



AfCAP
Africa Community Access Partnership



Capacity Building and Skills Development Programme for the Laboratories of the Local Government Infrastructure and Transportation Research Centre (LoGITReC) in Tanzania

Operational Laboratory Systems



Authors: M B Mgangira and D Ventura
Council for Scientific and Industrial Research (CSIR), South Africa

CONTRACT REF NO. AfCAP/TAN/2095A

August 2017



The views in this document are those of the authors and they do not necessarily reflect the views of the Research for Community Access Partnership (ReCAP), the CSIR or Cardno Emerging Markets (UK) Ltd for whom the document was prepared.

Cover photo: President's Office, Regional Administration and Local Government in Dodoma, Tanzania

Quality assurance and review table			
Version	Author(s)	Reviewer(s)	Date
1.0	M B Mgangira and D Ventura	N Leta (AfCAP)	12 June 2017
		L Sampson	21 June 2017
2.0	M B Mgangira and D Ventura	N. Leta (AfCAP)	28 August 2017

ReCAP Project Management Unit
Cardno Emerging Market (UK) Ltd
Oxford House, Oxford Road
Thame
OX9 2AH
United Kingdom



Abstract

The Africa Community Access Partnership (AfCAP) is funding a capacity building and skills development project for the Laboratories of the Local Government Infrastructure and Transportation Research Centre (LoGITReC) in Tanzania. The overall purpose of this project is to equip the laboratory of LoGITReC with the necessary skills and additional equipment.

The project will assist LoGITReC to achieve its objective of capacity building and skills development for its staff, to enable the facility to operate as a reference and quality control laboratory for PO-RALG and to support research activities by LoGITReC. The project was designed and planned to be implemented through three main activities, namely: (i) capacitation of laboratory staff, through hands-on training of the technicians in laboratory testing according to the CML Laboratory Testing Manual (2000) of Tanzania and secondment of the Laboratory Manager to an ISO 17025 accredited research laboratory, (ii) development of operational systems for the laboratory and (iii) procurement of additional equipment. This would be followed by preparation of equipment status and serviceability report for existing and new equipment.

This report focuses on Task 2 of the project, which is the development of the operational system for the laboratory and comprises the following:

- Development of documents that provide information on procedures, to ensure that a quality assurance and quality control scheme is in place, a requirement for a facility that must comply with ISO 17025;
- Development of a framework for a laboratory management system to ensure effective and efficient processing of laboratory material records.

Key words

Capacity building, laboratory quality management, laboratory process control, research laboratory, quality assurance.

AFRICA COMMUNITY ACCESS PARTNERSHIP (AfCAP)

Safe and sustainable transport for rural communities

AfCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa. The AfCAP partnership supports knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. AfCAP is brought together with the Asia Community Access Partnership (AsCAP) under the Research for Community Access Partnership (ReCAP), managed by Cardno Emerging Markets (UK) Ltd.

See www.afcap.org

Acronyms

AfCAP	:	Africa Community Access Partnership
CML	:	Central Materials Laboratory
CMRL	:	Central Materials Research Laboratory
CSIR	:	Council for Scientific and Industrial Research
DFID	:	Department of International Development
DID	:	Division of Infrastructure Development
ISO	:	International Organisation for Standardisation
LGA	:	Local Government Authority
LGTI	:	Local Government Training Institute
LoGITReC	:	Local Government Infrastructure and Transportation Research Centre
PO-RALG	:	President's Office, Regional Administration and Local Government
ReCAP	:	Research for Community Access Partnership
TANROADS	:	Tanzania National Roads Agency

Contents

Abstract	3
Key words	3
Acronyms	4
1 Introduction	6
2 Laboratory operational procedures	7
2.1 General	7
2.2 Laboratory standard operational procedure documents	7
2.3 Equipment calibration, verification and internal checks	9
2.4 Proficiency testing scheme	9
3 Development of a Laboratory Work Management System for CMRL	11
3.1 Structure of LoGITReC Lab Work Management System	13
3.1.1 <i>Main functions</i>	13
3.1.2 <i>Job registration</i>	13
3.1.3 <i>Registering samples</i>	14
3.1.4 <i>Other functions</i>	15
3.2 Using LoGITReC Lab Work Management System	16
3.2.1 <i>Functionality and testing of prototype</i>	16
3.2.2 <i>Benefits of LoGITReC Lab Work Management System</i>	16
4 Conclusions and recommendation	17

List of Tables

Table 1: List of Laboratory Operational Standard Procedures	8
Table 2: Recommended Calibration and Verification Frequencies for different Equipment..	23
Table 3: Example of sample register	27

List of Figures

Figure 1: Workflow chart	12
Figure 2: Interface after entering details of work request	14
Figure 3: Interface after entering the details of samples	15
Figure 4: Typical sample flow between the various stores and work areas in the laboratory.	28

1 Introduction

The Africa Community Access Partnership (AfCAP) is funding a capacity building and skills development project for the Laboratories of the Local Government Infrastructure and Transportation Research Centre (LoGITReC) in Tanzania.

