the chemicals stored within.
- Providing protection against freezing, as required. Freezing of air-entraining agents may cause solids to settle out resulting in wide variations in air content.
- Inspecting agitation devices as required to maintain uniform solution densities (e.g., standard calcium chloride solutions). Tanks, hoses, and dispensers for seasonal admixtures are operated weekly.
- Insuring that admixture dispensers are functioning correctly. Making sure that sight glasses are clean and are provided with legible graduations. Periodically checking for tank integrity and for leaking hoses and faulty connections.
- The dispenser units at our plants are visible from the batcher station for immediate detection of any malfunction.

6.4.4. Batching Equipment

- Making sure that weigh batchers remain freely suspended; the scale linkages clean; that wind protection is adequate for cement weigh batchers; there is no binding against the frame or other obstructions (check when weighing capacity loads); and there is no binding of scale cables (at entry port to control house).
- Insuring that the cement weigh batcher is properly vented and there is no back pressure on the scale system from pneumatically charging the cement or pozzolan silos (aerator; or from pneumatic unloading of transportation units).
- Monitoring batching records for verification of batching accuracy.
- Rotating the sheaves or cable pulleys periodically for uniform wear.
- Discussing record maintenance policies relative to time and cross reference to delivery tickets.
- Making provisions for periodically checking the actual admixture discharge into mixer.

6.4.5. Central Mixer

- Visual checks (as part of plant startup) for build-up of hardened concrete and blade wear weekly.
- Mixer uniformity evaluation for slump and coarse aggregate tests biannually.





6.4.6. Truck Mixers

- Checking for concrete build-up, blade wear, revolution counter in working condition, accuracy of water gauge or meter, general condition of truck water system (legible quantity indications, clean gauge, no water leaks), legible mixer rating plate.
- On units with hydraulic slump meters, correlation of hydraulic pressure to slump of standard mixes and load size established.





7. Materials Management

7.1. General

The quality of our ready mixed concrete is based, to a large extent, on the component materials used in the manufacture of the concrete. We select component materials as indicated in the following sections and inventory a number of component materials to be used in the production of our concrete. Component materials stored at our facilities include: cement, fly ash, silica fume, concrete admixtures, fine aggregates, coarse aggregates, fibers, color, and water.

7.2. Supplier Qualifications and Selection

Our component materials come from a number of different suppliers. We consider our suppliers to be a critical part of our business and we work closely with each supplier to enhance the quality of our products. We educate our suppliers on the relationship between the consistency and quality of their products (inputs) and the consistency and quality of our products (outputs). We invite and encourage our suppliers to provide on-going training of their products to our personnel. Their training may include: component material performance; storage and handling (including stockpile procedures); material testing; safety; etc.

Global Ready Mixed selects suppliers based on a number of criteria, including:

- previous experience with the supplier;
- component material availability;
- price;
- knowledge of the supplier's quality assurance/quality control program;
- State DOT Approved Materials;
- delivery; and
- support services available (training, safety, administrative, etc.).

Technical services, production and sales personnel are all involved in the product and supplier selection process. New suppliers are selected based on their qualifications and/or experience. They must be Certified (DOT, ISO, etc.), have a functional Quality Assurance/Quality Control Plan (Quality Manual) available for review, or undergo a quality audit by our Technical Services staff.

7.3. Supplier Requirements (Expectations)

At Global Ready Mixed our suppliers are our partners in producing quality ready mixed concrete. We strive to be as specific as possible with our suppliers in identifying our quality related requirements and expectations. We issue Purchase Orders (specific and/or open-ended) for each component material purchased, in accordance with Section 9, Purchasing of this Manual. For each of these materials we specify the testing, documentation and reporting that we require of the supplier. We have established and defined our office procedures to monitor regular receipt, review, and distribution of our supplier provided quality reports and





material certifications. We review each report or certification for changes from previous reports. Our requirements by component material include:

7.3.1. Coarse Aggregates

Each coarse aggregate supplier provides:

1. Aggregates, as specified, meeting the requirements of ASTM C 33 for normal weight aggregates and C 330 for lightweight aggregates;
2. Documentation that the material furnished is on the approved list of SC DOT;
3. A monthly summary of their gradation representing a minimum of one (1) sieve analysis for every 400 tons shipped, or a minimum of one test per week for each product purchased;
4. Specific gravity, absorption, and petrographic analysis test results every 3 years or when there appears to be a change in the aggregate quality, including a new lift or location within the quarry;
5. Tests results of the evaluation of the aggregate for potential alkali-silica or alkali-carbonate reactions;
6. Tests results for aggregates containing particles with an iron sulfide content that shows a stain index less than 20 when tested in accordance with ASTM C 641;
7. A visual check prior to shipment of aggregates for exposed surfaces, for general appearance against the approved sample;
8. Aggregate certification indicating compliance with ASTM or equivalent AASHTO specifications.

7.3.2. Fine Aggregates

Each fine aggregate supplier provides:

1. Aggregates, as specified, meeting the requirements of ASTM C 33 for normal weight aggregates and C 330 for lightweight aggregates;
2. Documentation that the material furnished is on the approved list of SC DOT;
3. A monthly summary of their gradation and fineness modulus representing a minimum of one (1) sieve analysis for every 200 tons shipped, or a minimum of one test per week for each product purchased;
4. Specific gravity and absorption test results every 3 years or when there appears to be a change in the aggregate quality;
5. Tests results for deleterious substances and organic impurities annually;
6. Tests results for materials finer than No. 200 sieve for new sources or any time variations are experienced;
7. Aggregate certification indicating compliance with ASTM or equivalent AASHTO specifications.

7.3.3. Cement

Each cement supplier provides:





1. Cement, specified by Type, meeting the requirements of ASTM C 150, C 595 and C 1157;
2. Mill Tests Report with each shipment of cement, certifying compliance to ASTM or AASHTO specifications.
3. Documentation that the material furnished is on the approved list of SC DOT;
4. A monthly ASTM C-917 (Cement Strength Uniformity) report by the 15th of the month following the 28-day cube breaks. This report may only be available for a predominant product from a cement source (not available for all product) but provides an indication of the uniformity of product from the source;
5. Immediate notification at any time that 7 day cube strengths fall 20 % below the running average;
6. An original notarized letter of the Manufacturer's Certification annually for each product purchased.

7.3.4. Fly Ash and Ground Granulated Blast-Furnace Slag

Every Fly Ash and Slag supplier is required to provide an original notarized letter of the Manufacturer's Certification annually, for each product purchased.

Each Fly Ash supplier provides:

1. Fly Ash, specified by Class, meeting the requirements of ASTM C 618;
2. Certification reports with each shipment of Fly Ash.
3. Documentation that the material furnished is on the approved list of SC DOT;

Each Slag supplier provides:

1. Ground Iron Blast-Furnace Slag meeting the requirements of ASTM C 989;
2. Certification reports with each shipment of Slag.
3. Documentation that the material furnished is on the approved list of SC DOT;

7.3.5. Chemical Admixtures

Our Chemical Admixture supplier(s) provide:

1. Chemical Admixtures meeting the requirements of ASTM C 494 or C260 for air entraining admixtures;
2. Recommended dosages for various applications and placement conditions;
3. Notarized statements on chloride content. Use of admixtures containing chlorides may be prohibited under certain conditions;
4. An original notarized letter of the Manufacturer's Certification annually for each product purchased.
5. Documentation that the material furnished is on the approved list of SC DOT;

7.4. Conformance Monitoring

At Global Ready Mixed receiving and conformance testing are routine quality assurance/quality control functions. Through verification testing we monitor the quality of the products we receive and verify the creditability of the reports provided by our suppliers.





Conformance testing of our concrete making materials is performed in accordance with the “NRMCA Guidelines for Conformance Testing of Concrete Component Materials” and at the frequencies recommended in the Guidelines.

Aggregate gradations are reviewed for consistency and conformance to grading requirements. Control charts for representative sieves are prepared for analysis by our Technical Services personnel. Additional aggregate tests are provided and evaluated as required.

Cement Mill Tests Reports are reviewed for changes from the previous reports and for:

- ASTM C 109 cube strength;
- Setting time
- Fineness;
- Compound composition;
- Loss on ignition (LOI);
- Total alkali, expressed as Na₂O equivalent.

Fly Ash Mill Tests Reports are reviewed for changes from the previous reports and for:

- Sum of SiO₂, Fe₂O₃, and Al₂O₃
- Material Retained on No. 325 Sieve (C 430).
- Loss on Ignition (LOI)
- Strength Activity Index with Portland Cement
- Total Alkalis

Slag Mill Tests Reports are reviewed for changes from the previous reports and for:

- Slag Activity Index (C 989)

7.5. Materials Handling and Stockpile Procedures

All of the Global Ready Mixed plants are served by truck (rail is not available). The Plant Manager and yard personnel at each plant receive extensive training in materials management. All drivers delivering component materials to our plants receive instructions regarding the yard layout, traffic flow, speed limit, personal protective gear, and materials discharge or placement. Aggregate ground storage areas are contained on three (3) sides and labeled by the material stored within. The fill pipes for overhead cement and cement supplement silos are clearly labeled for the respective silo.

Aggregates are stockpiled within ground storage bins, transferred by a front end loader to a hopper, and conveyed to overhead storage. The overhead aggregate bins are charged (receive materials) by either a radial stacker or a stationary conveyor with a turn-head. Each bin is clearly labeled on the bin and on the control panel, if applicable.

We use the following Table for submittals to summarize a Plant’s Material Handling:





MATERIAL HANDLING - SAMPLE

MATERIAL	DELIVERY TO PLANT	STORAGE TO MIXER/TRUCK
Cement	Tanker Truck	Overhead Silo – Gravity Feed
Fly ash	Tanker Truck	Overhead Silo – Screw Conveyor
Slag	Not Applicable	Not Applicable
Fine Aggregate	Dump Truck	Aggregate Bins - Conveyor
Coarse Aggregate	Dump Truck	Aggregate Bins - Conveyor
Chemical Admixtures	Tanker Truck	Admixture Tanks - pumped

7.6. Customer Property

Occasionally on a large or unique project, our customer will specify a component material that we do not routinely inventory. This may be a non-standard chemical admixture, a larger than normal aggregate size, Type K Cement, steel fibers, etc. We utilize “just-in-time” deliveries to the maximum extent feasible and isolate any customer provided product from normal operations.

Unique aggregates may be stored in an isolated location of the plant site. Non-standard admixes may be delivered and stored in totes or drums which are isolated and clearly labeled for the intended use. Unique cement or cement supplement products may be stored in a silo designated for that purpose or delivered and stored in separate trailers or “pigs”. Other products may be isolated and stored as the plant site dictates.

For extended projects, the customer provided materials are regularly inspected for condition, contamination, use, shelf-life, etc.





8. Concrete Mixture Development or Selection

8.1. General

The design of a new concrete mixture and the selection of the proper mixture proportions for a project or application is a critical aspect of our quality initiative. The quality of our ready mixed concrete is a function of the properties of the individual component materials as well as a function of the interaction of those selected materials in the composite mix. In Section 7 of this Manual we defined our methodology for selecting material sources and our testing requirements for those materials. Global Ready Mixed does not use any new materials in our concrete until all initial testing is complete and the results have been analyzed.

The initial requirement for designing or selecting the proper concrete mix proportions is to determine the performance characteristics of the ready mixed concrete. Performance characteristics for concrete may include, but are not limited to:

- Setting Characteristics
- Material compatibility evaluation
- Workability;
- Placeability;
- Strength;
- Uniformity;
- Durability; and
- Aesthetics.

8.2. Determination of Mixture Proportions and Selection of Component Materials

The objective in designing our concrete mixes is to develop a workable, economical concrete mixture that meets the performance criteria identified. At Global Ready Mixed, we have a Technical Services Department with the internal capability of designing, testing, implementing, and monitoring concrete mixes. We proportion mixes in accordance with practices identified by ACI Committee 211. When required by specification we use an outside Engineer or Independent Testing Laboratory to prepare the mixture proportion(s) and trial batch evaluation, though we prefer to do it in-house considering our available capabilities. When an outside laboratory is used, we require that it have been inspected by CCRL and conform to ASTM C 1077.

