QUALITY CONTROL TESTING LABORATORIES FOR CONSTRUCTION MATERIALS

KOSOVO CLUSTER AND BUSINESS SUPPORT PROJECT

June 2006

This publication was produced for review by the United States Agency for International Development. It was prepared by the KCBS project team of Chemonics International Inc. based on a Final Report prepared by Short Term Technical Advisor, Jeffrey L. Groom, P.E.

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THIS REPORT ADDRESSES AN ASSESSMENT AND THE STATE OF CONDITIONS OF CONSTRUCTION MATERIALS QUALITY CONTROL TESTING LABORATORIES THROUGHOUT KOSOVO. THE REPORT PRESENTS FIELD REPORTS AND RECOMMENDATIONS TO INCREASE THE ACCURACY AND RAISE THE LEVEL OF CONFIDENCE IN A LABORATORY'S TEST RESULTS.

Kosovo Cluster and Business Support project "Quality Control Testing Equipment for Construction Materials"
Contract No. AFP-I-00-03-00030-00, TO #800

This report submitted by Chemonics International Inc. / 16 Jun 2006

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PURPOSE OF ASSIGNMENT

The purpose of the assignment was to advise on the basic testing equipment to be provided, the organization of laboratories, training and certification of laboratory technicians, and certification/accreditation of laboratories through the following tasks:

- Review the existing structure of testing in Kosovo, the facilities currently in use and the steps needed to upgrade their operations to perform satisfactorily.
- Define the minimum needs to assure Kosovars that construction is being performed with materials that meet specification, and advise what necessary knowledge, training, and equipment must be provided.
- Advise what quality control and quality assurance procedures are required to be implemented in the laboratories.
- Advise on the certification and accreditation requirements for the laboratories and liaise with the Ministry of Trade and Industry's Standardization Agency in implementing these requirements.
- Develop a program for training the laboratory supervisors and technicians.
- Review the practicality of using testing facilities in neighboring countries as is proposed by the EU.

BACKGROUND

The USAID Mission in Kosovo has identified the construction materials cluster as one sector of industry with potential for significant development and for assisting the acceleration of private sector growth in Kosovo. The Kosovo Cluster and Business Support Program [KCBS] is working with leaders in the cluster to improve productive capacity, to improve market chain linkages and to improve quality control. The majority of construction in the boom years since the war ended in 1999 has been completed with little attention to standards and with little inspection during construction. KCBS has funded the translation of European Norms [EN] applicable to cement, aggregates, reinforcing steel into Albanian and is waiting for the Ministry to recommend their application for all construction. By the end of 2005, EN standards for concrete and concrete products will also have been prepared.

The facilities for testing materials incorporated in construction are limited. When tests are specified, many contractors use facilities at the University of Pristina, where professors see testing [on University equipment] and issuing certificates as secondary income. A rigorous approach to testing is not evident. At the same time, many construction products are imported – rebar, cement, blocks – and there are doubts about the authenticity of the certificates that accompany these products. Kosovo needs an authorized testing center where investors, engineers and quality-conscious contractors can be sure that test results are accurate and valid.

EXECUTIVE SUMMARY

Interviews, laboratory tours, and production facility tours were performed with USAID personnel to assess the current local standard of care associated with quality assurance/quality control [QA/QC] testing, the quality of testing equipment being utilized, the standards and test methods being followed, and the level of internal quality control used by laboratory personnel.

There is a movement within the Kosovo construction industry to have accredited laboratories with certified personnel performing the QC tests. Personnel within the industry understand basic QA/QC concepts but need guidance on how to improve the current local standard of care. Improving the accuracy of test results will benefit the overall construction industry but testing is a relatively small part of a much-needed improvement in overall construction practices.

The testing equipment currently in use is adequate for basic QC testing. Most of the equipment observed is less than three years old. There has been a significant investment made in all of the laboratories visited. The laboratory equipment encountered is in need of calibration, and based on the calibration results, may need some level of repair. Even the most elaborate testing equipment is relatively simple and can be easily repaired. Replacement parts are also easy to acquire. There seems to be an impression that equipment with more electronics is better. One lab had two pieces of equipment used to measure the stress and stain of hot mix asphalt samples. The more modern piece incorporated electronic pressure transducers to determine load and relied on linear variable distance transducers [LVDT] to measure displacement. The less modern piece of equipment used simple load rings and dial gauges to determine load and displacement. We were told the more modern piece was not working properly. At this stage in the industry the simpler pieces of equipment will suffice.

Material standards and test methods are not standardized within the industry. For each laboratory visited, different standards and test methods were being used. It is reasonable to assume that EN standards and methods should be adopted for Kosovo to compete in the European marketplace. There is a significant need for updated and translated standards and test methods. Organizations that publish the standards are constantly revising the standards and it is an important part of any QC program to keep the standards and methods current. Laboratory personnel are concerned that they are not applying and performing the material standards and test methods correctly.

The level of internal QC being practiced by laboratories is low to non-existent. Laboratories need to be trained in industry accepted internal QC procedures such as continual personnel training programs, proficiency sample testing, routine maintenance and calibration of test equipment, and third party assessment of test methods, facilities, and record keeping. The understanding and adoption of currently accepted industry QA/QC programs is, at a minimum, two years away.

The Assembly of Kosovo has adopted a law requiring testing laboratories be accredited [UNMIK Regulation No. 2006/15]. Based on discussions with the Head of Accreditation, the government is in the process of establish requirements for individuals who will be trained to asses and accredit testing laboratories.

The responsibility of KCBS and USAID will be to facilitate and expose all sectors of the Kosovo construction community [architects, engineers, contractors, and material suppliers] to current EN material standards, test methods, QA/QC program implementation; QA/QC based business practices, and construction practices that will result in higher quality and safer roads and buildings. To this end it is recommended that KCBS organize a Conference in which sessions are devoted to Pavement Construction, Portland cement Concrete and Hot Mix Asphalt.

In addition, the government should be convinced that initiating a program to accredit laboratories will be prohibitively expensive and that an oversight position will be more beneficial to the government, construction industry, and the people of Kosovo. The oversight should consist of establishing a list of acceptable accreditation agencies [i.e. the United Kingdom Accreditation Service] and making sure that agencies performing testing services on government funded projects are accredited by one of the approved agencies.

FIELD ACTIVITIES TO ACHIEVE PURPOSES

There were numerous field trips for the purpose of observing laboratories, material supplier facilities and practices. Discussions were held with individuals involved in the testing industry to establish the level of internal and external QC programs. Reports of the field trips are presented in Annex A.

TASK FINDINGS AND RECOMMENDATIONS

Findings:

- The current focus of the KCBS is providing better construction of roads and highways. To this end the Road Construction Association of Kosovo has been formed.
- The overall road construction process is in need of modification. The perception is that poor quality roads are the result of poor quality materials. The materials may be contributing to the poor quality but the methods of construction need to be improved as well.
- The University of Pristina seems to be the industry standard for testing. There is a general feeling throughout the industry that test results reported by the University of Pristina are not accurate.
- The existing equipment currently in use in all of the operations visited is adequate to provide QC testing and is relatively new and in good working condition.
- The equipment, industry wide, is in need of calibration. The Road Contractors Association of Kosovo (RKAC) should organize and coordinate an equipment calibration visit from a reputable company that routinely calibrates, verifies and maintains test equipment (Controls, or ELE International). The cost of the visit (approximately $10,000 US) should be shared by all participants. The following equipment is in need of calibration or verification:
    - Compression Machines and bearing plates
    - Load rings
    - Balances
    - Thermometers
    - Large capacity batch scales
    - Ovens
    - Molds
- A complete set of construction material standards and test methods needs to be translated and standardized to the European Norms.
- The personnel responsible for testing are competent but need training. Everyone interviewed expressed concern about whether they are applying the standards and test methods correctly. Training is paramount and all of the individuals interviewed are eager to learn.

- Everyone interviewed would like to see quality specified in construction documents.
- The testing industry is in a good position to start promoting quality based selection of services even though certification and accreditation may be years away.

Recommendations:

The following are recommendations, in order of importance, for the implementation of the presented tasks. The recommendations are listed as short, medium, and long term goals.