The strategy on capacity building is to address issues relating to the individual staff members, infrastructure and the organisation arrangements. Thus this project addresses capacity building through: (i) capacitation of laboratory staff, (ii) development of operational systems for the laboratory, and (iii) procurement of additional laboratory equipment. Issues related to capacitation of laboratory staff at LoGITReC Central Materials Research Laboratory (CMRL), hereinafter referred to as CMRL, have been covered in two separate Task 1 reports. The first report covered training of the CMRL staff at TANROADS-CML in Dar es Salaam. The second report covered the secondment of the Laboratory Manager to an ISO 17025 accredited research laboratory at the Council for Scientific and Industrial Research (CSIR) and hands-on training at CMRL in Dodoma. This report focuses on the development of operational system for LoGITReC.

As per Terms of Reference, it is expected of the research laboratory to have a system in place which meets the criteria for recognition as provider of quality service. As such one of the expected outcomes of this project is an operational system that should be installed at CMRL. This is a tool to strengthen the operational procedures for CMRL to fully function as a road materials testing laboratory, delivering credible test results, and outlining the required criteria for it to function as a reference and research laboratory.

This report is Task 2 output, covering operational system for CMRL, which includes preparation of general protocols/procedures, including guidance for equipment calibration and verification, safety requirements, a proficiency scheme and development of a laboratory management system to ensure effective and efficient processing of laboratory material records.

2 Laboratory operational procedures

2.1 General

An established operational and management system should be in place for a laboratory such as CMRL to function efficiently and effectively as a reference and research laboratory. This is a procedure on how the laboratory will deal with all operations pertaining to the efficient and effective running of the facility, from the handling of incoming samples to the verification of test results and reporting.

The general operational protocols/procedures regulate everyday management of the laboratory. The standardised procedures provide step-by-step instructions and are necessary to ensure consistency in procedures within a laboratory. Aspects that should be covered in standardised procedure include: sample acceptance protocols; test data recording and storage; schedules and procedures for (internal and external) calibration of laboratory equipment; maintenance of the work space and laboratory equipment; and storage and filing of completed work documents.

Laboratories for testing road construction and building materials in Tanzania are not at present accredited by external agencies. The following sections present essential laboratory standard operational procedure documents, prepared for the purpose of ensuring that CMRL has a quality assurance and quality control scheme in place, one of the accreditation standard requirements.

2.2 Laboratory standard operational procedure documents

The procedures for adoption by CMRL are relevant as they are similar to those being used by the CSIR's Advanced Materials Laboratory and have gone through revisions over the years to meet accreditation standard requirements. The relevance of each included procedure was discussed with CMRL Manager while on secondment at the CSIR. The operational procedures form the building foundation for laboratory quality management of CMRL and can be updated accordingly. The documents provide criteria and recommendations in line with requirements for a facility that must comply with ISO 17025¹. The following are technical requirements of ISO 17025:

- **Technical Records:** This covers a record of all raw data, observations, calculations and, request available / completed, records are permanent, corrections legible and authorised, calculations check and that data on computer is protected;
- **Personnel:** There should be proof of competence, appropriate method of determination of competence;
- **Test Methods and Method Validation:** Test method description, controlled copy of Test Method should readily be available;
- **Assurance of Validity of Results:** Method and proof of Inter-laboratory testing with accredited laboratory;
- **Equipment and Measurement Traceability:** This will include maintenance, completed records, description of equipment used in testing, equipment used in verification of testing equipment, equipment used in verification of verifying equipment;

¹ ISO/IEC 17025:2005. General requirements for the competence of testing and calibration laboratories

- **Accommodation and Storage:** To cover accommodation and environmental conditions, monitoring of controlled areas, effective segregation of tests, adequate storage areas;
- **Purchasing Services and Supplies:** Supplies verified prior to use to meet quality criteria as required for the methods;
- **Sampling and Handling of Test Items:** Should uniquely be identified, ensure that there can be no confusion;
- **Reporting of Results:** All relevant information is reported.

The standard procedures/protocols are provided in Appendix A and are to be contained in a designated folder or document holder at CMRL. Table 1 below presents a summary list of the standard procedures provided, related to the above requirements. Each document contains the following:

- Title – description of procedure;
- Purpose, which includes information about the procedure;
- When, frequency of procedure or linkage to another procedure
- Responsibility, designated specific person/in what capacity should be assigned, for implementing;
- Scope, detailed information for the procedure;
- Supporting instructions and forms;
- Name and signatures of approving officials, capacity and dates of approval.