Procedures for mixture proportion development and evaluation of trial batches are maintained on record at the central laboratory. The laboratory mixes and tests one standard concrete batch on a monthly basis with material kept aside specifically for that purpose. This standard mixture evaluation helps “calibrate” our mixture evaluation procedures.

Personnel involved in specification review and development of mixture proportions are required to be certified as ACI Laboratory Technicians. Personnel establishing mixtures and submittals for projects are required to have an NRMCA Concrete Technologist Level 2 certification.





8.3. Evaluate Mixture Development/Selection for Specification Criteria

In order to select the proper concrete mixture with the characteristics desired, it is important for us to understand the intended use of our concrete, the method of placement, and the method of finishing. For most major projects we can obtain this information by reviewing the specifications, drawings, and structural notes.

At Global, we believe that it is important to obtain a copy of the project specifications (when available) from the General Contractor, Engineer or Owner. The specifications are beneficial in determining pre-qualification tests requirements prior to the bid or delivery date; evaluating durability requirements; determining the correct placement location within the structure; and verifying that our order has been correctly placed.

For major and unique projects or applications we conduct internal meetings (pre-bid, pre-project, etc.) with sales, Technical Services, and production, to discuss production capabilities and to communicate special project requirements.

Performance criteria for each project proposed concrete mixture is established by a process of testing for the required performance criteria in the specification and additional items needed by the contractor. Some of these include:

- Concrete strength data from previous job test records evaluated per ACI 214.
- Required average strength for each class of concrete established based on past test records as per ACI 318 and ACI 301 for the specified strength in the project specifications.
- Trial mixture evaluation either by the producer or Independent Testing Laboratory
- Develop mixtures at varying levels of w/cm and cementitious content and composition
- Process of further optimizing of mixture proportions for economy for prescriptive and performance requirements
- Mixture evaluation for setting characteristics and slump retention at extreme temperatures
- Effects of varying admixture dosages on plastic concrete properties.

8.4. Validation of Mixture Selection and other specified Project Requirements

The performance of new concrete mix designs is based on the trial mixtures we prepare with the same materials that are to be used in the ready mixed concrete for the project or application. When we prepare trial mixes we often request the assistance of our supplier partners. Mixtures developed in this manner are provided a designation and all pertinent performance data is documented on spreadsheets. On some projects of a critical nature we will validate laboratory trial batches in production size batches.

Our established mixes are evaluated based on historical statistical data. Concrete properties that are established based on historical statistical data provide us with a lower level of risk of non-conformance. We identify specific concrete mixes from specific plants that we track and monitor. At a minimum we normally track a 3000 psi and a 4000 psi air entrained and non-air entrained mix from each plant. For comparison purposes we will track the same mix out of multiple plants, if possible. For plant standard deviations we test the concrete before the ready mixed truck leaves the yard. For field standard deviations we test the concrete on the





jobsite and utilize test results from Independent Testing Laboratories. Concrete strength data is evaluated in accordance with ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete. Section 15 of this Quality Manual provides further details regarding our procedures for analyzing the data collected.

As previously discussed, it is vital that our company understand the needs of our customers or potential customers. Beyond reviewing the project specifications and drawings, we try to insure that the concrete mix design(s) selected for a project or application meets the defined and undefined needs of our customer. We habitually contact the Architect or Engineer for clarification or recommendations regarding project specifications. We seek to have overly restrictive requirements (which do not diminish the performance criteria) removed from the specifications. We require our Technical Services, sales, and/or production personnel to attend Pre-Bid Conferences on major projects. These processes help us identify all pertinent details to ensure that the mixture we propose for the work satisfies the needs of the specification and that of the contractor. From these meetings we establish at a minimum:

- Point of sampling for acceptance tests;
- Identify unreasonable requirements in the specification that conflict with other requirements and establish consensus in writing
- Ensure that there will be proper testing and inspection on the project with qualified people
- Ensure that we are provided with all test reports in a timely manner so we can react to potential problems early
- Identify the special needs of the contractor based on the placement and finishing methods chosen for the project.

Other items that are identified in the specification review include:

- NRMCA Plant Certification (or others);
- Costs associated with unique test requirements;
- Specific types of production and batching systems;
- Special types of component materials or concrete;
- Record maintenance of batch weights and reporting requirements on delivery tickets;
- Restrictions on concrete unloading times;
- Restrictions on type of water or jobsite water addition;
- Rate of concrete delivery;
- Limits on concrete temperature;
- No chute/truck rinsing permitted on site;
- Potential costs associated with improper sampling or testing;
- Safety training prior to going on site; and
- Back-up plant facilities.





8.5. Concrete Mixture Verification and Submittal

Most major projects require significant submittal information. Our Technical Services Manager is responsible for verifying that the proposed concrete mixtures we select for a project or application conform to the requirements specified. Our submittal documentation generally includes the requirements identified in ACI 211.5, Guide for Submittal of Concrete Proportions. Submittal documentation varies significantly from prescriptive specifications to performance based specifications. For performance requirements we outsource special concrete tests such as shrinkage, ASR, and permeability and include the test report(s) with our submittal documentation.

Submittal documentation includes material certification of all component materials, designation of proposed mixtures and accompanying historical and evaluated test data for the proposed mixtures.

8.6. Control of Changes to Designated Concrete Mixtures

The Technical Services Manager or delegate are the only individuals in our organization that are authorized to make changes designated concrete mixtures (other than minor moisture and admixture adjustments). To minimize the potential for batching errors, changes to designated concrete mixtures are always communicated in writing. When a mix is changed, every employee assigned a Global Ready Mixed mix book receives a revised page reflecting the change.

8.7. Concrete Mix Summary

Once we have selected the mixture component materials, developed the mixture proportions, tested the mixture, and evaluated the results, a unique mix number is assigned to the mixture. Global Ready Mixed uses a proprietary alpha-numeric mix numbering system which identifies the component materials in the mix and the concrete strength classification of the mix.

The Master mix book is in the possession of the Technical Services Manager who is also responsible for maintaining the book. Mix books are divided by sections according to aggregate size and type (#57, #67, lightweight, etc.); cement and/or supplementary cementitious material use; and by special mix use. Mix books are assigned and distributed based on need (Technical Services, batch plant, and sales). Initial batch weights for the batch computers are determined and provided by the Technical Services Manager or delegate.

Once a "Notice to Proceed" is issued for a project, our Sales Manager is responsible for providing a list of mixes (including slump and air tolerances) to the appropriate production, quality assurance, and administrative personnel.





9. Purchasing

9.1. General

Purchasing is a critical component of the Global Ready Mixed quality process. In order for our ready mixed concrete to meet the performance requirements identified, our purchasing procedures must insure that our component materials are of sufficient quality. This Quality Manual limits Purchasing to the component materials of ready mixed concrete and excludes office supplies and incidental items.

9.2. Purchasing Process

Our purchasing process begins once the optimum sources for component materials have been identified for use. Many factors go into our determination of the optimum sources of materials, including but not limited to: availability, product quality, delivery, material costs, freight costs, quality control, and support. At Global Ready Mixed we consider it imperative that Technical Services personnel evaluate each concrete component material prior to making a purchasing decision regarding that material.

Our goal is to standardize the decision process for purchasing our component materials in a flow chart format.

9.3. Purchase Agreements

Once we determine the optimum sources of component materials Purchase Agreements or Purchase Orders are prepared. Purchase Agreements are written contracts and are prepared for each concrete making material we use. Global Ready Mixed Purchase Orders include reference to a technical standard and are written for a specific quantity or for deliveries within a specific time frame. We do not write time specific Purchase Orders for any longer than one (1) year in duration.

Once a material need has been identified, a purchase requisition is prepared by the appropriate Global manager. The requisition is required to be in writing on our pre-printed Requisition Form. This Form contains all of the required purchasing information and must be delivered to the appropriate Global manager for approval and subsequent purchase. Once the requisition is approved, the Purchase Agreement is prepared and issued.

Purchase Agreements for component materials stipulate (when available) that:

- Quantity of material or specific time period. These are renewed on a biannual basis;
- Pricing and terms and conditions
- Method and frequency of delivery
- Material description and purchase standard requirements
- Material certifications (when applicable) be included with each delivery;
- Specific tests results and summary reports be provided;
- Suppliers shall immediately disclose any non-conformance(s) of their product which may impact the quality of our company's products;





- Notarized letters of Manufacturer's Certification for each product must be provided annually;
- Technical support will be reasonably available to assist in concrete mix proportioning, troubleshooting, etc.;
- Our Chemical Admixture supplier(s) provide initial certification of each of the admixture dispensers and quarterly audits thereafter;
- Acceptance of material by Global Ready Mixed is based on acceptance inspection and testing as well as acceptable performance of the product;
- Nonconforming product will be evaluated for use, returned, or disposed of. All costs associated with nonconforming product are the responsibility of our supplier;
- Our suppliers shall provide a copy of the Material Safety Data (MSDS) for their product and copies of any subsequent revisions.
- Other items to be addressed may include: maximum allowable discharge pressures for cement, fly ash and slag; the use of drip pans under admixture hose connections; observing the posted Plant speed limits; and responsibility for equipment leaks and/or spills.

9.4. Purchasing Information

Our component materials suppliers for ready mixed concrete are selected as discussed in Section 7.2 *Supplier Qualifications and Selection* of this Quality Manual. The Purchasing Manager of Global Ready Mixed maintains an approved supplier list. Suppliers are placed on this list by the following methods:

- As of the effective date of this Quality Manual, all existing suppliers that have provided acceptable products and services were included;
- Demonstration of the capabilities to provide the product and services required. This may include DOT Certification, past performance history, ISO 9001 Certification, Quality Manual review, etc.;
- External Audit of the suppliers facilities and processes;
- Conditional approval based on the evaluation of future performance.

No products, except for those purchased on a trial basis, are purchased from a supplier that is not on the approved supplier list. The approved supplier list is reviewed annually by the Quality Committee.

9.5. Verification of Purchased Product

Delivery tickets are included with every component material shipment delivered to our plant(s). Each shipment is verified and the delivery ticket or packing slip is signed by the Plant Manager or delegate, and forwarded to purchasing.

Acceptance of the component material is based on receiving inspections, acceptance testing and the acceptable performance of the material. The quality testing and scrutiny that we apply to our suppliers is a function of the effect that their product has on the performance of our ready mixed concrete.





10. Order Processing and Dispatching Procedures

10.1. General

Prior to placing a confirmed order for concrete, a Global Ready Mixed Credit Application must be submitted by the customer and approved by our Accounting Department. A copy of our Credit Application is available on our web site and rush Applications can be submitted on line or faxed to our Accounting Department. Once the application is approved, the customer is assigned a customer number and certain restrictions may apply to that customer and number.

For major and unique projects a Proposal from sales and/or a Purchase Agreement from the customer, generally specifies the anticipated quantity and class of concrete (by mix number). Many of our established customers use the same concrete mixtures day after day. Small contractors and individuals often describe their performance requirements and ask our dispatch personnel what concrete mixture meets their criteria.

Orders for product are directly communicated between the customer and our order entry/dispatch personnel. Sales and management personnel may assist in facilitating communications between company dispatch personnel and the customer, however, the decisions regarding the order, including the time of delivery, are the responsibility of the order entry/dispatch personnel.

Most of our ready mixed concrete orders are received by telephone over a dedicated line, directly into our respective order entry/dispatch offices. We receive some orders by fax and more recently have facilitated receiving orders by email. Often a customer or potential customer will come by one of our dispatch offices to place an order.

10.2. Order Entry

As orders are received, the orders are written down on a standard form.. The order format follows the line of the Checklist for Ordering and Scheduling Ready Mixed Concrete© and this facilitates the dispatcher to ask pertinent questions of the purchaser. As telephone traffic slows during the day, orders are entered into our dispatch software from the Checklist. The information contained on the Checklist includes:

- Name and address of the customer;
- Individual placing the order and contact information (particularly a cell phone number);
- Date and time the order was received;
- Customer number – all customers, except pre-paid and COD customers, are assigned a customer number by the accounting department;
- Product and quantity desired – for ready mixed concrete the mix number and any additional requirements (fibers, color, etc.) should be identified. Other products to be delivered may include construction/expansion joint materials, finishing tools, etc.;
- Purpose or use of the concrete and method of placement;
- Required rate of delivery;
- Address of the delivery and detailed directions to the site;





- Date and time of delivery;
- Special site conditions which may include; location of a septic tank, no truck rinse water permitted on site; Personal Protective Gear; etc.; and
- Individual receiving the order.