A. Short term goals (0 to 3 months)

- Make available current EN standards for relevant materials and test methods. Architects, engineers, testing laboratories, material suppliers, and contractors should have the opportunity to purchase the documents. A pricing scheme should be established that will ensure all interested parties will have access to the documents.
- Identify proficiency sample programs and assist laboratories in the interpretation of results.
- Have RCAK organize and coordinate a country visit by a qualified company that maintains, verifies, and calibrates laboratory test equipment (Controls, or ELE International). Any company that has a load verification device, scale or other equipment should be eligible for the service. Each laboratory needs to establish and submit a list of testing equipment held by the laboratory. This will assist the calibration company in determining what equipment is needed for the calibrations. The list should contain the following information:
    - Type of equipment
    - Manufacturer
    - Serial number
    - Capacity, i.e. 3000 Kn for compression machines
    - Date placed in service [if known]
- Create a technical committee within the RCAK. Members should include the testing laboratories currently operating in Kosovo, technically oriented representatives of member firms, representatives of the Ministry or Trade, Ministry of transportation, and the Head of Accreditation. The purpose of the committee should include:
    - Technical education to member firms.
    - Determination of construction methods that improve quality
    - Establish end result construction specifications that benefit both the industry and the people of Kosovo
    - Determine acceptance testing criteria
- Start organizing a construction materials conference (2006 KCMC, “2006 Kosovo Construction Materials Conference”) which will provide education and training on materials, testing, and QA/QC practices. The conference could be held over a three to four day period. Sessions could include presentations on proper construction methods, construction material and associated testing techniques i.e. asphalt + aggregates, concrete + aggregates, and soils. Each session should contain a sub-session on QA/QC practices and procedures including the benefits of certification and accreditation. Speakers should be from Europe and

considered experts with respect to the different construction materials. A draft outline of a syllabus for such a Construction Conference is attached in Annex 2.

- The speakers can be found by contacting the BSI [organizations like BSI are always looking for new members. They are a potential sponsor of the conference.] After the conference the speakers should be prepared to spend at least one day in each of the participant's laboratories or production facilities. This would allow the laboratory personnel an opportunity to learn the latest methods and to find out what equipment may be needed to facilitate additional testing.
- Identify organizations to certify laboratory personnel to EN standards.
- Identify organizations that asses and accredit laboratories i.e. United Kingdom Accreditation Services.

B. Mid term goal (3 to 6 months)

- Hold the conference
- Assist laboratories and producers in establishing appropriate QC programs and documentation for the laboratory based on European Norms. The documentation required is;
    - Quality control manual (Index of Contents for a sample manual example is presented in Annex 3)
    - Training records for all employees
    - Records of calibration and verification for all laboratory equipment
    - Proficiency sample results
    - Internal audit records
    - Procedures needed to verify nonstandard test equipment [if any]
- Develop a certification program for laboratory technicians. The RCAK could become recognized as the body to administer the certification training and testing. The program should mimic the efforts of NAPA [National Asphalt Producers Association) and ACI International. Each of the organizations have certification programs established and these programs can be modified to incorporate the European Norms.

C. Long term goal (6 to 12 months)

- Hold certification classes for aggregates, asphalt, and concrete.
- Assist laboratories in gaining accreditation

Industry training needs to include a QA/QC component. Every seminar, meeting, and document published should contain some level of discussion on QA/QC. The industry needs to promote quality above price to maintain the professionalism of the industry. If the industry does not promote quality then the services provided become commodities.

ECONOMIC RESULTS

Establishing internal quality control procedures is expensive and it is difficult to measure the benefit to the organization. The expense comes in the form of the time necessary to establish the documentation required and modifying test reports to incorporate the information required by the European Norms. In addition there is significant cost in maintaining material standards and test methods [new standards and test methods need to be purchased annually]. Companies should expect to spend between $10,000 and $15,000 Euros a year just on training, calibration, and purchasing of standards and test methods. The actual costs should be established and an annual budget should be established based on a percentage of gross income.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITY

Quality cannot be tested or inspected into a project. Quality control testing is an important part of any construction activity and, as a part of an overall quality program, can contribute to infrastructure and structures that benefit the community.

Quality control is in its infancy in Kosovo. The associations established in the construction community need to promote quality in all facets of construction. The industry can dramatically improve, and measure quality in a short period of time. Future activity needs to focus on implementing project specifications that are specific to the end result quality desired by the investor, and how to measure conformance to the requirements.

A review of two recent road project contracts has shown that quality is mentioned in the contract but it is never adequately defined. The quality standards referenced are Yugoslavian specifications from 1979. Moreover, no design parameters, i.e. plans, were available to the contractor. The design was left to the contractor with no guidance from the government.

The Kosovo construction industry is in need of experts in the field of construction specifications. Based on discussions with RCAK, the government is not in a position to finance the overhaul of the present specifications nor does it have the expertise. The RCAK is in a position to establish and propose revised specifications based on the expert's advice and input from the industry.

The responsibility of KCBS and USAID will be to facilitate and expose all sectors of the Kosovo construction community [architects, engineers, contractors, and material suppliers] to current EN material standards, test methods, QA/QC program implementation; QA/QC based business practices, and construction practices that will result in higher quality and safer roads and buildings.

In addition, the government needs guidance in establishing a system where investors, including it, are responsible for project design and contractors are responsible for the construction of the project to the design criteria. Quality assurance testing is an integral part of this system as a way to measure conformance to the project requirements.

ANNEXES

Annex I	FIELD TRIP SUMMARY REPORTS
Annex II	CONSTRUCTION CONFERENCE – PROPOSED SYLLABUS OUTLINE
Annex III	EXAMPLE QUALITY CONTROL MANUAL FOR QUALITY CONTROL LABORATORIES

ANNEX I: FIELD TRIP SUMMARY REPORTS

Field Trips were made to the following agencies and businesses:

05.22.06	University of Prishtina Civil Engineering Materials Testing Laboratory
05.24.06	Eskavatori Hot Mix Asphalt Plant Ferizaj and Silicapor Plant Doganaj
05.26.06	Ministry of Trade and Industry
05.26.06	OTI Group Concrete Batch Plant
05.29.06	Renelual Tahiri, Prizren
05.29.06	Vellezerit E Bashkuar, Prizren
05.30.06	Papenburg & Adriani, Ferizaj
05.30.06	Proing Laboratories, Pristina
05.31.06	Granit, Istog
06.01.06	Sharrcem (Holcim Group), Kosovo/Macedonia border

FIELD TRIP SUMMARY REPORT

Date of Visit: May 22, 2006
Site Visited: University of Prishtina Civil Engineering materials testing laboratory.
Attending: Valdet Osmani, Jeff Groom, Cene Krasniqi

The purpose of the field trip was to observe the university's construction materials testing laboratory, and the private testing laboratory operated by Cene Krasniqi, to establish the level of sophistication of the local quality control (QC) industry. Our tour included observation of equipment and discussions regarding the testing procedures and within laboratory QC procedures. A summary of our findings is presented below.

University Laboratory

1) The university laboratory is comprised of several separate laboratories specializing in the different construction materials such as concrete, aggregates, bituminous mixtures (asphalt), and soils.
2) The laboratories were of adequate size and clean. There was little activity within the labs with the exception of the bituminous mixtures lab. There was some shuffling of pans from oven to counter top but no testing being performed. Cene Krasniqi indicated the equipment was primarily used to expose students to testing procedures for the various construction materials.
3) The equipment was in good condition but admittedly had not been calibrated or maintained since it was purchased.
4) It is my understanding the testing procedures used are from former Yugoslavia that have been modified to incorporate some German methods.

Private Laboratory

1) Based on the type of equipment observed the laboratory primarily is used to test aggregate and concrete.
2) The laboratory equipment observed in the private laboratory was relatively new and admittedly not calibrated. The reason stated for the lack of calibration was the cost of the services. Based on the number of concrete samples waiting to be tested the level of activity within the laboratory can be considered low. The samples were comprised of mainly concrete. Although equipment was available for the testing of aggregates, the equipment did not appear to be in use and there were no samples of aggregates waiting to be tested.
3) The laboratory has purchased some relatively expensive and sophisticated equipment such as:
    a. Modulus of elasticity frame used to determine the elastic coefficient for concrete. The coefficient is used in the design of structures. Most building codes dictate what the elastic coefficient should be. The equipment is used primarily for research or occasionally concrete that is exhibiting some level of distress in service.
    b. Rebound hammer – The rebound hammer is used to differentiate areas of lower strength concrete within a structure.

c. Pulse-velocity meter – The pulse velocity of concrete is used to determine differences in the density of concrete, crack depth, or the extent of honey-combing within concrete. The methods are used primarily for in situ concrete,
d. Pull-off testing load cell – used to determine bond strength of coatings placed over concrete
e. Metal detection equipment – used to determine the location and spacing of embedded ferrous materials.
f. Blaine Fineness – used to determine the fineness of cement.

These pieces of equipment are typically found in laboratories that provide some higher end testing services. All of the equipment in the laboratory could have been calibrated for the cost of the pulse-velocity equipment.

CONCLUSION

Both laboratories had the equipment needed to provide basic construction materials quality control testing. The equipment was in good condition. There is a need to establish calibration habits within the organizations and to update the standards being used within the laboratories. In addition the test methods used should be updated to incorporate current EN standards and an in-house quality control system should be established in an attempt to provide consisting testing practices.