Table 1: List of Laboratory Operational Standard Procedures

Standard Procedure description	Reference
Job Description	LoGITReC-LAB-1
Guidance for Calibration, Verification and intermediate checks	LoGITReC-LAB-2
Identification and Record Keeping of Equipment	LoGITReC-LAB-3
Incoming Samples Administration	LoGITReC-LAB-4
Review of Requests, Tenders and Contracts	LoGITReC-LAB-5
Testing of Certified and In-house Reference Samples	LoGITREC-LAB-6
Competency Assessment: Declaring Personnel Competent to carry out the various test methods	LoGITReC-LAB-7
Safe working procedures in the workplace	LoGITReC-LAB-8
Proficiency Testing	LoGITReC-LAB-9

The purpose of CMRL is to provide laboratory and field testing in support of the research agenda of LoGITReC and at nominal charges to provide services to other government departments, road authorities and the private sector. It will be expected to test, calibrate and verify precision

instruments, gauges, scientific apparatus and other laboratory and field measurement equipment to ensure compliance. The laboratory should therefore, have a system in place which meets the criteria for recognition as provider of quality service. To this end, the laboratory should not only have competent personnel, but also the right equipment that is calibrated, works properly and is well maintained. The laboratory should also show that processes are reliable to ensure validity of results and their accuracy. Equipment calibration requirements and the proficiency testing scheme are specifically highlighted below.

2.3 Equipment calibration, verification and internal checks

In accordance with ISO 17025, the procedure for equipment calibration, verification and maintenance should specify the schedule and requirements for calibration, performance verification and maintenance of the laboratory testing instruments and equipment. An equipment inventory should therefore be in place, providing information on manufacturer and model, serial number or other unique identification and its location. The equipment should be maintained in good operating order and according to manufacturer's maintenance requirements, calibrated and verified before use.

To be compliant with requirements of ISO 17025, calibration records should be maintained and associated with the unique identifier of each piece of equipment. Calibration records should include the following:

- Identity of the item of equipment and software.
- Name of manufacturer.
- Serial number or unique identifier.
- Date of calibration.
- Current location.
- Manufacturer's instructions or a reference to location.
- Reference standard, certified reference material or reference material used for calibration.
- Copies of all reports, results of calibration, and/or certificates of calibration.
- Maintenance plan and due date for the next calibration.
- Identity of the individual performing calibration.

Guidance for calibration, verification and intermediate checks is covered under Procedure LoGITReC-LAB-2. The procedure on the guidance for the calibration, verification and intermediate checks of equipment that should regularly be used in CMRL has also been provided in the report on equipment status and serviceability for existing and new equipment.

2.4 Proficiency testing scheme

The proficiency testing is the evaluation of participant performance against pre-established criteria by means of inter-laboratory comparisons. It is a means by which laboratories can prove their technical competence and the level of operation of their management system. The standards ISO 17025 and ISO 15189² require that laboratories seek confirmation for confidence in their results and

² ISO 15189:2007: Quality Manual and Procedures

organize quality control procedures for monitoring the validity of performed tests. In brief, this involves the monitoring of the participation in inter-laboratory comparisons or proficiency testing programs.

The standards ISO 17025 and ISO 15189, have identified key responsibilities of laboratories participating in a proficiency testing scheme, they include:

- Documentation
- Frequency of participation
- Statistical evaluation of the results
- Corrective actions

An accredited laboratory should take part in proficiency testing on a regular basis and define its frequency of participation. The standards such as ISO 17025, clearly state that a laboratory that cannot prove its test/calibration competence, either via proficiency testing or any other source available to the laboratory, is not allowed to issue results covered by accreditation. The challenge for CMRL to fulfil this condition, is the current situation, regarding ISO 17025 compliance. During the project kick-off meeting, it was established that TANROAD-CML is not ISO 17025 accredited. Mr John Malisa of TANROADS-CML also confirmed that as of April 2017, proficiency testing was not a standard practice in Tanzania, but efforts are being made to coordinate the practice.

The policy of the laboratory regarding the participation in proficiency testing is supposed to be documented in the quality manual or in other documents pertaining to the management system of the laboratory. To this end, it is suggested that in the case of CMRL, the participation in proficiency testing be covered under reference Procedure LoGITReC-LAB-9. By having standard procedures in place, CMRL is most likely to be set ahead of most of the civil engineering laboratories in Tanzania, in fulfilling some of the requirements for ISO 17025, as it will be able to provide proof of the existence of proficiency testing procedure.

3 Development of a Laboratory Work Management System for CMRL

The installation of a fully functional management system at LoGITReC is not only aimed at strengthening the operational procedures for CMRL, but as indicated in Section 2.2, one of the essential requirements of ISO 17025 is the proper keeping of records. Thus the practice of collecting and storing data systematically is essential for the CMRL to fully function, not only as road materials testing laboratory, but also as reference and research laboratory.