The written order entry form provides a hard copy for reference and back-up documentation in case of a computer failure.

All orders are verified to a Purchase Agreement or Proposal, where applicable.

Once orders are entered we make every effort to remain in contact with our customers. When the original orders are taken we make sure to ask for a contact number (preferably a cell phone). If orders are placed well in advance of the delivery date, we confirm the order prior to delivery. In the event of inclement weather, we contact the customer for confirmation of any outdoor concrete placements. If we are unable to deliver our concrete at the agreed upon time, we contact our customer and appraise them of our situation.

10.3. The Dispatch Process

We believe that dispatching a fleet of ready mixed concrete trucks is one of the most challenging tasks in the ready mixed concrete industry. In order to improve our customer service, we have installed global positioning system (GPS) sensors in our ready mixed concrete trucks and implemented the use of a fleet management software program. Through the use of our GPS we no longer use checkpoints for truck status since we know the location of our trucks at all times. The GPS and fleet management programs are not currently integrated, however, we envision that ultimately they will be.

Our order entry, dispatch and production personnel review the orders for the following day prior to the close of business of the current day. Orders are reviewed for accuracy; drivers are instructed when to report for work; Technical Services personnel are scheduled based on mixes and projects; and the equipment is cleaned, fueled and checked.

At the end of the day, the deliver records are compiled and provided to the divisional operations manager to quantify our on-time delivery record that facilitates improvement.

10.4. Batch Instructions

Once the order is entered and the delivery schedule determined, batch instructions are initiated for the concrete. A Delivery Ticket is electronically forwarded from the dispatch computer to the batch computer (process known as "ticketing a truck"). Delivery Tickets are received at the batch plant in the order to be batched and include the truck number of the truck to be loaded. The concrete batching process is further defined in Section 11, Concrete Production.

10.5. Recordkeeping

Order entry and dispatch records are maintained in the dispatch office by the order entry/dispatch personnel. The Checklists are filed daily in chronological order and the electronic records are filed electronically. The electronic records are backed up daily. Order





entry and dispatch records are retained for a period of 7 years in accordance with the RMCCO record retention requirements.





11. Concrete Production

11.1. General

Global Ready Mixed Concrete has the processes in place to monitor and control the production of our ready mixed concrete. The equipment we use for the production and control of our concrete is described in Section 6. *Facilities, Plant(s), and Equipment*. The component materials for the production of our concrete are received, tested, and stored (stockpiled) in accordance with the procedures described in Section 7. *Materials Management*.

11.2. Production Planning

Production planning is an on-going activity. Prior to each production day, we develop a plan for the allocation of resources. Component material inventories are reviewed and material deliveries are scheduled. Special material requirements for unique applications may require us to place orders months in advance.

Each evening our drivers are instructed of the time to report to work the following day. Drivers' hours are regularly monitored during the work week to avoid fatigue and to insure that we operate in compliance with all applicable regulations.

Scheduled maintenance of our ready mixed concrete trucks and plant equipment is anticipated to minimize the impact on our production. Preventive maintenance is a critical function of our plant operations. Ready mixed concrete trucks are washed, fueled, and checked at the end of each day (pre-trip inspection) and are ready to go, after a quick walk-around, the first thing each morning.

Daily planning is normally coordinated between production, dispatch and Technical Services personnel and communicated to the respective individuals through dispatch. Preliminary planning includes assigning Technical Services personnel, plant and/or project responsibilities prior to the day of production. Production planning continues throughout each day since change is inevitable.

11.3. Concrete Production

Prior to batching the first load of concrete each day, component materials are loaded into the plant; trucks are positioned for loading; and instructions are communicated to the concrete batch personnel. Once a day the Plant Manager, or delegate, performs a walk through inspection of the concrete plant.

Delivery tickets electronically communicate orders to the batch computer as discussed in Section 10, *Order Processing and Dispatch Procedures*.

Once the batch instructions are received, the batch operator instructs the designated truck to pull into the hole (under the plant for loading). Once the truck is properly positioned for loading, the batch operator initiates the computerized loading process of component materials into the central mixer or mixer truck receiving hopper and the:

- aggregates are weighed and conveyed;





- cement and supplementary cementitious materials are gravity fed or transferred by screw conveyor into the weigh batcher and subsequently discharged;
- water is weighed and discharged (all Global Ready Mixed plants have weighed, not metered, water); and
- concrete admixtures are introduced.

The component materials batching sequence is optimized, based on experience, to ensure batch uniformity following mixing. All of our plants are equipped with batch computers and our batch and dispatch software programs are integrated.

During the loading process, the driver remains with the truck and fills the truck mounted water tank (if necessary). In keeping with our water conservation procedures, all nozzles for water tank filling are equipped with automatic shut-offs. Once the truck is loaded, the delivery ticket is forwarded to the driver. Special requests are highlighted on the ticket and the driver reviews the directions. If additional items (expansion material, curing compound, etc.) are to be delivered to the jobsite, the driver will receive a verbal confirmation of the request from dispatch.

Once the driver understands the directions and has collected any additional items necessary, the truck proceeds to the designated slump rack. The concrete is mixed (at dry batch plants), the truck is rinsed and the concrete slump and consistency are observed. Minor adjustments to the concrete may be made by qualified drivers and significant adjustments require Technical Services personnel. Drivers are required to install chute or rock guards prior to leaving the yard.

Specialty concrete may require additional loading procedures at the plant or on the jobsite. Examples include adding steel fibers or color, or introducing liquid nitrogen for concrete cooling.

11.4. Production of Specialty Concrete

Global Ready Mixed specialty concrete production includes a number of different concrete applications. Established procedures are in place, documented, and filed for each of these specialty concretes. These applications may include but are not limited to:

- a) Colored concrete
- b) High strength concrete
- c) Lightweight concrete
- d) Heavyweight concrete
- e) Mass concrete
- f) Exposed aggregate concrete
- g) Pervious concrete

11.5. Production Environment

The environment that we operate in can have a significant impact on the quality of our ready mixed concrete. Since upstate South Carolina is generally considered a moderate climate, we have mild spring and fall seasons, relatively cold winters, and relatively hot summers. Most of the year, we operate without necessary precautions. During extreme conditions, we





utilize hot and/or cold weather concrete practices. The temperatures which necessitate hot and cold weather concrete practices may vary based on specification requirements.

Our procedures for hot weather (ACI 305) concreting may include, but are not limited to:

1. Loader operators are instructed in areas of materials management.
2. Overhead storage bins for aggregates are emptied at the end of each day.
3. Coarse aggregate stockpiles are continuously watered for cooling (aggregate moisture contents are verified regularly).
4. Delays in the ordering and delivery of concrete are minimized. All concrete is placed within 1 hour of the time the concrete was batched.
5. Random loads have temperatures checked throughout the day.
6. Various admixtures are used to avoid early setting of the concrete. Determination of the proper admixture and appropriate dosage rate is determined by the Technical Services Manager or qualified designated delegate.
7. Chilled water, ice or liquid nitrogen (for major projects) can be added at the customer's expense.
8. Re-tempered concrete is not used. During the placement of the concrete, if the concrete becomes stiff and requires the addition of excessive water for workability, it is disposed.

The procedures for cold weather concreting (as defined by ACI 306) include:

1. Loader operators are instructed in areas of materials management.
2. Overhead storage bins for aggregates are enclosed and heated, or are emptied at the end of each day.
3. Heated mixing water is used. The concrete temperature is maintained in accordance with ACI 306 Table 3.1.
4. The relative proportions of fly ash or slag to total cementitious materials may be reduced.
5. Accelerating admixtures may be used to shorten (accelerate) the concrete set time. Determination of the proper admixture and appropriate dosage rate is determined by the Technical Services Manager or qualified designated delegate.

11.6. Control of Plant Operations

It is important to us that we have adequate procedures in place to monitor our concrete production on a daily basis. One method of control that we use is NRMCA Plant Certification which requires monitoring for continued compliance with the NRMCA Checklist for Ready Mixed Concrete Production Facilities.

Global Ready Mixed specific controls include, but are not limited to:

11.6.1. Materials Receiving

- Materials are checked for conformance with the bills of lading or delivery ticket;
- Stockpiles are visually inspected for contaminants, deleterious materials (clay coal and lignite; off-color sand), woodsticks, excessive under/oversize coarse aggregate.



11.6.2. Materials Storage and Handling

Cement and Pozzolan Silos

- The respective fill pipes are properly labeled and tanker truck unloading is monitored.

Aggregates

- Proper storage (stockpile) procedures are used to prevent harmful segregation and degradation and to provide for uniform moisture as used.
- Coarse aggregate stockpiles are sprinkled for cooling during hot weather concreting.
- Lightweight aggregate stockpiles are sprinkled for saturation.
- Conveying processes are observed to minimize or eliminate spillage or overflow into adjoining compartments.
- Multi-use compartments are emptied completely before filling with different aggregate types.

Chemical Admixtures

- Admixtures are protected from contamination and dilution (rain water seepage; splash water from truck washdown; etc.).
- Admixture deliveries are monitored for connections to the proper tanks and to insure the use of drip pans under each connection.

11.6.3. Weighing and Batching

Measuring Accuracy

- A daily scale check is performed, including verifying zero and tare on the scales.
- Measuring devices are monitored for compliance with the applicable tolerances.

Batching Accuracy

- Batching accuracy is monitored, specifically our automated units, at designated intervals.
- Batching stations are provided with current mix information and invalid or obsolete information is promptly removed.
- Batch plant personnel are provided with clear and unambiguous dosage instructions for the various admixtures handled at the plant.
- Our plant operators and substitute operators are familiar with admixture dispenser operation, including the significance of measuring units (whether ounce units, or various cement weight equivalents for different dosage rates); and of the dosage setting and metering devices of automatic systems.

Batching Procedures

- The sequence of charging materials into the mixer is standardized.





- Delivery tickets indicate all of the information required by ASTM C 94 and those additional items requested by the customer.
- Our company policy on the disposition of returned concrete is observed.
- Our plant personnel are provided with guidelines on handling non-conforming batches of concrete.

11.6.4. Mixer and mixer controls

Central Mixer

- The concrete mixing time is monitored to insure that the minimum mixing time is observed.
- Our batch plant operators and substitute operators at our central mix plants are familiar with the amp/slump meter readings.

Truck Mixers

- All ready mixed truck drivers are aware of the required amount of mixing and of the standard mixing and agitating speeds.





12. Concrete Testing

12.1. General

The reasons for our concrete testing include the evaluation of component materials; concrete mixture proportioning; and the quality control of our ready mixed concrete production. This Section describes our Technical Services organization and the procedures for sampling and testing our concrete.

Ready mixed concrete is a simple, flexible, durable, and economical product with a multitude of applications. In order for our concrete to perform as specified, the concrete must possess certain properties which are necessary for the application intended. To confirm that the desired properties or performance criteria are (or will be) achieved, it is necessary for us to test our concrete in both a plastic and harden state.

12.2. Concrete Tests Frequency and Mix Selection

The accuracy and reliability of our (quality control) tests results, in representing the concrete tested, is largely dependent upon the frequency of tests we perform. The frequency of our quality control testing may be a function of many factors including, but not limited to:

- Project requirements;
- Evaluation of testing by others;
- Component materials analysis;
- Mix consistency and performance;
- Plant standard deviation; and
- Weather considerations.

Project requirements often dictate the frequency of tests performed by the Independent Testing Agency. On those projects where cylinders are being made by us for verification testing, our frequency is similar if not identical to that of the testing agency. For example:

According to ASTM C 94, strength tests as well as slump, temperature, density and air content tests shall generally be made with a frequency of not less than one test for each 150 yd³. Each test shall be made on a separate batch. On each day concrete is delivered, at least one strength test shall be made for each class of concrete. This frequency of testing is for acceptance testing and is not the frequency we use for our company's internal quality control testing.