University of Prishtina Concrete Testing Laboratory

University of Prishtina Asphalt Compaction Hammer

University of Prishtina Soils Laboratory Equipment (consolidation testing)

Private laboratory showing sieves (left), air meter (center), and splitting tensile jig (right)

Private laboratory showing oven and Blaine fineness apparatus (right)

Private laboratory compression test machine

FIELD TRIP SUMMARY REPORT

Date of Visit: May 24, 2006
Site Visited: Eskavatori Hot Mix Asphalt Plant Ferizaj and Silicapor plant Doganaj
Attending: Valdet Osmani, Jeff Groom, Eskavatori employees, Silicapor employees

The purpose of the field trip was to observe the respective laboratories and determine the needs of the laboratory personnel with respect to quality control testing. Our tour included observation of equipment and discussions regarding testing procedures and within laboratory QC procedures. A summary of findings is presented below.

Eskavatori Laboratory

1) The laboratory is comprised of three small rooms housing the sieve analysis equipment, extraction and compaction equipment, and laboratory office and load measuring equipment, respectively. The first two rooms are small but seem to be adequate for the current level of activity. As asphalt production increases the laboratory size will need to be increased.
2) The laboratory was adequately equipped for the testing being conducted. The testing equipment observed is typical for the level of quality control being performed. The equipment was in good working condition.
3) The standards and test methods used were from the former Yugoslavia and were published in the mid to late 1980's.
4) A computer was being used to store historic data and manage current test data.

Silicapor

1) This was a terrific tour of the manufacturing procedure for the Silicapor building blocks. It was obvious in talking with the employees that they are very proud of the facility and their product.
2) The quality control testing of the material is very simple consisting of determining the dry unit weight of the material and the compressive strength. The test equipment in the laboratory consists of an oven, balance, and compression test machine.
3) There was no discussion regarding an in-house quality control plan. The plan would be relatively simple to write and I would encourage the company to develop a plan. In general the plan should contain:
    a. Methods to determine the quality of the raw materials. The laboratory's scope could be increased to provide quality control testing of the raw materials or at the least obtain and track mill certificates from the suppliers of the raw materials.
    b. Determine frequencies for the calibration and verification of the weigh hoppers used to batch the raw materials.
    c. Determine if specifications and test methods exist for the product being produced. A good starting point would be the cellular concrete industry.
    d. Establish quality control procedures for the laboratory to decrease test to test variability.

CONCLUSIONS

The respective industries lack basic quality control programs from what seems to be a lack of exposure to such programs. The laboratory manager at Eskavatori asked if we could help him obtain current EN standards and test methods, and provide guidance on how to apply the standards and test methods. The written standards and test methods should be translated. The laboratories should establish in-house QC procedures to decrease test to test variations and have the laboratory equipment calibrated or verified at regular frequencies, typically annually.

Eskavatori hot mix asphalt plant

Eskavatori Laboratory

Eskavatori Laboratory

Inside Silicapor Plant

FIELD TRIP SUMMARY REPORT

Date of Visit: May 26, 2006
Site Visited: Ministry of Trade and Industry
Attending: Valdet Osmani, Jeff Groom, Hafiz Gara (Executive Chief of KSA), Ibush Luzha (Head of Accreditation), and Sinan Azemi (Director of Construction)

The purpose of the field trip was to meet with ministry personnel to learn more about the new accreditation law and the licensing of contractors and laboratories. A summary of findings is presented below.

1) There now exists UNMIK Regulation No. 2006/15, adopted on April 21, 2006 which requires testing laboratories be accredited by the Kosovo Accreditation Unit.
2) The Ministry of Trade is in the process of determining what qualifications individuals should have to become assessors. The intent is for the Accreditation Unit to provide assessment and accreditation.
3) The Ministry of Trade is in the process of licensing contractors and testing laboratories.

CONCLUSIONS

The Ministry of Trade stated that government accreditation is wide-spread throughout Europe. Typically, industries are responsible for setting these types of requirements. It would be in the best interest of the industry if KCBS recommends to the Ministry to provide only an oversight function with respect to accreditation and not provide the actual assessment and accreditation. There are private companies that can provide the assessment and accreditation. KCBS could also recommend that the Ministry of Trade select the company that will be responsible for on-site assessments and accreditations.

FIELD TRIP SUMMARY REPORT

Date of Visit: May 26, 2006
Site Visited: OTI Group concrete batch plant
Attending: Valdet Osmani, Jeff Groom, OTI employee

The purpose of the field trip was to observe the batch plant facilities and learn more about the ready mixed concrete industry. Our tour included observation of equipment and discussions regarding concrete batch proportions and testing procedures. A summary of findings is presented below.

1) The company has six concrete mixers and two concrete pumps. The batch facility is adequate in size for the level of production. The plant is a central mix plant meaning the concrete is mixed in a central mixer before being deposited into the truck. The batching of materials is semi-automated with a digital display for observing batch weights.
2) The company produces four primary concrete mixes. The concrete mixes are identified based on the target compressive strength. Water reducing and air entraining admixtures are not used. We had a short discussion regarding the benefits of admixtures especially the use of air entrainment. Air entrainment should be used in this area to increase the freeze/thaw durability of the concrete. There appears to be a lack of knowledge regarding modern concrete technology.
3) The plant is on a small lot. The large size coarse aggregate and fine aggregate are stored in separate stock piles. The two intermediate coarse aggregates are stored on opposite sides of the same stock pile. The intermediate sized aggregate is relatively far from the storage bins, which reduces batching efficiency. This is a function of the limited aggregate storage area.
4) The company saves concrete compressive strength reports. All of the testing was conducted by the University of Pristina laboratory. The test results indicate the concrete mixes meet or exceed the target specified strength.
5) There were some inconsistencies noted on the compressive strength reports; mainly two different sizes of test specimens were used 150 mm, and 100 mm diameter cylindrical test specimens.

CONCLUSIONS

The consistency of the concrete produced by the OTI Group is probably consistent because of the limited number of mixes produced, and redundancy in batching procedures. The quality of the overall operation could be increased by training the employees in concrete technology including quality control procedures. The employees are open to learning more about concrete quality.

FIELD TRIP SUMMARY REPORT

Date of Visit: May 29, 2006
Site Visited: Renelual Tahiri Prizren, Kosovo
Attending: Valdet Osmani, Jeff Groom, Renelual Tahiri employees

The purpose of the field trip was to observe the batch plant and laboratory facilities and learn more about the precast/ready mixed concrete industry. Our tour included observation of laboratory equipment, the batch plant operations, and discussions regarding concrete batch proportions and testing procedures. A summary of findings is presented below.

1) The company has two batch plants, one for the precast operation and one for the ready mixed concrete operation. The precast plant is new. Both plants are computer operated. The plants are on opposite ends of the company property.
2) The precast operation manufactures concrete pavers, block, and other small precast items.
3) There has been a significant investment in capital and the operation is very efficient.
4) The laboratory is equipped with new equipment that looks barely used. The equipment has not been calibrated. The laboratory investment is also considerable.
5) The laboratory consists of aggregate testing equipment (L.A. Abrasion, sieve shaker, NaCl for soundness), and the concrete test equipment consists of compression machine, slump cones, and total air content meter.
6) Reportedly EN standards are being used by the laboratory personnel.
7) The concrete materials are typical for the area and test results indicate the materials have relatively high compressive strength 35 – 40 MPa.
8) Freeze/thaw durability is achieved by adding a “waterproofing” admixture (Idrocrete DM) manufactured by Mapei. The product is sold as an internal waterproofing admixture.
9) The employees stated they do test their products but the only specimens in the laboratory were ready mixed concrete cubes.

CONCLUSIONS

The investment in the operation and laboratory is impressive. The company would be well served to have their laboratory equipment calibrated and establish a routine QC testing program based on European Norms. The program should include basic aggregate testing (sieve analysis, abrasion, soundness), and testing of the final precast products for strength and freeze/thaw durability. The frequency of testing should be at least weekly for the routine test and twice yearly for the freeze/thaw testing.

Renelual Tahiri Block Yard

Renelual Tahiri Compressive Strength Machine

FIELD TRIP SUMMARY REPORT

Date of Visit: May 30, 2006
Site Visited: Vellezerit E Bashkuar, Prizren, Kosovo
Attending: Valdet Osmani, Jeff Groom, P and A employees

The purpose of the field trip was to observe the batch plant and laboratory facilities and learn more about the local quality control testing procedures. Our tour included observation of laboratory equipment, the batch plant operations, and discussions regarding concrete additives. A summary of findings is presented below.

1) The company produces precast concrete, pavers, concrete pipe, and other small precast items like curb.
2) There has been a significant investment in capital and the operation is very efficient.
3) The laboratory has basic QC testing equipment except for a compressive strength machine, which is reportedly on order. None of the equipment is calibrated.
4) They use chemical admixtures, including air entraining admixtures in the concrete. This is not the norm in Kosovo. There is one employee Driton, who has spent a lot of time studying concrete, and concrete materials. He obviously likes working with the material and has conducted limited research on self consolidating concrete. With his knowledge and desire to learn he could easily be the industry “expert” on cement based products.
5) The laboratory is using limited EU standards.