Software called “LoGITReC Lab Work Management System” has been developed for CMRL, and is intended to effectively and efficiently process laboratory material records.

Figure 1 shows the work-flow chart as a guide in decision making process, from sample acceptance scheduling, sample preparation, testing and recording of results, filing of completed work documents storage and discarding of samples.

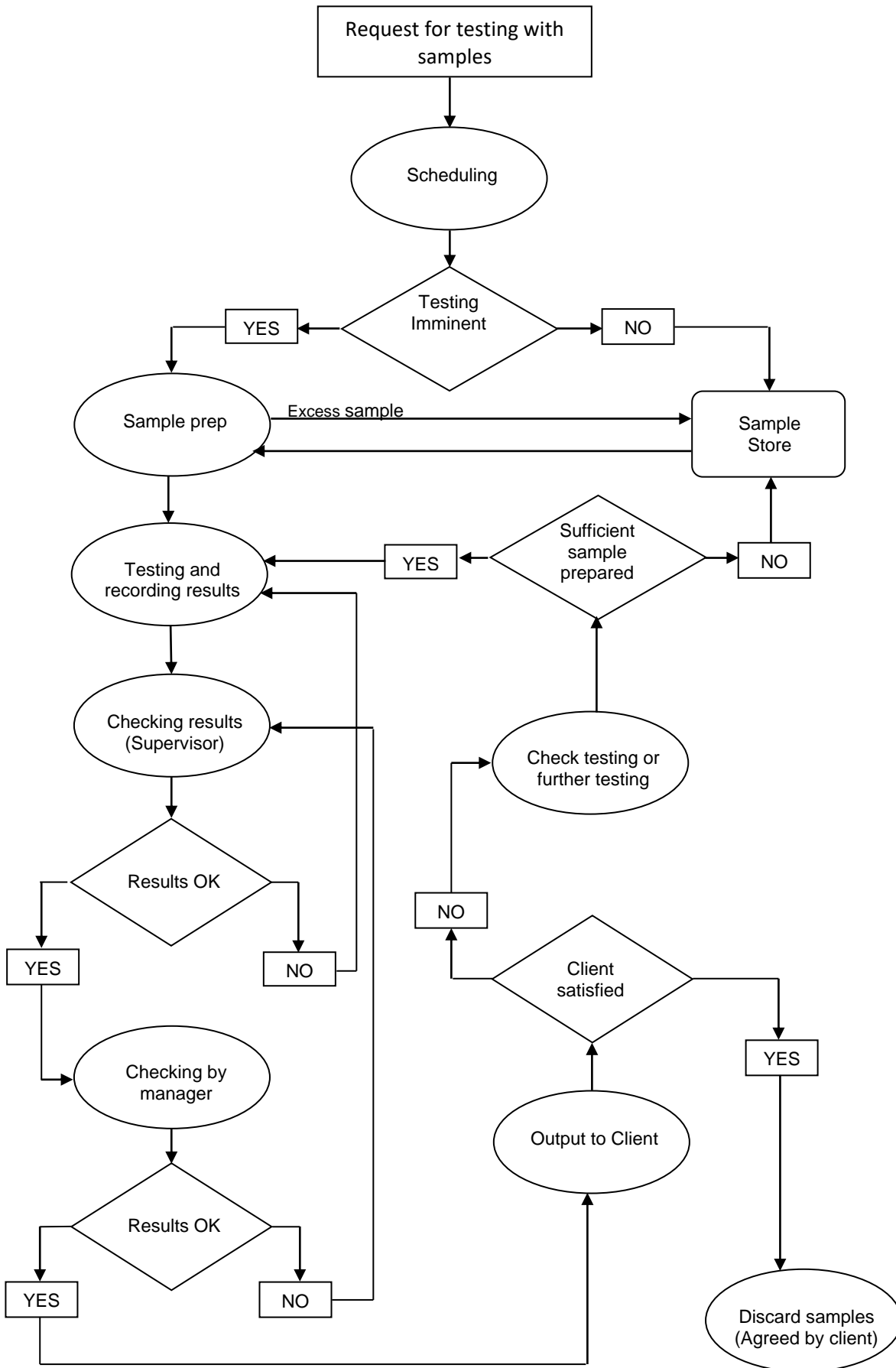


Figure 1: Workflow chart

3.1 Structure of LoGITReC Lab Work Management System

“LoGITReC Lab Work Management System” is an electronic job and materials management system for the administration of incoming work and the samples related to the work. The progress of jobs through the laboratory will be tracked using the system.