Slump, air-content, and temperature tests shall be made at the time of placement at the option of the inspector as often as is necessary for control checks. In addition, these tests shall be made when specified and always when strength specimens are made.

Regular testing of our standard reference mixes is a very useful indicator of mix and plant consistency. We regularly sample, test, and track established mixes, as discussed in Section 8, *Concrete Mix Design or Selection*. All sampling for tracked mixes is performed under the direction of our Technical Services Department. At a minimum, we require that each of our tracked mixes be tested weekly out of each of our operating plants. The mixes that we track





are sampled at the plant and on the jobsite for statistical analysis. The analysis of data obtained from these designated mixes is described in Section 15, *Measurement, Analysis and Improvement*.

12.3. Sampling and Testing of Freshly Mixed Concrete

Acceptance testing of our ready mixed concrete requires sampling in accordance with ASTM C 172, *Practice for Sampling Freshly Mixed Concrete*. We consider it critical that sampling for acceptance testing be accomplished by the precise techniques specified in order for the sample to be representative of the concrete being tested.

According to ASTM C 172, the sample(s) from stationary mixers and revolving drum truck mixers shall be taken during discharge from the middle portion of the batch. Samples for truck mixed concrete are generally taken at the job and samples from central mixed concrete may be taken at the plant and/or at the job site. Sampling procedures for our internal (tracked) mixes do not follow ASTM C 172. Samples are obtained after a preliminary $\frac{1}{2}$ yd³ of concrete is discharged to obtain test samples for mixture evaluation.

For verification testing, we obtain an independent sample from the same load tested by the Owner's testing agency, if possible. This permits us to compare testing practices. Otherwise, we sample on a random basis at the jobsite. If detailed data is desired on our concrete performance, we test pre-selected loads on which data has been generated for aggregate grading; aggregate mixture; mix water; cement characteristics; etc.

The following standardized procedures are used for sampling and testing of the companies quality assurance purposes as identified in ASTM C 94:

Compression Test Specimens – Practice C 31

Yield, Weight per Cubic Foot - Test Method C 138

Air Content – Test Method C 138; Test Method C 173 or Test Method C231

Slump – Test Method C 143

Sampling Fresh Concrete – Practice C 172

Temperature – Test Method C 1064

We require the use of a "check" test for all nonconforming test results. Once the concrete is confirmed as nonconforming, the batch plant and Technical Services Department are notified immediately.

Our qualified drivers are authorized to add water to our concrete as long as a specified water/cement ratio is not exceeded. Technical Services personnel are required to make any significant adjustments to our mixtures. The air content of our concrete may only be adjusted under the direction of our Technical Services personnel.

We conduct jobsite quality control tests for routine mix or plant monitoring as well as for special mixes and applications. For lightweight concrete production and consistency, it is important to keep the lightweight aggregates saturated. To maintain consistent yields of lightweight concrete, unit weight tests are conducted on the first load and every 100 cu. yd. thereafter. The batch weights of the lightweight aggregate may require periodic adjustments for the correct yield. Check test are performed to verify the adequacy of yield adjustments.





The testing frequency is dependent upon the variability of density or unit weights. A history of yield information is maintained for each monitored mix design.

For flexural strength concrete mixes, we monitor compliance with the narrow slump tolerances of low slump paving concrete. Our Concrete Technicians strictly adhere to conformance testing procedures, including the standard methods of making, curing, and testing beam specimens. Flexural strength tests (beam test) are highly sensitive to non-standard procedures. Subsequent strength variations on beams sawed from in-place concrete are subject to a high risk of not complying with project specifications. We make every effort to obtain satisfactory results on specimens molded from fresh concrete. One method we promote is to develop a laboratory correlation between compressive and flexural strength and then use compressive strength tests for field samples.

For High Strength Concrete we closely monitor the production and delivery of our concrete to assure that our concrete is at a slump within the specified range; that the concrete is promptly discharged; that appropriate molds are used for test cylinders; and that curing and testing procedures are strictly adhered to.

12.4. Testing Hardened Concrete

Compression test specimens for monitoring our ready mixed concrete quality control are pre-molded with freshly mixed concrete and cured in accordance with Practice C 31. Cylinder specimens for strength tests are routinely made for 3, 7, 28, and 90 day breaks, with a minimum of 7 and 28 day breaks and a set of reserve cylinders. Three-day test permit early recognition of variable strengths and a 90 day test history provides useful strength gain information, especially in the event of low 28 day test results.

Flexural strength testing of beams is conducted in accordance ASTM C 78 for third point loading.

In addition to strength test, additional hardened concrete tests which may be specified or used by Global Ready Mixed, include:

- Air Content and air void system
- Cement content
- Chloride Content
- Rapid indication of chloride ion penetrability
- Shrinkage
- Various durability characteristics, such as ASR, sulfate resistance, etc., as required for specific project needs.

Allegations of nonconforming hardened concrete are investigated by our Technical Services staff in accordance with the procedures identified in Section 14, Concrete Troubleshooting of this Quality Manual.





13. Concrete Delivery and Site Control

13.1. General

Our concrete delivery process begins when the ready mixed concrete truck leaves our yard and ends when the truck returns to the plant or other designated facility. We require that all of our ready mixed trucks be equipped with rock or chute guards; drums rotate at agitation speed during travel; trucks may not stop for food or breaks on the way to the jobsite and must seek permission from dispatch to stop on the way back; and that any concrete spillage be reported immediately to dispatch. We address a number of safety issues associated with driving our ready mixed concrete trucks in our Global Ready Mixed Safety Manual.

13.2. Truck Tracking

At Global Ready Mixed we use a computer software fleet management system for tracking our ready mixed concrete trucks. This fleet management system is fully integrated with our concrete batch computer software. All of our concrete trucks are equipped with a global positioning system (GPS) Locator System which we link to our fleet management software.

13.3. Jobsite Monitoring and Control

We are well aware of the importance of our truck drivers as representatives of Global. From a customer focus standpoint, many of our customers will never meet anyone else from our organization other than our driver(s). From a quality standpoint our drivers are often our primary jobsite liaison.

We place considerable emphasis on training our drivers in jobsite awareness, including but not limited to:

- Unusual concrete appearance (under/over sanded mix, fluffy paste/excessive air, elongated aggregates, etc.)
- Observations of the sampling (middle of load) and testing procedures of the Owner's testing agency;
- Care and handling of concrete cylinders;
- Water added on the jobsite (requested and signed for by the customer);
- Other materials added by the customer;
- The slump as used;
- Method(s) of concrete placement;
- Check test requirement for nonconforming concrete test due to slump or air content;
- Adverse weather conditions; and
- Location of concrete placement (on unstable base, on poly, on red clay, etc.).

Certain jobsite conditions necessitate prompt notification of dispatch, batch plant, and/or Technical Services personnel. Notification of jobsite irregularities are communicated from the driver to dispatch and dispatch is responsible for notifying the proper individuals or Department.





On major and unique projects our Technical Services personnel often visit the site to observe operations and monitor concrete sampling and testing. Specific areas observed include water demand, rate of slump loss, workability, bleeding rate, finishing characteristics, and time of set.

All of our ready mixed concrete trucks are equipped with tanks for adding High Range Water Reducer (HRWR) on the job. Truck mounted HRWR tanks are calibrated quarterly unless there is reason to suspect that there may be a problem earlier. Occasionally a specification will require the manual addition of HRWR on the jobsite, in which case we will store a tote or tank of admixture on the jobsite. A Technical Services representative of Global Ready Mixed is the only individual authorized to make jobsite admixture additions to our concrete, unless other delegates are authorized by the Technical Services Manager. Global Ready Mixed does not provide any warranty for concrete when the customer adds calcium chloride, fibers or other additives.

Prior to pump placements of ready mixed concrete the *Checklist for Pumping Ready Mixed Concrete*® is completed. Normally when we begin concrete pumping operations for placements on a new project, we have a Technical Services representative on site to confirm the pumpability of the mix. This is especially important when pumping lightweight concrete mixes.

Jobsite quality control (verification) testing is addressed in Section 12, *Concrete Testing*.

Jobsite safety requirements may include the use of hard hats, safety glasses, ear plugs, safety vest, and/or uniforms. We emphasize to our employees the importance of complying with jobsite requirements for personal protective gear and observing jobsite speed limits.

Jobsite environmental concerns are adding increased responsibilities to us as a ready mixed concrete producer. Our drivers receive training regarding jobsite truck (chute) rinse procedures and rinse water restrictions that may apply to certain projects. Each of our plants has established procedures for the utilization of excess (returned) concrete.

As discussed in Section 4, *Customer Focus*, all of our employees are issued forms (pads) for recording customer complaints. Forms completed by drivers on a jobsite are turned in with the signed delivery ticket.

13.4. Identification and Traceability

The ready mixed concrete that we deliver to the jobsite is identifiable and traceable. If we discover that a critical nonconforming mix component was used in batching our concrete, it is important that we be able to locate concrete used at other locations or projects with the same defective material. Our goal is to divert that delivery before the material is discharged on the project. Our delivery ticket identifies the plant and time that our concrete was batched and the truck number of the truck delivering the concrete. From this information, the batch tickets at the plant can be reviewed and the component materials and proportions determined.

As previously discussed in Section 9, *Purchasing*, all component materials delivered to our plants require the inclusion of a delivery ticket with each load. The delivery ticket illustrates the product received, the date the product was received, and the quantity of product received. The component material delivery ticket references the purchase order number for the product. The specific component materials used in a given load on a given day may be





identified based on the receiving records and the production schedule of concrete using the same component materials (consumption). The production of concrete within the identifiable time constraints defines the usage of the product. All concrete related component materials are inventoried on a monthly basis to verify the accuracy and accountability of receiving and production records. Mill Test Reports are required with the delivery of cement and fly ash. The testing of component materials is in accordance with Section 7, *Materials Management*.

The preservation of ready mixed concrete is primarily limited to concrete in a plastic state and throughout the finishing and initial curing processes. As a ready mixed concrete producer, our primary preservation responsibility is preserving our concrete (in a plastic state) until it can be used for the purpose intended. In Section 11, *Concrete Production*, we identified our procedures for producing concrete during extreme work environments (hot and cold weather concreting). At the direction of the Technical Services Department, concrete retarding admixtures may be used for short term preservation of the concrete in a plastic state.





14. Concrete Troubleshooting

14.1. General

The production of ready mixed concrete is a complex process involving the proportioning, batching, and mixing of various component materials under constantly changing conditions. In spite of our best efforts there will inevitably be a need for concrete troubleshooting. In this section we define our method(s) for responding to complaints (inquiries), tracking the complaint, investigating the cause, analyzing the data, and summarizing the findings.

14.2. Complaints and Inquiries

We often learn of the existence of nonconforming product through an inquiry or a complaint. The origin of the complaint or inquiry may be from any number of sources including Global Ready Mixed personnel, the customer, the owner, an end user, an interested party, etc. We consider it important to view each legitimate complaint as an opportunity to evaluate and improve our operations. In Section 4, *Customer Focus* we identified our procedures for receiving and distributing customer complaints and inquiries. We understand that time is of the essence in dealing with complaints and we train our employees regarding the importance of being responsive.

We believe that in concrete troubleshooting it is extremely important to treat all complaints as valid until determined otherwise. It is equally important to emphasize to our employees the importance of listening to the customer. Through active listening we can specifically identify the problem(s) and minimize our investigation and subsequent analysis.

14.3. The Investigation

As discussed in Section 4, all complaints that we receive are documented on our Complaint Form and forwarded to our Customer Service Representative. This Representative, or delegate, immediately distributes a cover memorandum and Complaint Form to the responsible manager for resolution, with copies to other interested company personnel. The responsible manager is now the owner of this complaint and leads the investigation of the complaint and/or concrete problem. Normally the Technical Services Manager is responsible for resolving concrete related complaints and the Plant or Operations Manager is responsible for operational complaints.

At Global Ready Mixed we use ACI 201.1R as a guide for preparing our checklist; conducting our investigation; and documenting our report.

ACI 201.1R, *Guide for Making a Condition Survey of Concrete in Service* is a guide which "provides a system for reporting on the condition of concrete in service. It includes a check list of the many details that may be considered in making a report, and repeats the ACI 116 standard definitions of terms associated with the durability of concrete. Its purpose is to establish a uniform system for evaluating the condition of concrete".