CONCLUSIONS

The investment in the operation is impressive. The company would be well served to have their laboratory equipment calibrated and establish a routine QC testing program based on European Norms. Based on the technical expertise of Driton, the company will be able to differentiate itself through technology.

Vellezerit E Bashkuar Laboratory

FIELD TRIP SUMMARY REPORT

Date of Visit: May 30, 2006
Site Visited: Papenburg & Adriani
Attending: Valdet Osmani, Jeff Groom, P and A employees

The purpose of the field trip was to observe the batch plant and laboratory facilities and learn more about the local quality control testing procedures. Our tour included observation of laboratory equipment, the batch plant operations, and discussions regarding contracts and quality paving. A summary of findings is presented below.

1) The company has one hot mix asphalt plant and one concrete batch plant setup in the same yard. Both plants are computer operated.
2) There has been a significant investment in capital and the operation is very efficient.
3) The laboratories are in separate rooms. Internal QC testing is performed for every 1000 tons of asphalt. Concrete is rarely tested for QC purposes,
4) The equipment observed is is relatively old as compared to other material suppliers but is adequate for the QC testing needed. The equipment has not been calibrated.
5) The supplier does not use chemical additives in the concrete.
6) The laboratory uses former Yugoslavia test methods
7) The management of the company would like to see quality specified in project documents. They showed us a typical contract for road building and the quality section was extremely open ended with such requirements as “as the contractor is responsible for building a quality road” but not specifying what “quality road” meant.

CONCLUSIONS

The investment in the operation is impressive. The company would be well served to have their laboratory equipment calibrated and establish a routine QC testing program based on European Norms. The management thinks their products are quality products and would like to have quality specified in the construction/contract documents. Their biggest complaint is that companies with lesser quality keep getting work based on pricing.

Papenburg & Adriani Marshall test machine

Papenburg & Adriani Concrete Testing Equipment

FIELD TRIP SUMMARY REPORT

Date of Visit: May 31, 2006
Site Visited: Granit, Istog, Kosovo
Attending: Valdet Osmani, Jeff Groom, Ismet Loshaj

The purpose of the field trip was to observe the two batch plants and learn more about the local road building industry. Our tour included observation of the aggregate production facility, the asphalt batch plant, and the concrete batch plant. We discussed road building contracts and the lack of design and quality standards. A summary of findings is presented below.

1) The company has one hot mix asphalt plant and one concrete batch plant setup in the same yard. Both plants are computer operated.
2) There has been a significant investment in capital and the operation is very efficient.
3) On average the company produces 3,000 cubic meters of concrete and 25,000 tonnes of asphalt per year.
4) There is no laboratory but the owner expressed interest in purchasing the equipment.
5) The supplier does not use chemical additives in the concrete. He indicated the use of chemical admixtures was based on what the purchaser orders and that purchasers do not want the admixtures due to the additional cost.
6) We read 2 road building contracts. Each contract referrs to 1979 Yugoslavian specifications.
7) We drove two sections of road that were constructed one year ago. Both sections showed no signs of distress.

CONCLUSIONS

The investment in the operation is impressive. The company would be well served to establish a basic QC laboratory to monitor the materials produced. The management thinks their products are quality products and would like to have quality specified in the construction/contract documents.

FIELD TRIP SUMMARY REPORT

Date of Visit: May 30, 2006
Site Visited: Proing Laboratories, Pristina, Kosovo
Attending: Valdet Osmani, Jeff Groom, Proing Employees.

The purpose of the field trip was to observe the testing laboratory and establish the level of sophistication of the local quality control (QC) industry. Our tour included observation of equipment and discussions regarding the testing procedures and within laboratory QC procedures. A summary of our findings is presented below.

1) The testing laboratory's equipment is very advanced and new. Some pieces were still wrapped. The laboratory can test aggregates, concrete, asphalt, and reinforcing steel.
2) The laboratories were of adequate size and clean. There was little activity within the lab.
3) The equipment had not been calibrated but the lab did own a load cell used to verify the compressive strength machine. There was no indication the load cell had been verified.
4) It is my understanding the testing procedures used are from former Yugoslavia. The personnel would very much like to see European Norms be accepted but are concerned that the government is not moving fast enough to adopt the norms.
5) Most of the materials tested are brought to the laboratory. They do not sample products in the field. There is little to no information given when samples are delivered.

CONCLUSION

The laboratory is better equipped than most laboratories in the US. The equipment was in good condition. There is a need to establish calibration habits within the organizations and to update the standards being used within the laboratories. In addition the test methods used should be updated to incorporate current EN standards and an in-house quality control system should be established in an attempt to provide consisting testing practices. There is a need for this type of company to be included in the activities of the RCAK.

PROING Laboratories New Asphalt Testing Equipment

PROING Laboratories Compressive Strength Machine

FIELD TRIP SUMMARY REPORT

Date of Visit: June 1, 2006
Site Visited: Sharrcem (Holcim Group), Kosovo/Macedonia border
Attending: Jeff Groom, Isbush and Hafiz from Ministry of Trade

The purpose of the field trip was to observe the testing laboratory in the cement manufacturing facility. Our tour included observation of the cement production facility, and laboratory. We discussed QC testing of cement and internal quality control methods.

1) The company manufacturers cement and is part of the Holcim Group, the largest manufacturer of cement in the world. The plant has been in operation since 1936 and was modernized in 2001. The production is roughly 1 million tones per year.
2) The laboratory has all of the cement testing equipment required to provide QC testing of its product. The lab is similar to other laboratories I've observed in various cement manufacturing plants.
3) Most of the equipment id automated. There were calibration stickers on the equipment but the date was over one year old. The laboratory manager indicated he was due for calibration.
4) The company has strict QC programs.
5) During our visit Isbush asked if Sharrcem could volunteer employees to provide assessment services when needed. The management agreed to hold additional meeting to determine what was actually needed.

CONCLUSIONS

The cement plant is managed by the largest cement manufacturing company in the world. It is reasonable to assume that any QC programs involving the laboratory are handed down from the parent company. The individuals involved in the production department would be good individuals to have in the RCAK. Since the company is quality oriented, principles of the QC programs could be shared with RCAK members.

ANNEX II: CONSTRUCTION CONFERENCE PROPOSED SYLLABUS OUTLINE

PAVEMENT CONSTRUCTION

1) Sub-grade preparation
    a. Equipment needed
    b. Proper techniques
    c. Field testing
2) Sub-base Preparation
    a. Materials
        i. Properties/testing
        ii. Equipment needed
        iii. Proper construction techniques
        iv. Field testing
3) Wearing course
    a. Bituminous Pavement
        i. Construction equipment needed
        ii. Construction techniques
    b. Portland cement concrete
        i. Construction equipment needed
        ii. Construction techniques

PORTLAND CEMENT CONCRETE

1) Concrete Technology
    a. Cement
    b. Aggregates
        i. Fine
        ii. Coarse
    c. Additives
        i. Mineral
        ii. Chemical
2) Concrete Production
3) Construction of concrete flatwork
4) EN Standards for Concrete
5) EN Standards for cement and cement testing

6) EN standards for aggregate and aggregate testing
    a. Concrete testing
        i. Basic QC tests
            1. Slump
            2. Total Air Content
            3. Unit Weight/Density
            4. Compressive strength
            5. Tracking of Test Results
        ii. Laboratory Testing
            1. Mix proportioning
            2. Laboratory Mixing
            3. Concrete project submittals
        iii. Field Testing

HOT MIX ASPHALT

1) Hot Mix Asphalt Technology
    a. Binder
    b. Aggregates
        iv. Fine fraction
        v. Coarse fraction
    c. Additives
2) Hot mix asphalt production
3) EN Standards for Hot mix asphalt
4) EN Standards for binder and binder testing
5) EN standards for aggregate and aggregate testing
    a. Hot mix asphalt testing
        vi. Basic QC tests
            1. reference density
            2. determination of field density
        vii. Laboratory Testing
            1. Mix proportioning
            2. Laboratory Mixing
            3. Hot mix asphalt project submittals
        viii. Field Testing

ANNEX III: QUALITY CONTROL MANUAL FOR QUALITY CONTROL LABORATORIES

MATERIALS LABORATORY
QUALITY CONTROL/QUALITY ASSURANCE MANUAL

CTL/THOMPSON, INC.
DENVER MATERIALS LABORATORY
22 LIPAN STREET
DENVER, COLORADO 80223

CORPORATE OFFICES

CTL | THOMPSON, INC.
7306 South Alton Way
Centennial, Colorado 80112

Prepared By:

Approved By:

Date:

Copy No.:

Revised June 11, 2005

REVIEW SCHEDULE

Date Reviewed	Revisions Made	Reviewer Signature

MATERIALS LABORATORY
QUALITY CONTROL/QUALITY ASSURANCE MANUAL

CONTENTS

SECTION 1.0 INTRODUCTION

One of the primary business objectives of CTL/Thompson, Inc. is to provide geotechnical, materials, and environmental engineering to public, private and industrial clients. Laboratory test results are used to judge the performance characteristics of construction materials. The management of CTL/Thompson thinks it is imperative that tests performed in the laboratories provide reliable and consistent data to help meet project schedules. The purpose of this document is to convey a system to assist the laboratory managers at the central laboratory and branch locations to control the quality of our laboratories.