3.1.1 Main functions

The program consists of two sections, the first, for registering, incoming work (“Jobs”) and second part for registering sample details. Both these sections have main screens which open when the program is activated. Main screen 1, shown in Appendix B as Figure 5, shows all the details of the jobs that have been entered. Main screen 2, Figure 6, shows the details of the samples that have been recorded.

3.1.2 Job registration

When a request for work is received by the laboratory manager it is entered into the “ LoGITReC Lab Work Management System” program by logging into the program using a password selected by the user. The main screen will open. Selecting the “Jobs” tab will open the main “jobs” screen (screen 1) showing all the details of the registered work, past and present. Selecting the “jobs/samples” tab on the main menu on top will open a “jobs” pop-up screen, shown in Figure 2.

The fields that need to be filled to register the job details are:

- Job number: Sequential number created by the program – do **not** fill in this field
- Created by: The person who is initiating the Job on the system
- Date in: the date on which the job is created
- Date to technician: the date on which the technician starts work on the job
- Technicians: the names of the technician(s) doing the work
- Requested: Person requesting the work
- Company: The institution the person requesting the work is an employee of
- Order number: The person requesting the work has to provide an order number or some form of official document proving that the work is required.
- Description: A short description of the job, e.g. samples from Dodoma rd.
- Testing: The tests required
- Binder/Aggregate/Soil/Asphalt/Other: The type of material being tested
- Sample number: Sample numbers generated on screen two
- Date required: The date on which the test results are required
- Estimated completion date: The estimated completion date
- Completion date: The actual completion date
- Date sent to client: the date on which the results were sent to client
- Invoice requested (if required): Invoice requested from financial office
- Invoice paid: Has the invoice been paid – yes/no
- Completed: Once all the testing has been done, invoiced and paid, the job can be marked as complete and the program will show a green mark next to the job number

The screenshot shows a software window titled "LoGITReC Lab Work Management System". The form contains the following fields and values:

- Job number: 5936
- Date in: 20/02/2017
- Date to Technician: 20/02/2017
- Requested by: Mr X
- Company: BE
- Order Number: (empty)
- Technicians: A. Smith
- Description: Aggregate from Tanzania (Malula Quarry - Arusha region)
- Testing: Grading analysis, Magnesium sulphate soundness, TFV, ACV, AIV etc
- Sample Numbers: 15459, 15460, 15461, 15462, 15463, 15464, 15465, 15466
- Checkboxes: BIND, AGG, SOILS, ASPH, OTHER
- Date Required: N/A, 20/02/2017
- Estimated Completion Date: N/A, 20/02/2017
- Completion Date: N/A, 20/02/2017
- Date to Client: N/A, 20/02/2017
- Invoice Requested Date: N/A, 20/02/2017
- Invoice Amount: 0
- Invoice Paid: Complete: Upfront Payment: 0

Figure 2: Interface after entering details of work request

This information will be recorded by the program and shown on the main “jobs” screen (Main Screen 1).

3.1.3 Registering samples

A request for testing is normally accompanied by the materials (samples) to be tested. These have to be logged into the “Job List” system. This is done by firstly logging on to the “LoGITReC Lab Work Management System” program in the normal way and opening the main Sample sheet by clicking on the “Samples” tab. The main “samples” screen will open. Clicking on the Jobs/Samples main menu and selecting “New” will activate a “pop-up” screen to appear, Figure 3) in which the sample details are entered, namely:

- Sample number created automatically – no need for entering own sample number;
- Date sample received;
- The name of the person entering the data;
- The name of the owner of the sample;
- The number assigned to the sample by the owner;
- The condition of the container in which the sample is received;
- The Job Number created for this particular work – done previously;
- The origin of the sample;
- The type of material;

- Where the sample is stored and;
- Approximate quantity of the material (kg).

The screenshot shows a 'Samples' dialog box with the following data:

Sample number:	15459	Date in:	20/02/2017	Recorded By:	John
Owner:	Mr X	Owner number:	0-5	Container condition:	Plastic bag
JR Number:	5936	Sample origin:	Tanzania (Malula Quarry - Arusha f	Material Type:	Aggregates
Storage Store:	SOILS	Shelf:	SOILS	Quantity approx (kg)	1
Remarks:	SP12.5 Notes: NO QUANTITY				

Figure 3: Interface after entering the details of samples

This information will be transferred and shown on the main “Sample” screen (Main Screen 2).

Normally a Job has more than one sample and each sample must be entered into the system. A simple way is by highlighting on the main sample screen the first sample entered and clicking on the Job/Samples main menu tab. Options to: Enter a new sample, edit the selected sample, remove the sample from the database and create a copy of the sample, will appear. By Selecting “create copy” will cause the same pop-up screen to appear with all the previous information entered for the prior sample, but with the following sequential sample number. Information may now be altered for this new sample.