The check list illustrated in ACI 201.1R encourages our investigator to "select those items important to the specific concerns relating to the reasons for the survey". Also included in ACI





201.1R are photographs illustrating the various types of distress associated with concrete in service.

NRMCA Publications 133 – *In Place Concrete Strength Evaluation* – A recommended practice and the Concrete in Practice (CIP) series are invaluable tools in investigating, analyzing, and reporting concrete conditions. The CIPs address the *What, Why, and How?* of concrete in practice.

We also hire consultants on occasion to assist us with concrete troubleshooting.

14.4. The Analysis

Our initial analysis includes securing relevant information from jobsite personnel, sales representatives, drivers, and/or independent testing laboratory personnel as soon as possible. For complaints and/or problems relating to defective concrete we take digital photographs for ease of distribution to interested parties.

We continue our analysis by obtaining all records associated with the problem (or other reason for this investigation), which may include but are not limited to:

- Customer complaint form;
- Independent testing laboratory report(s);
- The condition survey;
- Ordering information;
- Dispatch records;
- Driver log;
- Delivery ticket;
- Batch ticket;
- Records on the same class of concrete from the same plant tested elsewhere.

Specific items addressed during the analysis may include the addition of water; the age of the concrete when discharged; materials added by the customer; unusual appearance of the concrete at the time of placing; concrete temperature; etc. We stress the importance of our personnel remaining objective in their analysis of the information available.

Our analysis may require hiring a consultant(s) for jobsite evaluation or more detailed concrete sample tests using chemistry, petrography, etc. and depends upon the financial implications of the initiating complaint.

We encourage an arbitration process for dispute resolution, whenever possible.

14.5. Summary Report

Our investigation and subsequent analysis of the concrete is summarized in a report. It is important that this summary report be fact-based with supporting documentation. The report summarizes our findings and presents the conclusion(s) and recommendations, if appropriate.





Our Technical Services Department maintains reference documents and files addressing the most frequent problems associated with concrete. Literature identifying methods of avoiding concrete defects is often provided to our customers prior to concrete placements.

If we provide recommendations for remedial actions in our summary report, the recommendations are supported by printed information originating from established authorities in the field.

If we are responsible for the non-conforming product or service, Global Ready Mixed Company accepts responsibility for any necessary corrective actions. If it is determined that we are not at fault, we will evaluate our response and subsequent activities, on a case by case basis.





15. Measurement, Analysis and Improvement

15.1. General

In order to improve our operations we establish and measure key indicators of our performance. In this section, we identify representative activities that we have selected to measure; how we monitor those activities; our analysis process; and the method(s) that we use to review the measurement data. Through the process of measuring key indicators throughout our operations, monitoring those activities, and analyzing the results, we can:

- Evaluate our ready mixed concrete consistency;
- Improve our processes; and
- Evaluate the effectiveness of our Quality Management System.

15.2. Monitoring and Measurement

Selecting the proper activities or items to measure is critical in understanding and evaluating our company's performance.

15.2.1. Customer Satisfaction

Customer satisfaction is measured as discussed in Section 4, *Customer Focus*. Monitoring our customer satisfaction includes:

- Reviewing customer satisfaction data at our quarterly Quality Committee meetings. This data includes the results of customer surveys, Customer Advisory Committee minutes, complaint review, customer correspondence, and personal interactions;
- Management review of customer complaints and inquiries, including Summary Reports;
- Review of our company's customer focus at our weekly sales meetings.

The goal in evaluating the level of customer satisfaction with our company is to determine if we are meeting our customer's requirements and our customer's perception of Global Ready Mixed.

15.2.2. Internal Audits

Internal Quality Audits are conducted at each of our facilities semi-annually. These Audits address multiple aspects of our organization and evaluate conformance to the Global Ready Mixed Quality Management System.

The procedures for Internal Audits and proposed schedules for each facility are listed in Appendix E. Different audit levels are defined for production facilities, central laboratory, maintenance operations, and central office in Appendix E.

The Internal Audit Checklist in Appendix F addresses items within each Section of our Quality Manual. This Checklist was prepared based on the importance of the processes within the category being evaluated. Only pertinent sections are used for different facilities as defined by the Audit Level required. Our Audit Checklist is reviewed and revised (if applicable) annually, based on the previous Audits and established corporate priorities.





The Quality Committee, at its initial meeting each year, schedules the first Quality Audit(s) of the year for each of our facilities. The Audit Team assigned to conduct the Audit is identified and may consist of any of the following, or combination thereof:

- Quality System Coordinator
- Production/Operations Manager
- Plant Manager (other than the facility being audited)
- Quality Committee member
- Specific employees designated by the Quality Committee
- Consultant

Records of each Audit are maintained by the Quality System Coordinator. The results of each Audit are reviewed and discussed at the following Quality Committee meeting. Based on the results of the Audit, corrective actions are defined and the responsible manager is provided a list of corrective actions. The manager subsequently corrects any non-conformances within the agreed upon time frame.

The Quality Committee reviews the status of nonconformities to confirm that the necessary corrective actions have been made or appropriate processes implemented.

15.2.3. Monitoring and Measurement of Processes

Global Ready Mixed selects critical tasks (key indicators) to monitor within our QMS. The measurements and monitoring of these tasks represent the performance of the process identified. Sample measurements of key indicators of our production processes may include, but are not limited to:

- Trips per truck per day
- Average cubic yards per load
- Cubic yards produced per hour
- Total concrete production per plant (per day, per week, per year)
- Frequency of failure of production systems and time to restore
- Average number of trucks available for delivery per day
- Various benchmarks as recommended by NRMCA Benchmarks for Productivity

If monitored processes fail to achieve the desired results, the cause of the failure is analyzed and if necessary, change is implemented.

15.2.4. Monitoring and Measurement of Product

Concrete sampling and testing is performed as defined in Section 12, *Concrete Testing*. Concrete sampling and testing is conducted at the plant and jobsite for both dry batch and central mix plants on defined frequencies for designated mixtures as established by the Quality Committee. For the internal purpose of evaluating our plant production and designated mixture performance, concrete from our plants is tested at the plant under the direction of Technical Services personnel. The purpose of jobsite testing is to validate our mixture performance at the jobsite and to verify commercial quality assurance testing of our products.





The primary concrete characteristics (conformance testing) monitored include:

- Slump or spread;
- Setting characteristics
- In some cases, a subjective evaluation of finishing characteristics
- Temperature;
- Density and yield checks
- Air Content, and
- Compressive strength.

The Technical Services Manager is responsible for maintaining records of conformance testing and these records are maintained at our corporate laboratory.

During everyday operations, our ready mixed truck drivers are responsible for verifying the visual characteristics of our concrete and releasing the product. All such observations are documented on delivery tickets. On critical placements our Technical Services personnel observe or test the product and subsequently accept responsibility for releasing the product.

15.3. Control of Nonconforming Product

Product which fails to conform to requirements may be identified through observation, utilization, and/or conformance testing. Our processes for control of non-conforming product include ingredient materials. Nonconforming ready mixed concrete is investigated and analyzed in accordance with Section 14, *Concrete Troubleshooting*. Dispatch, batch, and Technical Services personnel are immediately notified of nonconforming ingredient product concrete.

Technical Services personnel are our only representatives authorized to adjust the concrete mixture characteristics (other than minor moisture content, aggregate, and admixture adjustments). Water may only be added by production and delivery personnel to the extent that the design water cement ratio is maintained. Air may be added on the jobsite under the direction of our Technical Services representative. Nonconforming product may be used for a different purpose when the product conforms to the new requirements and/or performance standards.

A Non-Conformance Report is developed for the following:

- Ingredient materials
- Batching process and incorrect materials
- Incorrect delivery
- Non-compliance with specifications or order
- Customer complaints for both plastic properties and subsequent defects

The Non-Conformance Report includes:

- reporting source of the non conformance;
- identifying information to purchase order or delivery ticket;
- type of non-conformance;





- reason for non-conformance with necessary details;
- disposition;
- correction needed to process and product;
- cost to Global Ready Mixed.

15.4. Analysis of Data

Through experience and process analysis we have determined what activities or items to monitor, measure, and track that represent our key processes. We collect data for analysis and analyze the selected data at varying intervals depending upon the process or item measured. The analysis of our data enables us to evaluate our operations and the effectiveness of our QMS.

Statistical Process Control provides an important method of evaluating and analyzing our concrete component materials and concrete characteristics.

We track specific measurements for all ingredient materials by source on control charts. All control charts have established control limits that trigger needed action. These quality level limits are defined by the Quality System Coordinator and are most often tighter than project acceptance or established criteria for purchasers.

We monitor concrete strengths for all designated mixtures in accordance with ACI 214, *Recommended Practice for Evaluation of Strength Test Results of Concrete*. Along with strength data, material sources and batch quantities, slump, temperature, density and yield, air content and other properties are tracked. Control limits are used to trigger action. This enables us to often visually identify the cause of a problem. The trend analysis often allows us to react to a situation before it becomes a quality problem.

Standard forms and control charts are maintained by the Quality System Coordinator and revised as necessary. He is responsible for analysis and action and training people on the use of these charts. On critical projects, control charts are reviewed daily. On most projects a weekly review is conducted. Revisions to the data measured, analysis and charting are often done by the Quality System Coordinator and reviewed with his delegates.

15.5. Improvement

A primary goal of Global Ready Mixed is to continuously improve our quality management system. The methods that we use to seek improvement include, but are not limited to:

Defining and re-defining our Quality Policy;

- Planning;
- Management review;
- Customer feedback;
- Training;
- Facilities, Plant, and Equipment improvements;
- Materials management;
- Purchasing;





- Production and delivery;
- Internal Audits;
- The collection and analysis of data; and
- Corrective and preventive actions.

15.5.1. Corrective Action

Through monitoring and tracking nonconformities our company can minimize or eliminate the cause(s) that creates the respective nonconformity. As discussed in Section 14, *Concrete Troubleshooting*, each non-conformance is evaluated to prevent or minimize recurrence and a Summary Report of findings is prepared. Corrective action processes are also defined in this Section. The general procedure is:

- Identify the source of the non-conformity – customer complaint or internal
- Investigate the cause and identify it to process, product, quality system; and record the results of investigation
- Determine necessary corrective action and subsequent action to eliminate the cause for future non-conformities
- Controls established to ensure corrective action is taken and documentation of its effectiveness.

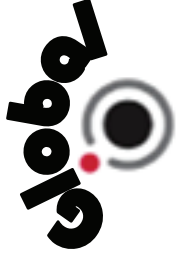
15.5.2. Preventive Action

At Global Ready Mixed we are proactive in anticipating nonconforming product in situations where defects have occurred in the past. Our dispatch, operations, and Technical Services personnel notify and educate our customers about the preventive actions that they can take to minimize problems associated with the placement, finishing, and curing of concrete. We caution our customers about potential problems during the order entry and order confirmation processes. We mail literature to select customers regarding procedures that they may implement to minimize certain foreseeable problems. On major and/or unique projects we discuss preventive actions that may be implemented during various stages of the project.