"Quality" as used herein means:

1. The tests accomplished by the laboratory conform to the test methods specified by standard or contract;
2. The laboratory provides data with minimum test variation when compared with inter-laboratory testing programs; and
3. The assigned test procedures meet client requested schedules.

Tests that are completed days or weeks behind schedule are perceived by the client to be of little value or low quality. When schedules can't be met, the laboratory manager must inform the project engineer. Clients must be advised when test schedules exceed the client's expectations.

1.1 SCOPE OF THE MANUAL

1.1.1 Definition and Terminologies

Definitions and terminologies used in the manual are presented in Appendix A.

1.1.2 Tests Covered by the Manual

Standard tests provided by the laboratory are shown on Section 1.2.

1.1.3 Issue, Distribution, and Maintenance of the Manual

1.1.3.1 The laboratory/quality assurance manager is responsible for the issue, review and updating

of the Laboratory Quality Manual. Engineers will assist the laboratory manager as needed to prepare necessary sections within the manual.

1.1.3.2 The Quality Assurance/Quality Control manual will be available to all employees concerned. The distribution of the manual will be controlled with a distribution list. The purpose of this control is to assure that changes are distributed to recipients of the manual when necessary.

1.1.3.3 The laboratory/quality assurance manager is responsible for the timely, periodic review of the manual to ensure that it reflects current operating conditions. The review will be performed annually.

1.2 TESTS PROVIDED BY THE LABORATORY

TEST STANDARDS	TITLE
CONCRETE:	
AASTO T 141/ ASTM C 172	Standard Practice for Sampling Ready Mixed Concrete
AASHTO T 19/ ASTM C 143	Test Method for Slump of Hydraulic Cement Concrete
AASHTO T 121/ ASTM C 138	Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
AASHTO T 196/ ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
AASHTO T 152/ ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 1064	Test Method for Temperature of Freshly Mixed Portland Cement Concrete
AASHTO T 23/ ASTM C 31	Practice for Making and Curing Concrete Test Specimens in the Field
AASHTO T 126/ ASTM C 192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
AASHTO T 22/ ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
AASHTO T 97/ ASTM C 78	Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
AGGREGATES:	
AASHTO T 88/ ASTM C 136	Particle Size Analysis of Soils
AASHTO T 40/ ASTM C 117	Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T 85/ ASTM C 127	Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
AASHTO T 84/ ASTM C 128	Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

AASHTO T 21/ ASTM C 40	Test Method for Organic Impurities in Fine Aggregate for Concrete
AASHTO M 92/	Wire-Cloth Sieves for Testing Purposes
AASHTO T 19/ ASTM C 29	Test Method for Unit Weight and Voids in Aggregates
AASHTO T 96/ ASTM C 131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
AASHTO T 104/ ASTM C 88	Test Method for Soundness of Aggregates by Use Of Sodium Sulfate or Magnesium Sulfate
AASHTO T 176/ ASTM D 2419	Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

CEMENT:

AASHTO M 152/ ASTM C 230	Specification for Flow Table for Use in Tests of Hydraulic Cement
AASHTO T 106/ ASTM C 109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Or 50-mm Cube Specimens)
AASHTO T 129/ ASTM C 187	Test Method for Normal Consistence of Hydraulic Cement
AASHTO T 131/ ASTM C 191	Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
AASHTO T 137/ ASTM C 185	Test Method for Air Content of Hydraulic Cement Mortar
AASHTO T 153/ ASTM C 204	Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus
AASHTO T 154/ ASTM C 266	Test Method for Time of Setting of Hydraulic Cement Paste by Gilmore Needles
AASHTO T 162/ ASTM C 305	Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistence
AASHTO T 186/ ASTM C 451	Test Method for Early Stiffening of Portland Cement (Paste Method)
AASHTO T 192/	Test Method for Fineness of Hydraulic Cement by

ASTM C 430	The 45-μm (No. 325) Sieve
ASTM C 91	Specification for Masonry Cement
ASTM C 778	Specification for Standard Sand

SECTION 2.0 ORGANIZATION AND TRAINING

2.1 IDENTIFICATION

This manual is prepared for the materials laboratory of CTL/Thompson, Inc. at its central office.

2.2 FIELD OF ACTIVITY

CTL/Thompson, Inc. is a consulting engineering firm practicing in geotechnical engineering, materials testing, construction observation, and environmental engineering. The company has offices in the states of Colorado, Wyoming, and Texas with principal office at 7306 South Alton Way Centennial, Colorado 80112. The names of the principal officers and directors are listed below:

Chief Executive Officer:	Ronald M. McOmber
President:	Orville R. Werner
Vice-President:	Jeffrey L. Groom
Vice President:	Penny Leslie

The organizational chart is presented in Appendix B.

Each office has laboratories providing testing services. These testing services are used by our clients for engineering, research, and as quality control for their construction projects. The materials laboratory is staffed and equipped to support the projects that require construction materials testing and observation services.

2.3 ORGANIZATION OF THE LABORATORY (Staff)

The materials laboratory is under the supervision of a registered professional engineer who is a full-time employee of the firm having at least 5 years' engineering experience in the testing of construction materials. At the Denver office, the materials laboratory is under the technical supervision of the Senior Principal Engineer (Orville R. Werner II) (see organizational structure on Appendix B). The Principal Engineer (Jeffrey L. Groom) (also the laboratory manager) directly supervises a laboratory supervisor (Phillip Jones), a field supervisor (Phillip Jones), coordinates daily work, tracks the laboratory schedules and has overall responsibility for quality assurance in the laboratory. The laboratory supervisor is responsible for seeing that work is performed in a timely manner and is responsible for the check of calculated test results. In the absence of the laboratory manager, the laboratory supervisor becomes responsible for the quality assurance in the laboratory. The laboratory is normally staffed with two full-time Materials Technicians who perform routine materials testing. Personnel of materials field services also work regularly in the laboratory when their field assignments allow. Operational position descriptions are presented in Appendix I. A resume (biographical sketch) is maintained by the laboratory manager in the individual=s technical personnel file.

Depending upon the size of the branch office, it may have a similar structure to the Denver office. In the small offices, the office manager also acts as the laboratory manager and the laboratory personnel may also work in the field.

2.4 TRAINING PROGRAM

2.4.1 Laboratory personnel should have appropriate training and qualification for the tests they are performing.

2.4.2 The laboratory manager is responsible for providing the required training to the personnel and maintaining the training records.

2.4.3 The training program for the laboratory staff will include technical issues (such as performing tests, data reduction, calibration and maintenance) as well as education for safety, loss prevention program, Workmen's Compensation, and hazardous material safety. The training will be updated annually to achieve the continued competence of laboratory personnel.

2.4.4 The training criteria will be based on published standards such as ASTM, AASHTO, or State requirements.

2.4.5 Employees will be considered ATrainees@ until the appropriate certification, i.e. ACI

Field Level 1, or Laboratory Level I, is achieved. After achieving the certification, the employee is considered an Engineering Technician I.

2.5 TRAINING METHODS

2.5.1 <u>Guidance Training</u>

The training will be conducted by observing an experienced and qualified co-worker perform a test and then performing that test under the direct supervision of an experienced co-worker or laboratory supervisor.

2.5.2 <u>In-house Training</u>

This is classroom study held during working hours. Courses may be given by qualified laboratory personnel or by watching videotapes.

2.5.3 <u>Outside Part-Time Courses</u>

The laboratory encourages continued education in job-related areas and encourages the employees to seek certification through NICET, ACI, and AWS.

2.6 TRAINING EVALUATION

The following methods can be used to evaluate the effectiveness of the training program:

2.6.1 <u>Testing</u>

A written or oral test following training can be given in order to assess the effectiveness of the training effort. The instructor may give a pre-training test in order to determine the level of knowledge prevailing prior to the start of the training courses.

2.6.2 <u>Proficiency Checks</u>

In order to measure skill improvement, trainees can be assigned work tasks or perform comparison tests to indicate proficiency.

2.7 LOSS PREVENTION

Various audio tapes are available to train laboratory personnel with respect to professional liability loss prevention techniques. These tapes developed by ASFE are endorsed by the company as an excellent training aid. The laboratory manager may require each lab technician to listen to the tapes. The entire tape series should be heard by each employee annually. The technician's personnel file should indicate the completion of this training.