3.1.4 Other functions

It is possible to edit or remove a “job” or “sample” record. This is done by displaying the main “job” or “samples” screen (Figures 5 or 6, in Appendix) and then highlighting the record that is to be altered by clicking on it and clicking on the “Job/samples” tab. To remove click on the “remove” option and the record will be deleted. To alter the information, click on “edit” and a pop-up screen Figure 2 or Figure 3, will appear (depending on the main screen selected) and it will be possible to edit the data.

Users, Institutions, technicians, and requestors may be added or edited by clicking “manage” on any of the main screens.

3.2 Using LoGITReC Lab Work Management System

3.2.1 Functionality and testing of prototype

Briefly, the first step when using the program is to enter a new “Job” number by clicking on the Jobs/Sample tab, ensuring that the Jobs screen is open below and not the samples screen and following the instructions given under “Registering Jobs”. The second step is to fill in the Sample details. This is done by following the steps given under “Registering Samples”.

The functionality of prototype software was tested at the CSIR, before being installed at CMRL. The software was installed on the CMRL Manager’s computer in April 2017 and was tested and demonstrated to the CMRL Manager after installation. Subsequently, the Laboratory Manager demonstrated the software to all the technicians and they all can now use the system.

The main objective to develop and install an operational management system has successfully been achieved. All functionalities of the software have been tested and function as expected as per satisfaction feedback statement provided by CMRL Manager (Appendix C). However, the software currently can only be accessed on two computers at CMRL, due to an institutional problem that has yet to be resolved. CMRL is physically situated in a separate building from the PO-RALG Headquarters and is not connected to the PO-RALG network.

3.2.2 Benefits of LoGITReC Lab Work Management System

The Lab Work Management System has been developed for the collection of data regarding laboratory operations making it easy to collect and manage the data.

All the details pertaining to the job, e.g. owner, technicians doing the testing, date received, date completed, etc. are entered and stored in the program. The system will ensure that all data about laboratory operational procedures is recorded and kept in a centralised database. The system will enable the technicians to check, search and update sample status.

The practice of collecting and storing sample data systematically will now be embedded at CMRL, which is an essential process for sustaining good practices in laboratory information management. It will improve data security, as data is currently recorded on paper forms. The management of the data is complimentary to standardised procedures and provides the means for sound operational and management procedures in the laboratory, this is provided for in Procedure LoGITReC-LAB-3.

The Lab Work Management System is simple, but allows for the required inputs to capture and store required data for managing the laboratory operations and further processing and application, when required. It will enable CMRL meet the requirements for sustaining good practices in laboratory information management, one of the requirement expected for an accredited laboratory.

4 Conclusions and recommendation

The project is aimed at assisting LoGITReC to achieve its objective of capacity building and skills development for its staff, in particular at CMRL, to enable the facility to operate as a reference and quality control laboratory for PO-RALG and to support research activities by LoGITReC. This report focused on development of operational systems for the laboratory, a requirement that must comply with ISO 17025, for a facility of this nature, if it is to be recognised as provider of quality service.

Documents have been prepared that provide information on procedures, to ensure that a quality assurance and quality control scheme is in place at CMRL. In addition, a laboratory management system, the *LoGITReC Lab Work Management System*, has been developed that will ensure effective and efficient processing of laboratory material records and permanent storage of data for future reference.

The requirements for technical competence for the type of test and calibration the laboratory undertakes are specified in Clause 5 of ISO 17025. The prepared procedures are in line with ISO 17025 which states that the testing and calibration laboratories that comply with the requirement of the International Standard ISO 17025, will operate a quality management system for their testing and calibration activities that also meets the principles of ISO 9001. CMRL has therefore a quality system aimed at improving the laboratory's ability to consistently produce valid results, an essential basis for accreditation from an accreditation body.

Laboratories for testing road construction and building materials in Tanzania are not at present accredited by external agencies. Maintenance of quality assurance and quality control scheme will be dependent on CMRL being accredited. A move towards the accreditation of CMRL to improve quality assurance and quality control will require additional resources. **It is recommended that a specific funding allocation be set aside to ensure the accreditation process is realised.**

APPENDIX A

Laboratory Operating Procedures

LoGITReC LABORATORY
Procedure LoGITReC-LAB-1

Job Descriptions

Purpose

This procedure deals with ensuring all personnel in the lab have a job description. The job description should define relationships and authorities. The job description should also reflect the role and responsibilities of all personnel.

When

All personnel must have a job description on file.

Responsibility

The laboratory manager will draw up any new job descriptions as required and approve them. The relevant personnel members will also sign as an indication that they agree with the information contained in the job description.

Scope

Job descriptions will be drawn up for every new position created in the lab. New staff members will be assigned a job title and given a job description matching the title. The laboratory manager will approve the job description assigned to the specific person. In addition, the relevant personnel member has to co-sign the job description.