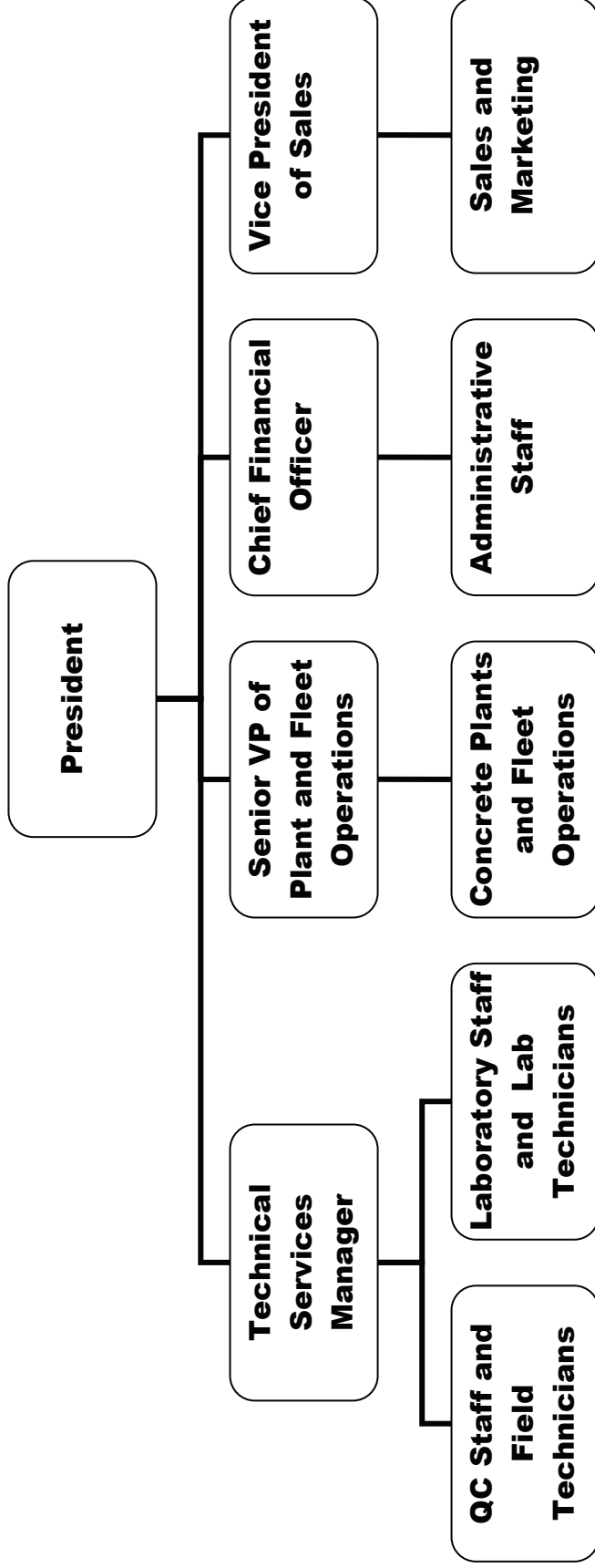
The general procedure for preventive action is:

- Use of appropriate information sources to detect analyze and eliminate potential causes of nonconformities – audits, control charts, customer complaints, etc.
- Determination of steps needed
- Initiation of preventive action and establishing controls to ensure it is effective
- Verification that steps taken are effective and submit for management review





Appendix A: Organization Chart of Management Team Global Ready Mixed





Appendix B - Job Description and Responsibilities of QC Personnel

Technical Services Manager

The Technical Services (TS) Manager of Global Ready Mixed is responsible for implementing our management's objectives concerning the desired level of product quality. The TS Manager is responsible for planning, implementing, and monitoring the quality assurance and quality control activities of Global Ready Mixed. Our Technical Services Manager has a broad understanding of the aspects of quality assurance and quality control which impact the quality of our ready mixed concrete. The TS Manager reports directly to the President of Global Ready Mixed. Specific responsibilities of the Technical Services Manager include:

I. Quality Assurance/Quality Control

- A. Establish, implement and maintain quality policies and procedures consistent with industry standards and Global Ready Mixed's QMS. Specifically:
 - 1. work with the component material suppliers to establish standards for concrete materials and the materials tests requirements to be accomplished by the supplier;
 - 2. establish standards for receiving, testing, and acceptance of component materials;
 - 3. research and development testing;
 - 4. failure analysis and prevention;
 - 5. advising on technical aspects of promotional activities;
 - 6. define and monitor processes and set up standards for production testing.
 - 7. determine concrete tests standards and evaluate concrete performance;
 - 8. product optimization;
 - 9. establish procedures for retrieving and responding to customer complaints (including concrete troubleshooting).
- B. Participate with the Plant Managers in defining the short and long term direction of the plants with respect to overall product quality and continuous improvement.

II. Personnel

- A. Staff and supervise the required personnel for:
 - Laboratory Technician
 - Concrete Technician(s)
- B. Maintain required certifications (ACI, DOT, etc.) for all quality control personnel.
- C. Facilitate personnel training.
- D. Insure that all staff responsibilities (included on following pages) are performed accurately and completely.





III. Laboratory and Materials Testing

- A. Maintain laboratory facility and equipment;
- B. Maintain appropriate test data from suppliers of component materials;
- C. Determine, implement, monitor, and evaluate results of all plant and laboratory testing.

IV. Mix Proportion Maintenance

- A. Review of project specifications and selection of job mixtures;
- B. Preparation of concrete mix designs and other product information for approval by the building official or specifying agency;
- C. Develop and maintain up to date mix books for all product mix proportions required;
- D. Perform mix adjustments as required.





Concrete Technician

Our Concrete Technicians are responsible for performing concrete tests and monitoring the quality of our ready mixed concrete. Our Concrete Technicians report directly to the Technical Services Manager. Specific responsibilities include:

I. Ready Mixed Concrete Testing

A. Perform concrete tests and procedures in accordance with applicable ASTM standards:

- | | | |
|----------------|-------------------|-------------------------|
| 1. Sampling | 4. Unit Weight | 7. Yield |
| 2. Slump | 5. Temperature | 8. Concrete Workability |
| 3. Air Content | 6. Make Cylinders | |

B. Perform proper handling and procedures for test cylinders

- | | |
|-------------------|-------------------------------------|
| 1. Stripping | 5. Test Report |
| 2. Identification | 6. Establish and record break dates |
| 3. Log-in | 7. Cap and break cylinders |
| 4. Curing | |

II. Recordkeeping

A. Maintain all concrete test results.

B. Maintain concrete statistical data for each standard mix.

III. General Requirements

C. Notify the Technical Services Manager of any nonconforming product.

D. Maintain all concrete test equipment in good working order (including calibration requirements).

E. Compensate for free moisture in aggregates, air content, and the effect of admixtures as required in the concrete batching

F. Maintain ACI Field Technician Grade I Certification

G. Assist the Technical Services Manager in mix proportioning and mix adjustments.

H. Assist the Laboratory Technician in the preparation of trial mixes in the lab. Coordinate trial batches for new or verified mixes at the concrete plant(s).

I. Recognize and report immediately any malfunction of proportioning equipment and perform necessary activities for correction.

J. Employ general knowledge and troubleshooting capabilities regarding hardened concrete.





Laboratory Technician

Our Laboratory Technician has a good understanding of the objectives of testing and of the principles of operation of all our laboratory testing equipment. The Laboratory Technician has demonstrated familiarity with, respect for, and access to the applicable ASTM, AASHTO, and project standards governing the methods of performing all tests assigned. The Laboratory Technician works directly for the Technical Services Manager. Specific responsibilities of our Laboratory Technician include:

I. Component Material Testing

- A. Assist the Technical Services Manager in procuring and maintaining all required supplier provided component material information.
- B. Perform routine laboratory testing, including but not limited to;
 - 1. Sieve analysis and fineness modulus of all coarse and fine aggregates,
 - 2. Fine and coarse aggregate moisture contents,
 - 3. Coarse and fine aggregate unit weight and voids,
 - 4. Cement and fly ash color plate tests,
 - 5. Foam index testing.

II. Other Testing

- A. Perform admixture analysis and comparison testing.
- B. Run trial mixes to evaluate new and existing mix components and proportioning.

III. General Responsibilities

- A. Maintain laboratory facility and equipment (including equipment calibrations).
- B. Maintain records of all relevant receiving and production testing.
- C. Inform the Technical Services Manager of non-conforming test results.
- D. Maintain ACI Laboratory Testing Technician Grade I Certification
- E. Recognize and report immediately any malfunctioning test equipment.
- F. Assist the Concrete Technicians, as required.





Appendix C - Production Facilities

Description of the following production facilities of Global Ready Mixed Company

- **Silver Creek Plant, 2447 Industrial Boulevard, Silver Creek, SC**
- **Madison Plant, 613 North Wendover Street, Madison, SC**
- **Golden Plant, 805 Rural Route 3, Golden, SC**
- **Andover Plant, 5159 Fairfax Drive, Andover, SC**
- **Portland Plant, 9931 Pleasantburg Drive, Portland, SC**
- **“Mobile” Plant, c/o Central South Carolina Power, Rural, SC**





**Silver Creek Plant
2447 Industrial Boulevard
Silver Creek, South Carolina
USA**

Plant Manufacturer	Sevier Manufacturing	
Rated capacity, cubic yards per hour	200 cubic yards per hour	
Concrete Mixing	Central Mixer	
STORAGE CAPACITY		
Cement, tons	300 tons	
Fly Ash, tons	120 tons	
Slag, tons	none	
Coarse Aggregate, tons	600 tons	
Fine Aggregate, tons	300 tons	
Air entraining admixture, gal	1000 gallons	
Water reducer, gal	1500 gallons	
Others: Non-chloride Accelerator	1000 gallons	
High Range Water Reducer	1500 gallons	
Corrosion Inhibitor	1000 gallons	
Number of Trucks	15	
DESCRIPTION OF PLANT		
<p>The Silver Creek Plant is centrally located in the Crosscreek Industrial Park, 3 miles from downtown Silver Creek and 1.5 miles off of Interstate 85. This central mix plant is equipped with computerized batch controls, a 2.5 MBTU hot water heater, a moisture probe for fine aggregates, high bin indicators in each silo, and a water chiller. Lightweight and normal weight coarse aggregate stockpiles are equipped with misters for absorption and cooling.</p>		
CERTIFICATION AND INSPECTION OF CONCRETE PLANT AND TRUCKS		
Plant Certified by:	National Ready Mixed Concrete Association	Expiration: _____
Plant Certified by:	South Carolina Department of Transportation	Expiration: _____





**Madison Plant
613 North Wendover Street
Madison, South Carolina
USA**

Plant Manufacturer	Sevier Manufacturing	
Rated capacity, cubic yards per hour	150 cubic yards per hour	
Concrete Mixing	Dry Batch (Truck Mixing)	
STORAGE CAPACITY		
Cement, tons	200 tons	
Fly Ash, tons	100 tons	
Slag, tons	none	
Coarse Aggregate, tons	400 tons	
Fine Aggregate, tons	200 tons	
Air entraining admixture, gal	1000 gallons	
Water reducer, gal	1500 gallons	
Others: Non-chloride Accelerator	1000 gallons	
High Range Water Reducer	1500 gallons	
Corrosion Inhibitor	1000 gallons	
Number of Trucks	10	
DESCRIPTION OF PLANT		
<p>The Madison Plant is located off Highway 76 (Wendover Street) 4 miles north of downtown Madison. The plant primarily serves the rapidly growing commercial and industrial markets and the outlying rural areas of Franklin County. This dry batch plant is equipped with computerized batch controls, a 2.0 MBTU hot water heater, a moisture probe for fine aggregates, and high bin indicators in each silo. Lightweight and normal weight coarse aggregate stockpiles are equipped with misters for absorption and cooling.</p>		
CERTIFICATION AND INSPECTION OF CONCRETE PLANT AND TRUCKS		
Plant Certified by:	National Ready Mixed Concrete Association	Expiration: _____
Plant Certified by:	South Carolina Department of Transportation	Expiration: _____





**Golden Plant
805 Rural Route 3
Golden, South Carolina
USA**

Plant Manufacturer	Sevier Manufacturing	
Rated capacity, cubic yards per hour	100 cubic yards per hour	
Concrete Mixing	Dry Batch (Truck Mixing)	
STORAGE CAPACITY		
Cement, tons	150 tons	
Fly Ash, tons	none	
Slag, tons	75 tons	
Coarse Aggregate, tons	200 tons	
Fine Aggregate, tons	150 tons	
Air entraining admixture, gal	500 gallons	
Water reducer, gal	750 gallons	
Others: Non-chloride Accelerator	500 gallons	
High Range Water Reducer	750 gallons	
Corrosion Inhibitor	500 gallons	
Number of Trucks	6	
DESCRIPTION OF PLANT		
<p>The Golden Plant is located just outside of the small town of Golden. A major percentage of this plant's production is attributed to the routine concrete placements at the paper mill and the power plant near Golden. This dry batch plant is equipped with computerized batch controls, a 1.5 MBTU hot water heater, a moisture probe for fine aggregates, and high bin indicators in each silo. Lightweight and normal weight coarse aggregate stockpiles are equipped with misters for absorption and cooling.</p>		
CERTIFICATION AND INSPECTION OF CONCRETE PLANT AND TRUCKS		
Plant Certified by:	National Ready Mixed Concrete Association	Expiration: _____
Plant Certified by:	South Carolina Department of Transportation	Expiration: _____