2.8 RECORDS OF TRAINING AND QUALIFICATION

Laboratory personnel will have records of training maintained in the laboratory and in the personnel file. The laboratory manager will keep a record of qualified personnel for each type of testing.

FIGURE 2.1

TECHNICIAN TRAINING RECORD

Technician Name: ________________________ Start Date:

SECTION 3.0 CONTROL OF TEST EQUIPMENT

3.1 EQUIPMENT INVENTORY RECORDS

Inventory records of major laboratory test equipment (Aggregate and Concrete Test Equipment Notebook) provide control of the calibration and maintenance of the equipment. An inventory list of the major equipment used by the laboratory will be maintained in a log or file. The inventory records will be completed and updated annually by the laboratory manager.

3.2 CALIBRATIONS

The calibration of laboratory instruments will be conducted either on a periodic, scheduled basis or prior to each use. The supervisor in each division shall determine a method to maintain equipment calibration at the appropriate intervals. The method can be electronic, i.e. computer software, or manual, i.e. a 12 month folder, containing a list of equipment which needs to be calibrated that month. The equipment calibration record is kept in the appropriate notebook. Calibration of instruments and gages should have traceability to National Institute of Standards and technology (NIST) standards.

3.2.1 Calibration Intervals

Instruments and gages will be assigned an established calibration interval . The calibration interval will be established based on the equipment manufacturer's recommendations, requirements of the project, frequency of testing and experience. The calibration intervals may be adjusted from time-to-time, based on experience gained through use over a period of time, as evidenced by data from calibration records.

3.2.2 Calibration procedures

When in-house calibration or verification is performed, written step-by-step procedures for calibration of test equipment will be prepared in order to reduce possible measurement inaccuracies due to differences in techniques, environmental conditions, personnel changes, etc. These calibration procedures may be prepared by the laboratory, or based on published standard practices or written instructions that accompany the purchased equipment. Calibration procedures will be kept in the calibration notebook and will be maintained for each piece of equipment. Accessory equipment for calibration will be available and in good condition.

3.2.3 Reference Standards

Where the calibration of equipment is not traceable, i.e. ovens, reference standards shall be used for calibration purposes. Reference standards held by the laboratory shall be used for calibration only, unless it can be demonstrated that their performance as reference standards has not been invalidated. Reference standards should be calibrated and have traceability to NIST standards.

3.2.4 Calibration Records and Labeling

Calibration records or reports for each major equipment will be maintained by the laboratory/quality assurance manager in a notebook or file. These records shall contain evidence that the calibration is traceable. Equipment that is calibrated shall have sticker placed on the equipment indicating the calibration date, and the date of the next calibration. Equipment which has been subjected to overloading or mishandling, or which gives suspect results, or has been shown by verification or otherwise to be defective, shall be taken out of service and identified until it has been repaired and calibrated. Equipment that does not have a current calibration shall have an identifying mark indicating it is not calibrated. These pieces of equipment shall not be put into service until they have been calibrated.

3.3 MAINTENANCE

The laboratory will conduct orderly, positive actions (equipment cleaning, lubricating, reconditioning, adjusting, and/or testing) to prevent instruments or equipment from failure during use.

3.3.1 Maintenance Schedule

The laboratory/quality assurance manager will prepare and implement a maintenance schedule (Fig. 3.1) for laboratory test equipment. The maintenance schedule will be based on the purpose of testing, environmental influences, physical location of equipment, and the level of operator skills.

3.3.2 Maintenance Tasks

Checklists should be prepared to specify maintenance tasks according to the maintenance instructions provided by manufacturers of the equipment or based on the laboratory's documented experience with the equipment.

3.3.3 Maintenance Record

A record of preventive maintenance and service checks will be maintained by the laboratory/quality assurance manager. The records may include the manufacturer=s name, serial number, the date received and placed into service, condition when received, copy of operating instructions, dates and results of calibrations, details of the maintenance performed, and a history of any damage, modification or repair.

3.4 PURCHASING OF EQUIPMENT

Quality of the equipment affects the quality of test data and productivity of the laboratory. Prior to purchasing equipment, the laboratory manager will evaluate the technical and quality requirements of the equipment. The manufacturer should provide the laboratory manager with the equipment calibration records that are traceable to NIST standards and procedures, or instructions for routine preventive maintenance and calibration. The manufacturer should be capable of providing prompt services for repair, maintenance and calibration of the equipment. Newly purchased equipment will be verified or calibrated prior to use.

FIGURE 3.1

TEST EQUIPMENT CALIBRATION/MAINTENANCE RECORD

DESCRIPTION:	
EQUIPMENT SERIAL NO.:	MANUFACTURER:
CALIBRATION FREQUENCY EVERY:	CALIBRATION PROCEDURE OR STANDARD:

DATE CALIBRATED	CHECKED BY	RESULTS/CORRECTIONS

SECTION 4.0 ENVIRONMENT AND FACILITIES

4.1 ENVIRONMENTAL CONTROL

4.1.1 The environment in the working areas of the laboratory will be controlled by commonly used heating, ventilating, and air-conditioning equipment. The materials laboratories (except fog and 50% humidity rooms) have no special requirements beyond normal good housekeeping practices.

4.1.2 Masks, gloves and hoods with ventilation fans will be used when performing chemical tests or handling samples with hazardous vapor, smell or dust. Hoods will be checked for proper operation prior to each use.

4.1.3 Hazardous chemicals will be properly marked and stored in an appropriate place. Material Safety Data Sheets will be maintained in the MSD sections of the Hazardous Materials Communication Program.

4.1.4 Strip chart or similar type recorders of temperature will be available in the laboratory for certain types of testing that require close control of temperature.

4.2 FACILITIES

4.2.1 Laboratory management will designate adequate spaces for sample receiving, processing and storage. Tests shall not be performed in areas where materials, environment or equipment affect the test results.

4.2.2 A quiet area with a desk, chair, calculator or computer, and drafting tools will be provided for test data reduction.

4.2.3 Test equipment will be spaced to prevent interference. Dangerous equipment such as compression test machines for rock or concrete will have a cover or screen to protect the operator and adjacent equipment.

4.2.4 First aid kits, oxygen and fire extinguishers will be furnished at convenient places in the laboratory. Details of safety precautions in the company safety manual will be followed.

4.2.5 The laboratory will have an appropriate security/alarm system.

SECTION 5.0 TEST METHODS AND PROCEDURES

5.1 DOCUMENTATION OF STANDARD TEST METHODS

5.1.1 It is the policy of the company that tests and equipment will be in accordance with standard procedures of the American Society for Testing and Materials (ASTM) or other published standards such as the Earth Manual of Bureau of Reclamation, laboratory manual of The Corps of Engineers, and Colorado Department of Transportation as required by specific contracts.

5.1.2 The standard test methods for each test will be documented as shown in Section 1.2. The publications of the test procedures will be readily available in the office for laboratory personnel.

5.2 SELECTION OF TEST PROCEDURES

It is the responsibility of the project engineer or laboratory manager to determine if the test requested can be performed and select the appropriate test procedures. The project engineer will review the project scope (or proposal) and visually inspect the samples prior to assigning the tests.

5.3 NON-STANDARD TEST METHODS AND PROCEDURES

Due to project requirements or at client's request, nonstandard test methods or procedures may be adopted. Any nonstandard test method or procedure will be documented and validated as per section 5.4. The documentation of nonstandard test methods and procedures will be maintained in the job file and recorded in the laboratory log book.

5.4 VALIDATION OF NON-STANDARD PROCEDURES

It is the responsibility of the project engineer and laboratory manager to validate the nonstandard test methods and procedures. Validation will include the evaluation of the technical correctness, data completeness, capacity of test equipment, skill of operator and cost. Nonstandard methods and procedures will be accepted by the client prior to use. Written documents will be prepared and maintained in the job file for the adopted nonstandard methods and procedures.

SECTION 6.0 SAMPLE HANDLING, STORAGE AND DISPOSAL

6.1 SAMPLING PROCEDURES

Sampling programs will be set up by the project engineer to specify sufficient, representative and appropriate samples be obtained. Sampling procedures will follow the appropriate ASTM standards such as ASTM C 172 and ASTM D 75 or other published standards.

6.2 RECEIPT AND LOG-IN PROCEDURES

6.2.1 Concrete specimens shall not be transported to the laboratory until at least 8 hours after final set. During transportation, protect the specimens with suitable cushioning to prevent damage from jarring. The specimens will also be protected from freezing and moisture loss during transporting. Transportation time shall not exceed 4 hours.

6.2.2 Samples will be placed at the designated receiving area of the laboratory. Samples will be labeled with ticket number or Job number and other pertinent information to identify the sample.

6.2.3 Samples brought in or furnished by the client will be received by the laboratory manager or project engineer. The following information will be obtained when receiving samples: client's information, project name, documentation of client's sample procedures and date, tests required, purpose of testing and requested testing schedule. Whenever possible, the quantity and conditions of the samples will be checked with the client to determine their suitability for the requested tests. The client will be informed immediately if the conditions of the received samples are not suitable for the requested tests.