Job descriptions will be kept in each staff member's personal file.

Supporting instructions and forms

Format of job description to be drawn up by the laboratory manager.

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY

Procedure LoGITReC-LAB-2

Guidance for calibration, verification and intermediate checks

Purpose

This procedure provides guidance for the calibration, verification and intermediate checking of equipment regularly used in the laboratory.

This procedure covers:

1. *Balances*
2. *Compacting equipment*
3. *Sieves*
4. *Atterberg Limit devices*
5. *Ovens*
6. *Thermometers*
7. *Presses*

This procedure does not however override any specific requirements stipulated in the test methods.

When

Calibration or verification of all equipment will be done before any testing is undertaken.

Responsibility

It is the responsibility of all staff members to ensure that equipment used for testing is properly calibrated/verified. The laboratory manager is responsible for ensuring that the calibration/verification of all equipment is maintained by the responsible personnel.

Scope

1. *Balances*

Presently, most balances used are of the electronic variety. This type of balance generally requires less maintenance than the older mechanical type. It is, however, still necessary to occasionally check that these balances are performing according to specifications. The easiest way to do this is to use several weights of different masses (for balances having different weighing capacities). Balances are verified using standard mass pieces. The masses of these weights must be determined very accurately by an institution that specialises in the calibration of mass pieces. The weights are **only** used for the purpose of carrying out intermediate checks of scales and nothing else.

Balances will be calibrated if the intermediate checks indicate the calibration status might be compromised or after a maximum period of two years. This will be done by an external accredited facility.

The balance is verified by placing calibrated weights on the corners and centre of the weighing platform. The readings obtained from the corners of the platform should not differ by more than 0.1% of the centre reading and the centre reading should not differ by more than 0.1% of the calibrated weight mass.

2. Compacting equipment

Compacting equipment such as, compaction hammers, moulds, etc. are especially prone to wear due to the nature of their use.

Compaction hammers are checked to determine whether they conform to specifications. The mass is determined, the length of fall of the hammer is measured and it is ensured that the hammer falls freely. It is also important to check that the hammer face is flat as this sometimes becomes rounded with use (see Fig. A1). The hammer should be discarded when this occurs. This should be checked on a monthly basis.

Moulds used for compaction are weighed and the volume determined and this data recorded. Each time the mould is used these mould values are re-used. The moulds are, however, subject to rusting and also chipping from blows of the compaction hammer. It is thus imperative that the mass and volume of the moulds be determined from time to time and this is normally done yearly.

The steel straight edge that is used to cut off the excess material protruding from the mould after compaction is also be checked for wear. The straight edge tends to become rounded with use, and results in the mould containing more material i.e. the mould volume effectively increases. When this happens the straight edge is machined to a true straight edge.

The tins used for moisture content determinations are likewise weighed and these values re-used when the tins are used successively. The tins are especially susceptible to rust and also accumulation of dirt and soil. Special care must be taken when cleaning the tins. They are also weighed on a regular basis, depending on use.

3. Sieves

Sieves have a limited life as they are subjected to significant wear. The finer sieves (-0,425 mm and finer) are especially vulnerable to the abrasive materials that pass through them. The 0,075 mm sieve is especially subject to tearing and stretching of the sieve material and is examined more regularly than other sieves. Once the sieve mesh has stretched (manifested as sagging in its frame) the sieve no longer conforms to specifications and is replaced. The fine sieves are also prone to blocking and should be cleaned on a regular basis, depending on usage.

Sieves equal to or smaller than a 4.75mm will be compared to a set of master sieves. This involves testing a sample in the master sieves and then running the same sample through the test sieves under similar test conditions (e.g. time shaken) and comparing the gradation. Sieves larger than the 4.75mm will be measured with a set of callipers.

4. Atterberg Limit devices

The most important aspect is to ensure that the drop cone is in good condition and according to specifications. The cone tends to wear and blunt with use. The calibration disc

supplied with the instrument to verify the “sharpness” of the cone shall be used for this purpose at least once weekly when the apparatus is used on a regular basis.

The weight of the cone and stem assembly should also be checked regularly (80g ±0.1g). Also important is that the cone assembly slides freely when the release button is pressed. Worn cones cannot be repaired and must be replaced.

The linear shrinkage troughs used for linear shrinkage determinations are sometimes inadvertently damaged. These are checked when being used for dents, shape etc. The linear shrinkage troughs are verified on an annual basis using.

5. Ovens

The ovens’ thermostats are checked yearly to ascertain whether or not they are working properly. This is done by putting a thermometer in the oven and checking that the thermometer reading is similar to the thermostat setting. It is important to take note of the variation in temperature between consecutive cycles of the element being switched on. During this annual check the overall condition of the oven will also be checked. This includes the door seal of the oven to ensure that it is not broken or defective in any way. A fan is present in most ovens (especially larger ones) to provide air circulation and thus equalise the temperature throughout the oven, this will also be checked during the annual oven check.