**Andover Plant
5159 Fairfax Drive
Andover, South Carolina
USA**

Plant Manufacturer	Sevier Manufacturing	
Rated capacity, cubic yards per hour	150 cubic yards per hour	
Concrete Mixing	Dry Batch (Truck Mixing)	
STORAGE CAPACITY		
Cement, tons	190 tons	
Fly Ash, tons	80 tons	
Slag, tons	none	
Coarse Aggregate, tons	450 tons	
Fine Aggregate, tons	250 tons	
Air entraining admixture, gal	1000 gallons	
Water reducer, gal	1500 gallons	
Others: Non-chloride Accelerator	1000 gallons	
High Range Water Reducer	1500 gallons	
Corrosion Inhibitor	1000 gallons	
Number of Trucks	14	
DESCRIPTION OF PLANT		
<p>The Andover Plant is centrally located in the Forest Acres community of Andover, 2 miles from midtown and 3 miles off of Interstate 26. This dry batch plant is equipped with computerized batch controls, a 2.0 MBTU hot water heater, a moisture probe for fine aggregates, and high bin indicators in each silo. Lightweight and normal weight coarse aggregate stockpiles are equipped with misters for absorption and cooling.</p>		
CERTIFICATION AND INSPECTION OF CONCRETE PLANT AND TRUCKS		
Plant Certified by:	National Ready Mixed Concrete Association	Expiration: _____
Plant Certified by:	South Carolina Department of Transportation	Expiration: _____





**Portland Plant
9931 Pleasantburg Drive
Portland, South Carolina
USA**

Plant Manufacturer	Sevier Manufacturing	
Rated capacity, cubic yards per hour	180 cubic yards per hour	
Concrete Mixing	Central Mixer	
STORAGE CAPACITY		
Cement, tons	250 tons	
Fly Ash, tons	150 tons	
Slag, tons	none	
Coarse Aggregate, tons	550 tons	
Fine Aggregate, tons	300 tons	
Air entraining admixture, gal	1000 gallons	
Water reducer, gal	1500 gallons	
Others: Non-chloride Accelerator	1000 gallons	
High Range Water Reducer	1500 gallons	
Corrosion Inhibitor	1000 gallons	
Number of Trucks	15	
DESCRIPTION OF PLANT		
<p>The Portland Plant is centrally located in the highly industrialized southeast section of Portland. The site is served by rail and is contiguous to the Northern Connector. This central mix plant is equipped with computerized batch controls, a 2.5 MBTU hot water heater, a moisture probe for fine aggregates, high bin indicators in each silo, and a chiller. Lightweight and normal weight coarse aggregate stockpiles are equipped with misters for absorption and cooling.</p>		
CERTIFICATION AND INSPECTION OF CONCRETE PLANT AND TRUCKS		
Plant Certified by:	National Ready Mixed Concrete Association	Expiration: _____
Plant Certified by:	South Carolina Department of Transportation	Expiration: _____





**“Mobile” Plant
c/o Central South Carolina Power
Rural, South Carolina
USA**

Plant Manufacturer	Sevier Manufacturing	
Rated capacity, cubic yards per hour	150 cubic yards per hour	
Concrete Mixing	Dry Batch (Truck Mix)	
STORAGE CAPACITY		
Cement, tons	200 tons	
Fly Ash, tons	120 tons	
Slag, tons	none	
Coarse Aggregate, tons	400 tons	
Fine Aggregate, tons	200 tons	
Air entraining admixture, gal	1000 gallons	
Water reducer, gal	1500 gallons	
Others: Non-chloride Accelerator	1000 gallons	
High Range Water Reducer	1500 gallons	
Corrosion Inhibitor	1000 gallons	
Number of Trucks	5	
DESCRIPTION OF PLANT		
<p>The “Mobile” Plant is currently located on the Central South Carolina Power (CSCP) project near Rural, South Carolina. This portable dry batch plant is equipped with computerized batch controls, a 1.5 MBTU hot water heater, a moisture probe for fine aggregates, and high bin indicators in each silo. Lightweight and normal weight coarse aggregate stockpiles are equipped with misters for absorption and cooling.</p>		
CERTIFICATION AND INSPECTION OF CONCRETE PLANT AND TRUCKS		
Plant Certified by:	National Ready Mixed Concrete Association	Expiration: _____
Plant Certified by:	South Carolina Department of Transportation	Expiration: _____



Appendix D - List of Laboratory Equipment

- **Hydraulic Testing (Compression) Machine** - 250,000 lb. capacity
- **Sample splitter**
- **Bench Scale**
- **Gram Scale**
- **Hot Plate**
- **Mechanical Sieve Shaker (Coarse Aggregate) and Sieves**
- **Mechanical Sieve Shaker (Fine Aggregate) and Sieves**
- **Slump Cone Mold**
- **Laboratory Mixer (2 cu. ft.)**
- **Pressure Air Meter**
- **Volumetric Air Meter**
- **Unit Weight Bucket**
- **Cylinder Molds**
- **Beam Molds**
- **Sulfur Mortar and Capping Jig**
- **Neoprene Caps and Extrusion Rings**
- **Thermometers/Temperature Recorders**
- **Mechanical Sieve Shaker**
- **Accessory Equipment**
 - wheelbarrow (4 cu.ft.);
 - No. 2 metallic scoop;
 - tamping rod;
 - mallet with a rubber head;
 - wood float;
 - 10 quart bucket;
 - short-handled square-end shovel;
 - box of clean rags;
 - work gloves; rubber gloves;
 - 6 ft. ruler;
 - 100 ft. tape;
 - magnifying glass;
 - plywood boards;
 - pocket calculator.
- **Other Incidental Equipment**



Appendix E - Internal Quality Procedure and Schedule

General:

Audits of all elements of the Quality Plan of Global Ready Mixed will be scheduled, at least semi-annually. Selected critical items may be audited more frequently based on the status and importance of the activity being audited.

1.0 Qualifications

- a. The Quality System Coordinator (QSC) shall have completed the auditor certification offered by the RMCCO or equivalent.
- b. All personnel serving as auditors will be undergo training by QSC and shall have participated in at least one audit as an observer.
- c. The QSC may appoint one observer to participate in an audit.

2.0 Schedule

- a. The QSC shall prepare an audit schedule that is approved by the President.
- b. The schedule will be entered into document control and distributed to the management team, production facilities and auditors.

3.0 Plan

- a. The lead auditor and additional auditors will be assigned by the QSC; an auditor cannot audit processes or regions under his/her area of responsibility.
- b. An audit checklist will be utilized as in Appendix F. The lead auditor can include additional items based on the area or follow ups from prior audits.
- c. The audit plan will be completed by the lead auditor and delivered to the plant manager(s) at least 14 days prior to the audit. At least 3 days advance notice for an audit is required. The plan should describe the purpose of the audit, areas being audited, time(s) the audit will be conducted, etc.

4.0 Perform

- a. The audit will be performed according to the audit plan. The lead auditor may add additional items at the time of the audit.
- b. The lead auditor will coordinate and review the audit plan with the audit team.
- c. The audit team will review the audit plan with the Plant Manager and then perform the audit.

5.0 Report

- a. The lead auditor will complete an audit report on completion of the audit.
- b. The lead auditor will develop an Internal Audit Corrective Action Report for each audit finding and indicate the recommended time for action to be completed.
- c. Copies of the audit report will retained by the QSC and the audited Plant Manager(s).

6.0 Follow Up

- a. Corrective and Preventive Actions must be addressed by the audited Plant Manager for each finding in the audit and submitted to the QSC within 14 days of the recommended date for completion of action.
- b. The lead auditor must be named as the "Evaluator" for each finding from the audit. The audited Plant Manager will record the follow up action on each Audit Corrective Action item.
- c. The QSC will report corrective and preventive actions from audits to the Management team.





Internal Audit Schedule

Facility	Audit Date	Audit Level	Lead Auditor
Central Office	Jan 7, June 15	1	QSM
Central Laboratory	Jan 15, June 21	3	QSM
Maintenance Shop	Jan 7, June 15	4	OPS
Silver Creek Plant	Feb 1, Aug 15	2	PM2
Madison Plant	Feb 7, Aug 1	2	PM1
Golden Plant	Feb 14, Aug 7	2	PM5
Andover Plant	Feb 21, Aug 21	2	PM3
Portland Plant	Feb 28, Aug 28	2	PM4
“Mobile” Plant	When set up	2	QSM

Audit Level 1 – Sections 1-15

Audit Level 2 – Sections 6, 7, 8.5, 8.6, 10, 11, 12.3, 15.2, 15.3

Audit Level 3 – Sections 7.4, 8, 9.5, 12, 13, 14, 15

Audit Level 4 – Sections 6, 11





Appendix F - Internal Quality Audit Form

Facility: _____ Date of Audit: _____

Audit Team: _____

1.	Introduction	
	A.	Is the General Introduction up-to-date?
	B.	Is the Quality Policy accurate?
2.	Quality Management System	
	A.	Is the composition of the Quality Committee is defined?
	B.	Are the two (2) list (Manuals assigned and page numbers with revision date) being maintained?
3.	Management Responsibility	
	A.	Has the Quality Manual been approved and signed by the Chief Executive Officer?
	B.	Are the methods identified for communicating the QMS being used?





C.	Is the Quality Committee meeting quarterly as stated?

4.	Customer Focus
-----------	-----------------------

A.	Is the Customer Advisory Committee meeting a minimum of two (2) times per year?

B.	Is the Complaint Form available and being used?

C.	Are complaints centralized through the Customer Service Representative?

5.	Human Resources
-----------	------------------------

A.	Is the organization chart illustrated current?

B.	Are the position descriptions illustrated all inclusive?

C.	Is employee Training being performed as indicated?





6.	Facilities, Plant(s) and Equipment
A.	Are the Plant descriptions illustrated accurate?
B.	Is the laboratory equipment identified available for use?
C.	Are the equipment calibration frequencies as indicated?
7.	Materials Management
A.	Are component material suppliers selected by the methods indicated?
B.	Are component material suppliers providing the information indicated?
C.	Do all drivers delivering component materials to this Plant receive the instructions indicated?
D.	Is customer property handled as identified?





8.	Concrete Mixture Development or Selection
A.	Are specific concrete mixes at this Plant identified for monitoring?
B.	Are concrete mixes changed as indicated?
C.	Are mix books available and organized as defined?
9.	Purchasing
A.	Are Purchase Orders prepared for all component materials?
B.	Do Purchase Orders include the requirements specified?
C.	Is an approved supplier list maintained as indicated?
10.	Order Processing and Dispatching Procedures
A.	Are order entry forms (index cards) used as indicated?





B.	Are order entry and dispatch records maintained as indicated?
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11.	Concrete Production
------------	----------------------------

A.	Is dispatch verbally confirming orders for additional items to be delivered to the jobsite with the drivers?
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B.	Are the procedures identified for hot and cold weather concreting being used?
----	---

12.	Concrete Testing
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A.	Are check test routinely being performed for nonconforming concrete tests?
----	--

B.	Is lightweight concrete being tested as indicated?
----	--

13.	Concrete Delivery and Site Control
------------	---

A.	Are ready mixed truck drivers being trained in jobsite awareness as indicated?
----	--





B.	Are Technical Services personnel available on site for initial pumping operations on new projects?
----	--

C.	Is the concrete identifiable and traceable as indicated?
----	--

14.	Concrete Troubleshooting
------------	---------------------------------

A.	Are customer complaints centralized and distributed for resolution as indicated?
----	--

B.	Is nonconforming concrete investigated by the guidelines illustrated in ACI 201.1R?
----	---

C.	Are Summary Reports prepared for each investigation?
----	--

15.	Measurement Analysis and Improvement
------------	---

A.	Is customer satisfaction reviewed as indicated?
----	---

B.	Are internal audits being conducted semi-annually?
----	--





C.	Is measurement data being collected and analyzed as indicated?
D.	Are Preventive Actions being initiated as discussed?