6.2.4 When necessary a laboratory testing program sheet will be completed by the project engineer or laboratory manager to initiate laboratory testing.

6.3 STORAGE AND DISPOSAL

6.3.1 Samples that remain after testing will be sealed and stored in the designated storage area for at least 30 days (or a time period specified by the client) after the test report is published. The storage area will be such that contamination or damage to the test samples will not occur. Further storage or transfer of samples can be made at the client=s expense upon written request.

6.3.2 Where items must be stored under specific environmental conditions, these conditions shall be maintained and monitored.

6.3.3 Prior to the disposal of the samples, the project engineer will be informed to determine if further retention of the samples has been requested.

6.4 SAMPLE MANAGEMENT

The following procedures will provide tracking of samples throughout the testing system.

6.4.1 Samples selected for laboratory testing will be placed in the area designated for specific tests.

6.4.2 After setting up the test, the testing program sheet will be marked to indicate the sample is under testing.

6.4.3 If splitting of the sample is needed, each split sample will be labeled.

6.4.4 Standard forms will be used to record test data. Sample identification, set-up date, sample description, operator's name, test instruction, container's number and test equipment will be recorded on the test data form to track the samples.

6.4.5 Samples under testing will be concentrated at designated locations for each type of testing.

6.4.6 When tests are completed, test data sheets will be attached to the testing program sheet. The test items on the testing program sheet will be marked to indicate that testing is completed.

SECTION 7.0 TEST RESULTS

7.1 VERIFICATION OF TEST RESULTS

All the test results will be reviewed by the laboratory manager to screen for any abnormal data based on previous experience and the data base established from previous tests. The project engineer, who will prepare the test report, will also review the test data. If questionable test results are discovered, the test records, calculations and procedures will be checked to verify the validity. Verified invalid test data will not be reported and retesting will be performed if necessary.

7.2 TEST REPORTS

7.2.1 The test report will be prepared by the project engineer or laboratory manager. The report will contain such information as job number, project name, data and type of sample received, tests performed, test methods and procedures used, test results, and recommendations. Standard printed forms, figures and tables will be used to present the test data. The report will be reviewed by a principal of the firm.

7.2.2 The report shall include the following information; a title, name and address of the laboratory and client, the job number, description of item tested, condition of the item, date of receipt and testing, test method used, sampling procedure, any deviations from the test method, results, a signature of the party responsible for the results, a statement indicating the results relate only to the items tested, and test results of subcontractors where used.

7.3 REVISION OF TEST REPORTS

When an error or quality problem is discovered in a test report, the laboratory manager and project engineer will be informed immediately. The cause of the problem will be investigated to determine corrective measures. If re-sampling or retesting is necessary, it will be performed and given first priority. If the report has been published, the client will also be informed when necessary. The published test reports may be recalled if feasible. A revised test report will be issued as soon as possible and be marked as "revised".

7.4 COMPUTER DATA PROCESSING

The person performing computer data processing must understand how the program works and be able to make manual calculations to verify the computer output. When a new program is set up for test data reduction, it will be thoroughly tested and checked with hand calculations before installation in the computer system. Input data will be checked. Routine test data processed by computers will be randomly checked with manual calculations. Computer programs for test data reduction will be documented and the documentation updated when the program is revised.

7.5 TRANSMISSION OF TEST RESULTS

Where clients require transmission of test results by telephone, telex, facsimile or other electronic or electromagnetic means, confidentiality of test results is to be protected. A final report shall be provided via U.S. Mail or appropriate delivery means.

7.6 SYSTEM AND PROCEDURES OF RECORD MANAGEMENT

All test data including raw and reduced data and the test report will be kept in the job file. The job file will be handled in accordance with the established company filing system. Active files will be kept in the office. Inactive files will be retained in locked storage for 10 years before disposal.

7.7 SECURITY OF RECORDS

Test data and job files will only be accessible to authorized personnel. File storage will be locked. Computers used to reduce data and produce reports will be password protected. The original of the test report will only be used for reproduction and not for other purposes. Test results will only be discussed with the client unless client permission is given to discuss results with others.

7.8 HISTORIC FILE OF TEST METHODS

Test methods may be changed due to technological advances or revisions of the standards. Filing of the past test methods provides a valuable continuity of test methods' development. Past test methods should be maintained in the inactive files whenever feasible.

SECTION 8.0 DIAGNOSTIC AND CORRECTIVE ACTIONS

8.1 QUALITY PROBLEMS AND CORRECTIVE ACTION

8.1.1 Quality problems can be identified through routine supervision of laboratory work, review of test data, quality system auditing, and participation in inter-laboratory testing programs.

8.1.2 When a quality problem is discovered, the laboratory supervisor and associated personnel will be informed. The occurrence of the quality problem will be noted in a log. The cause(s) will be investigated to determine whether the problem is due to the sample, equipment, test procedure, data reduction or operator error.

8.1.3 Based on the results of the investigation, the laboratory manager will determine whether corrective action should be taken, if a new sample is required, if the client should be notified, if retesting is necessary, or whether the results should be confirmed by independent third party testing.

8.1.4 To prevent the recurrence of the problem, the laboratory manager will determine whether test equipment needs more frequent calibration and maintenance, if additional training is necessary, or laboratory quality control procedures should be revised.

8.1.5 The results of the investigation and adopted corrective action will be documented and maintained in the job file. In the case of corrective actions taken to satisfy the comments or suggestions of outside auditors from accrediting organizations, detailed explanations will be given of measures taken to prevent recurrence of the problem.

8.2 CLIENT COMPLAINTS

Technical complaints and negative comments from clients will be turned over to the Project Engineer or laboratory manager for review, handling, and reply. In each case, the individuals concerned will be advised as to the nature of the complaint. Corrective measures will be initiated when necessary. Upon completion of corrective action and the finding of a solution to the problem, the laboratory manager will advise the client accordingly. The test report will be revised per section 7.3 if necessary.

8.3 INTER-LABORATORY TESTING PROGRAM

To check the proficiency of laboratory personnel, our firm has participated in the CCRL and AASHTO inter-laboratory testing programs annually. An inter-laboratory testing program can also be conducted internally between our laboratories. Results of the testing program can be used to determine if any corrective actions are needed to improve the quality system of the laboratory. The records of the inter-laboratory testing program will be maintained by the Quality System Manager.

8.4 INTERNAL QUALITY SYSTEM AUDITS

Quality system audits can be performed internally between laboratories or by a cognizant accrediting organization. Internal audits can be conducted alternately between laboratories with the laboratory managers auditing the other laboratory's quality system. The audit should be performed every 6 months and shall include a review of proficiency sample reports, on-site inspection reports, external quality system evaluation reports, equipment calibration, verification and inspection reports, and technician training records. Results of each audit will be maintained in a notebook.

SECTION 9.0 SUBCONTRACTING

9.1 CONDITIONS FOR SUBCONTRACTING

Outside laboratories or agencies can be used on a contract basis to provide testing or calibration services which are beyond the capabilities of this laboratory.

9.2 QUALITY ASSURANCE IN CONTRACT LABORATORIES

Each contracted laboratory will maintain its own internal quality assurance system. The capability of the contractor to maintain a high quality of work will be evaluated and weighted heavily as a part of the subcontractor selection process. Each major subcontractor will be reviewed on a yearly basis to review and document the contractor=s internal quality assurance system. Where subcontractors participate in interlaboratory proficiency programs, copies of result summaries and corrective actions will be maintained. "Audit" samples can be furnished to each new contracted laboratory to evaluate its work quality.

9.3 LEASED EQUIPMENT

Quality of the leased equipment affects the quality of test data and productivity of the laboratory. Prior to leasing, the laboratory manager will evaluate the equipment's technical capabilities and other quality requirements. The equipment should be well maintained and have calibration records that are traceable to NIST standards. The leasing company should be capable of providing prompt services for repair, maintenance and calibration of the equipment. Generally, the company avoids leasing except in special circumstances.

SECTION 10.0 OUTSIDE SUPPORT AND SUPPLIES

10.1 CONDITIONS FOR OUTSIDE SUPPORT AND SUPPLIES

Where outside support and supplies are required for testing, only services and supplies of adequate quality shall be used. Newly purchased equipment and consumable goods shall not be used until calibrated or otherwise verified as complying with the standard specifications for the tests concerned. Calibration records of the equipment and goods used shall be documented and maintained.

Appendix A

DEFINITIONS AND TERMINOLOGIES

Quality--Quality as used herein means:
1. The tests accomplished by the laboratory conform to the test method specified by standards or contract;
2. The laboratory provides data with minimum test variation when compared with inter-laboratory testing program; and
3. The assigned test procedures meet client requested schedules.