Quality Management System For Ready Mixed Concrete Companies

Part C: Ready Mixed Concrete Company External Quality Audit
Checklist for Compliance with Quality Plan

February 2008

Prepared by:
NRMCA P2P Steering Committee





READY MIXED CONCRETE COMPANY EXTERNAL QUALITY AUDIT CHECKLIST FOR COMPLIANCE WITH QUALITY PLAN

Background

The NRMCA has developed a Guideline for a Quality Plan for Ready Mixed Concrete Companies outlining items in fifteen (15) sections in accordance with the primary outline used in ISO 9000 certification for quality systems. The NRMCA Guideline is made pertinent to the ready mixed concrete industry as a minimum standard as a basis to support the qualifications and credibility for ready mixed concrete producers involved in performance based projects. The Guideline document was developed in support of the NRMCA's P2P Initiative by the P2P Steering Committee and endorsed by the NRMCA Research Engineering and Standards Committee. However, the Guideline is not intended solely for this performance based projects and can be used as a good outline for all ready mixed concrete companies desiring to progress their individual quality initiatives and establish a written quality plan endorsed and supported by the executive management with defined responsibilities for those defined initiatives. Producers that endorse the concepts in the Guideline will be more progressive towards establishing systems in place and establish their reputation for quality in a particular market and possibly provide them a superior position when bidding on performance based concrete projects. For more information on the P2P Initiative visit www.nrmca.org/p2p.

Purpose of the External Quality Audit Checklist

While the guideline manual addresses several quality systems that should be in place in a ready mixed concrete company, many of these are internally focused for improving quality process of various activities. The guideline ensures that certain activities and processes are in writing in the Companies Quality Plan with delegated responsibilities for carrying out these actions. This audit checklist extracts only those items related to quality control and quality assurance that are of interest to a purchaser of concrete as a means to document the existence and compliance of a Company's Quality Plan that might be a submittal requirement in project specifications. Because Quality Plans will vary considerably between ready mixed concrete companies, this outline only serves as a basic outline that can help the purchaser of concrete to audit the necessary items that impact product quality. Purchasers might require more or less than the items listed in this External Quality Audit Checklist. The P2P Steering Committee has decided that if there is a significant need for this audit process in the concrete construction industry then this Audit Checklist could be evolved to a Ready Mixed Concrete Producer Certification program that could be awarded based on an audit by an independent third party and administered by an organization like the NRMCA.

The purpose of an audit is for a third party independent of the Company to review and verify that the Company does what they say they will do in the Quality Plan.

The format of this External Quality Audit Checklist provides the primary headings of interest to the Purchaser, lists the general items that could be audited and provides some commentary on each item as guidance to the user of this document.

This Checklist is a preliminary listing of audit items that might be conducted by an external entity. The NRMCA P2P Steering Committee and the Research Engineering and Standards Committee will review this audit checklist and update it as appropriate.



Checklist	Commentary
1. Company's Quality Management System	
1.1 Company's Quality Manual with sections pertinent to purchasers with the minimum content outlined in this check list	<p><i>A Company's Quality Manual will typically have several items that discuss internal processes that impact the organization and activities that impact the quality of the product. This Quality Manual as a whole is generally a confidential document controlled within the company. The Quality Manual mentioned here that will be in a submittal to a project is a subset of the Company's Quality Manual that will only outline those activities that will impact product quality that can be documented for external review. Some of the items that might of interest to the Purchaser relative to the Company's quality initiatives are:</i></p> <ul style="list-style-type: none"> • <i>sampling and testing of concrete and concrete materials;</i> • <i>plant and field control of concrete production;</i> • <i>personnel training;</i> • <i>concrete mixture optimization;</i> • <i>research and development testing;</i> • <i>specification review;</i> • <i>evaluation of concrete performance; and</i> • <i>failure analysis and prevention.</i>
1.2 Names and titles of company personnel with responsibility and authority for quality functions.	<p><i>The organizational structure of the Company with names and titles with responsibility and authority for quality functions.</i></p> <ul style="list-style-type: none"> • <i>Management</i> • <i>Technical Services</i> • <i>Quality Control managers</i> • <i>Quality Control Technicians</i> • <i>Batch plant operators</i>
1.3 Company personnel (Quality Committee) that control the Quality Manual development, review and revisions	<p><i>The Quality Plan in a Company has to be developed, reviewed and revised, and disseminated by an Executive level team. This item should list that team that develops and controls dissemination and implementation of the Quality Plan. The process of control and dissemination should be described.</i></p>
1.4 Internal process for communicating and monitoring quality processes	<p><i>This section should describe the process of communicating and implementing the Company's Quality Policy and Initiatives and also the processes and systems used to monitor and improve product quality.</i></p>
1.5 Process of control of quality records and associated responsibilities	<p><i>This section should describe the process of monitoring quality of concrete ingredients - such as the use of control charts or log books, who is responsible to evaluate these quality and the process of controlling these quality records within the company.</i></p>
2. Resources for Quality Management	
2.1 Documentation of company personnel qualifications including pertinent certifications and responsibilities for quality functions.	<p><i>The qualifications and the detailed responsibilities of Company personnel can be listed in this section. If the project calls for industry certifications, these can also be documented in this section. If the project does not require personnel certifications, these can be documented also as a means to establish the reputation and credentials of the Company and its commitment to quality. The primary people/job functions that impact product quality that could included in this section include:</i></p> <ul style="list-style-type: none"> • <i>Manager of Quality Assurance or equivalent</i> • <i>Manager responsible for developing concrete mixtures and establishing processes for batching designated mixtures</i>

Checklist	Commentary
	<ul style="list-style-type: none"> • <i>Quality Control Technicians</i> • <i>Batch plant operators</i> • <i>Truck drivers</i>
<p>2.2 Documentation of laboratory facility, either in-house or on contract and pertinent quality plan</p>	<p><i>An important part of a Company's quality initiative is to measure and improve the quality of its product by testing. This section should document the testing facilities used by the company in monitoring its quality and possibly include its quality plan. A laboratory quality plan for facilities involved in acceptance testing of concrete (project quality assurance) is outlined in ASTM C 1077 and could be the basis of what the Company uses for quality control functions. However the scope of the quality plan required in ASTM C 1077 may not be required for quality control functions. A laboratory quality plan should document available equipment, calibration frequencies and records, participation in reference sample testing program and documentation, personnel certifications for laboratory and field technicians.</i></p>
<p>3. Materials Management</p>	
<p>3.1 Process of management of materials from suppliers to include documentation and material certifications.</p>	<p><i>This section outlines the Company's processes of documenting ingredient material certifications from their suppliers and the process of selecting these materials as it might relate to project specifications for concrete. The material certifications and documentation of classes and types of materials should include:</i></p> <ul style="list-style-type: none"> • <i>Cementitious Materials</i> • <i>Aggregates</i> • <i>Chemical admixtures</i> • <i>Special ingredient materials</i>
<p>3.2 Conformance monitoring of materials received and inventory control processes and documentation.</p>	<p><i>In this section the company documents their process of receiving component materials, storage and handling and inventory control. The Company documents the material certifications they collect and save, type of tests they conduct and frequencies of these tests on each shipment of all material sources.</i></p>
<p>3.3 Process for management of non-conforming materials.</p>	<p><i>In this section, the Company documents their processes of managing materials that do not conform to their purchase agreements and/or approved sources or materials specifications.</i></p>
<p>4.0 Production Facilities</p>	
<p>4.1 Documentation that production facilities and delivery vehicles conform to the requirements of ASTM C 94:</p>	<p><i>In this section the Company documents details of plant infrastructure including component manufacturers and age, compliance with CPMB Standards, if applicable</i></p> <p><i>Process of monitoring accuracy of measurement devices including monitoring frequency and calibration records</i></p> <p><i>Equipment maintenance schedules and items monitored for:</i></p> <ul style="list-style-type: none"> • <i>Bins and silos and batching processes for cementitious materials</i> • <i>Aggregate storage, and batching processes including moisture adjustments</i> • <i>Admixture storage and dispensing systems</i> • <i>Water storage, heaters and chillers and batching processes</i> • <i>Central mixer, if applicable</i> • <i>Truck mixers</i>
<p>4.2 Materials receiving, storage and handling procedures.</p>	<p><i>The Company documents their process of storing and handling ingredient materials for concrete production. The process of</i></p>



Checklist	Commentary
	<i>handling the following materials at a minimum:</i> <ul style="list-style-type: none"> • Cementitious materials • Aggregates • Chemical admixtures
4.3 Batching procedures and batch records evaluating batching accuracy	<i>The Company documents the process of batching, sequence of batching materials, monitoring of batching accuracy and record retention of batch records identifiable to delivery tickets. A current certificate of conformance from the NRMCA Plant certification program satisfies the requirements in 4.1 and 4.2.</i>
4.4 Procedures for corrective action and addressing nonconforming product	<i>The Company describes the tests or other indicators that identify non-conforming product and the process of ensuring the resolution and management of this product.</i>
5. Product Management	
5.1 Procedures used for concrete mixture development, verification testing and validation for conformance to specification requirements	<i>The Company documents their process of mixture proportioning for project submittals, process of maintaining documents of test results from previous jobs for future submittals, the process for verifying mixtures as appropriate in lab trial batches and production runs to verify conformance to project specification materials and the development of a submittal package for projects including personnel responsibility for these functions.</i>
5.2 Control of changes to established mix designs – responsibility and authority	<i>The Company identifies the levels of changes to established mix designs delegated to individual personnel and those responsible for incorporating those changes in mixture records.</i>
5.3 Order Entry process and verification of order fulfillment	<i>The Company documents their process of receiving orders, record keeping, scheduling and order fulfillment process and tracking.</i>
5.4 Recordkeeping process	<i>The record keeping process of project, mixture and other information is documented. Period of record retention based on type of information and types of project are also documented.</i>
6. Measurement Systems	
6.1 Prequalification test data for designated performance mixtures in accordance with project specifications	<i>The company documents the process of developing pre-qualification data to support project submittals both for project specification conformance and other quality control and materials qualification purposes. These data can include but are not limited to:</i> <ul style="list-style-type: none"> • Strength and standard deviation test records • Alkali aggregate reactivity tests • Shrinkage • Rapid Chloride Permeability • Setting time • Heat signature • Material compatibility information • Air content • Density
6.2 Frequency of testing and verification of prequalified concrete mixtures	<i>The frequency of testing and verification of material ingredients and for standard and special concrete mixtures is documented. The frequency of testing will vary depending on the type of test, its duration and the type of market served.</i>
6.3 Monitoring of product quality at jobsite	<i>Ready mixed concrete companies often do independent testing to monitor concrete quality both for the purposes of field quality control and verification of independent testing. In this section the company documents whether this testing is conducted and</i>



Checklist	Commentary
	<i>the types of tests and projects where concrete product quality is monitored in the field.</i>
6.4 Jobsite mixture identification and traceability processes	<i>In this section the Company documents the process of developing mixture designation and the process of communicating this information to customers and in project submittals. The traceability of designated mixtures in the Company's databases to delivery tickets is documented.</i>
6.5 Frequency of internal audits for quality process	<i>The Company documents their process of internal audits of quality systems, personnel responsible for accomplishing these audits and criteria used to establish when and what changes are necessary to the process.</i>
6.6 Process for monitoring and measurement of quality processes and associated documentation.	<i>The Company documents the processes and systems they use to monitor and measure their quality processes, the documentation generated from this monitoring and the review process involved to ensure that deficiencies in quality systems are corrected. These include items like accuracy of measuring devices, batching accuracy, handling and management of ingredient materials, etc.</i>
6.7 Process for monitoring and measurement of product quality , associated documentation and analysis process (need commentary)	<i>The Company documents the processes and systems they use to monitor and measure product quality, the documentation generated from this monitoring and the review process involved to ensure that deficiencies in product quality are corrected. These include items the use of control charts to track properties of ingredient materials and concrete.</i>
6.8 Concrete troubleshooting and summary reporting process.	<i>The Company documents their process of troubleshooting concrete problems and defects, the analysis process, and reporting and resolution of these issues.</i>