Quality assurance--for laboratories, the activity of providing the evidence needed to establish confidence that data provided by a laboratory meet the standards adopted by the company.

Quality control--for laboratories, the process through which a laboratory measures its performance, compares its performance with standards, and acts on any differences.

Quality manual--a document stating the policy, system and practices used by an organization to maintain quality.

Calibration--the set of operations which establishes, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measurement.

Traceability--the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

Proficiency testing--determination of the laboratory calibration or testing performance by means of inter-laboratory comparisons.

Appendix B

ORGANIZATIONAL CHARTS

APPENDIX C

JOB DESCRIPTIONS OF LABORATORY PERSONNEL

TITLE - PRINCIPAL ENGINEER

WORK PERFORMED: Supervises overall technical operation of materials engineering and laboratories. Provides technical direction for specialized engineering and testing of construction materials.

ADDITIONAL RESPONSIBILITIES: Marketing and client contact.

EDUCATION/EXPERIENCE: College Degree. Ten to fifteen years of field and laboratory experience.

REGISTRATION/CERTIFICATION: Professional Engineer

SUPERVISION RECEIVED FROM: Operating Committee

SUPERVISION EXERCISED TO: Laboratory Manager

TITLE - LABORATORY MANAGER

WORK PERFORMED: Supervises overall operation of materials laboratories. Provides technical direction for specialized testing of concrete and aggregates.

ADDITIONAL RESPONSIBILITIES: Adjusts field and laboratory technician assignments as work loads change. Reviews laboratory test results and calculations. Assists in training of new laboratory technicians. Performs laboratory tests as needed.

EDUCATION/EXPERIENCE: Minimum technical degree (2 year) or high school diploma. Five or more years of field and laboratory experience.

REGISTRATION/CERTIFICATION: Minimum National Institute for Certification in Engineering Technologies (NICET III or IV) or equivalent.

SUPERVISION RECEIVED FROM: Principal Engineer

SUPERVISION EXERCISED TO: Engineering Technician III

TITLE- ENGINEERING TECHNICIAN I (Materials)

WORK PERFORMED: Performs routine laboratory physical properties tests on concrete and aggregate samples. Entry level position.

ADDITIONAL RESPONSIBILITIES: Responsible for performing routine laboratory and field tests on concrete and aggregates using standardized procedures. Performs basic mathematical calculations and reports test results on appropriate forms. Responsible for care of testing equipment and cleaning of laboratory areas.

EDUCATION/EXPERIENCE: High school diploma (or G.E.D.). No experience necessary.

REGISTRATION/CERTIFICATION: None

SUPERVISION RECEIVED FROM: Engineering Tech. II

SUPERVISION EXERCISED TO: None

TITLE - ENGINEERING TECHNICIAN II (Materials)

WORK PERFORMED: Performs routine physical properties on concrete and aggregates. Should have working knowledge of most field and laboratory tests associated with concrete and aggregates.

ADDITIONAL RESPONSIBILITIES: Responsible for performing concrete and aggregate tests using standardized procedures and appropriate forms to report test results. Assists engineers with field investigations and laboratory studies.

EDUCATION/EXPERIENCE: High school diploma (or GED). Two to five years field and laboratory experience.

REGISTRATION/CERTIFICATION: NICET Level II or equivalent.

SUPERVISION RECEIVED FROM: Engineering Tech. III

SUPERVISION EXERCISED TO: Engineering Tech I

TITLE - ENGINEERING TECHNICIAN III (Materials)

WORK PERFORMED: Performs specialized testing and inspection of concrete and aggregates.

ADDITIONAL RESPONSIBILITIES: Responsible for performing tests and inspections using standardized procedures and appropriate forms to report results. Prepares field reports at job site and determines compliance of construction materials with job specifications.

EDUCATION/EXPERIENCE: High school diploma or 2-year technical degree. Three to five years of field and laboratory experience plus technical degree or five to ten years of field and laboratory experience.

REGISTRATION/CERTIFICATION: NICET II or III or equivalent.

SUPERVISION RECEIVED FROM: Laboratory Manager

SUPERVISION EXERCISED TO: Engineering Tech II

Appendix D: References (Annotated Bibliography)

1. "Quality Assurance Manual", by The American Council of Independent Laboratories, 1986.
   American Council of Independent Laboratories (ACIL), 1725 K Street, N.W. Washington D.C. 20006, (202) 887-5872.
   A laboratory management practice manual which contains management considerations, fundamental concepts and elements of quality control and assurance of laboratories. The topics for a quality assurance manual presented in the reference were used for preparing the outline of our manual.

2. "General Requirements for Accreditation", by American Association For Laboratory Accreditation, 1991.

   American Association For Laboratory Accreditation (A2LA), 656 Quince Orchard Road, Gaithersburg, MD 20878-1409, (301) 670-1377.
   The document contains three parts: general requirements for the competence of calibration and testing laboratories, conditions for accreditation, and A2LA accreditation process. Although our manual is not prepared for obtaining accreditation, some of the requirements presented in this reference are considered and included in our manual.

3. "WACEL Quality Assurance Laboratory Accreditation Program Guide", by Washington Area Council of Engineering Laboratories, 2nd Edition, 1985.

   Washington Area Council of Engineering laboratories (WACEL), 8811 Colesville Road, Suite 106, Silver Spring, MD 20910, (301) 588-8668.
   The reference provides detailed procedures for implementing a quality assurance laboratory accreditation program. The information is useful for the preparation of laboratory auditing.

4. "Quality Assurance for Consulting Engineers", ACEC Guidelines to Practice, Volume V, Number 2, 1986.

   American Consulting Engineers Council (ACEC), 1015 15th Street, N.W., Washington, D.C. 20005, (202) 374-7474.
   This reference outlines business and technical practices that have been found conducive to quality assurance. The information is useful for the preparation of peer review.

5. "Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction", The American Society for Testing and materials (ASTM) Standard Practice D3740-88.

   ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, (215) 299-5400.
   The reference provides criteria for use in evaluating the organizational, human resource, and physical capabilities of a testing or inspection agency.

6. "The Deming Management Method" by Mary Walton, 1988.

   G.P. Putnam's Sons, 200 Madison Avenue, New York, NY 10016.
   Dr. W. Edward Deming's theory of management also known as "Total Quality Management" (TQM) has been successfully applied by many Japanese and American businesses and firms. The book presents many unique management concepts such as fourteen points, seven deadly diseases, and some obstacles. Some concepts are very valuable for the inspection, quality control and

management of the laboratory system.

7. "1991 Annual Book ASTM Standards, Section 4, Construction, Volume 04.08", by American Society for Testing and Materials (ASTM).

   ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, (215) 299-5400.
   The publication contains most of the standards of soils tests used by our laboratories. It is an important reference for performing soils tests. Standards may be revised periodically and the book is published annually.

8. "Testing Methods for Evaluating Solid Waste", EPA SW-846, Method 9100, Volume IC, 3rd Edition, 1986.

   Office of Solid Waste and Emergency Response, Washington, D.C. 20460.
   This publication contains the test procedures for performing the Flexible Wall permeability Test which is commonly used for landfill clay liner design.

9. "Earth Manual", U.S. Department of Interior, Bureau of Reclamation, 1980.

   U.S. Government Printing Office, Washington, D.C.
   A technical publication that contains certain test procedures used by our laboratories. It also contains useful information for training and education of laboratory personnel.

10. "The Measurement of Soil Properties in the Triaxial Test", by A. W. Bishop and D. J. Henkel, 2nd Edition, 1962.

    Imperial College of Science and Technology, University of London.
    A technical reference for the calibration, performing, and data reduction and interpretation of various types of triaxial tests. Since ASTM standards only cover one type of triaxial test, this reference serves as a standard and textbook for other types of triaxial tests.

11. "Engineering Properties of Soils and Their Measurement", by Joseph E. Bowles, 2nd Edition, 1978.

    McGraw-Hill Book Company.
    A book used by many engineering colleges for courses of soil mechanics testing. It describes test equipment, procedures, data reductions, and theoretical background for various soil tests. A good reference for training of laboratory personnel.

12. "Terrametrics Point Load Test", by Terrametrics, Inc., 1980.

    Terrametrics, Inc., 16027 W. 5th Ave., Golden, CO 80401.
    The user's manual for the Point Load Test equipment manufactured by Terrametrics, Inc. It contains test procedures, data reduction and engineering application of the test results.

13. "Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation", The American Society for the Testing and Materials (ASTM), Standard Practice C 1077.

ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, (215) 299-5400.
The reference provides criteria for use in evaluating the organizational, human resource, and physical capabilities of a testing or inspection agency.

14. "Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction", American Society for Testing and materials (ASTM) Standard Practice E 329.

    ASTM, 1916 Race Street, Philadelphia, PA 19103-1187, (215) 299-5400.
    The reference provides criteria for use in evaluating the organizational, human resource, and physical capabilities of a testing or inspection agency.

15. AASHTO R 18-04