6. Thermometers

Thermometers are verified at least every two years against master thermometers. Thermometers have to be highly accurate for certain types of testing (e.g. some types of testing in the Binders laboratory). Master thermometers are calibrated externally by an accredited metrology laboratory. New thermometers may then be checked against the calibrated thermometers to determine whether they are performing satisfactorily.

7. Presses

The suggested interval for press calibration (CBR) is every 12 months. Calibration of presses will be done by accredited institutions (TBS) as it is a specialized job. However, should a fault be obvious (e.g. sticking gauges, obvious damage, etc.) then the apparatus should not be used until repaired.

Supporting instructions and forms

The attached Table suggests the frequency of calibration/verification for various types of equipment.

Table 2: Recommended Calibration and Verification Frequencies for different Equipment

Equipment category	Frequency	Calibration/ Verification
Balances, Scales and weights	12 months	Calibration
Test thermometers	24 months	Calibration/Verification
Analytical balances	12 months	Calibration
Sieves	12 months	Verification
Viscometers	12 months	Calibration/Verification
Kneading compactor	12 months	Verification
Timers	12 months	Calibration/Verification
Ovens	12 months	Verification
Penetrometer	12 months	Verification/Calibration (needles)
Ductility apparatus	12 months, moulds when new	Verification
TFO & RTFO oven shelf/carriage	12 months	Verification/calibration (flow meter)
Compression or loading devices	12 months	Calibration
Mechanical compactor	When in use, 3 monthly	Verification
Moisture tins	3 months	Verification
Moulds	12 months	Verification
Manual hammer	When in use, weekly	Verification
L. A. machine / Texas ball mill	12 months	Verification
Steel balls (L.A. apparatus)	12 months	Verification
Atterberg Limit device	When used, Shore D when new	Calibration (base)/verification
pH meter, pH probes	When used	Verification
Asphalt rutting apparatus	12 months	Verification
Skid resistance tester	12 months	Verification
CBR Apparatus	12 months	Calibration
Bitumen foaming device	12 months	Verification
Vibration compactor	As deemed necessary	Calibration
Brushing Apparatus	12 months	Verification
Water/oil baths	12 months	Verification
Ring and ball device	12 months	Verification
Liquid chromatograph	12 months	Verification
Brookfield viscometer	12 months	Calibration
Gas chromatograph	12 months	Verification
High shear mixer	12 months	Verification
Dynamic shear rheometer	12 months	Verification
Load cells	12 months	Calibration
LVDT's	12 months	Verification
Micrometer	12 months	Calibration
Tri-axial apparatus	12 months	Calibration

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY

Procedure LoGITReC-LAB-3

Identification and Record Keeping of Equipment

Purpose

This procedure handles the identification and record keeping of equipment.

When

This procedure will be relevant to all equipment used in the laboratory.

Responsibility

It is the responsibility of the quality manager/laboratory manager to ensure that all equipment is uniquely identifiable and that records are kept of all equipment. The laboratory manager will designate the responsibility of looking after equipment to specific staff members.

Scope

A record of all equipment will be kept in a file designated as the "Equipment File" Records. All equipment will be readily identifiable by a unique number and description.

Each piece of equipment will be assigned to a specific staff member. This person will be responsible for ensuring the continued and correct operation of the piece of equipment, ensuring the equipment is within calibration, ensuring the equipment is safe to operate and that it is properly maintained. A separate list will be drawn up which will be issued to staff as an indication of which equipment they will be responsible for. These files will all be kept in the laboratory manager's office.

Included in the file will be a maintenance schedule for which the relevant personnel member will be responsible. The maintenance schedule will be drawn up by the laboratory manager. The responsible personnel member need to make sure that the schedule is adhered to and records kept on the relevant forms.

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY

Procedure LoGITReC-LAB-4

Incoming Samples Administration

Purpose

This procedure deals with handling incoming samples their identification and recording.

When

This procedure will be relevant to all samples that are received by the laboratory for testing.

Responsibility

It is the responsibility of the laboratory manager to ensure that all samples are uniquely identifiable and that records are kept of all samples received. The manager will designate the responsibility of recording incoming samples to specific staff members.

Scope

Materials laboratories work with sampled materials. Handling of samples is the first step in materials testing and is obviously a very important one. It is thus imperative that sound sample management methods are used so that samples are not lost, misplaced, incorrectly numbered etc., and so that they may be handled as efficiently as possible.

Incoming samples

Incoming samples have to be properly stored (see sample storage in section 4) until testing takes place. A record must also be kept of all incoming samples in a sample register. The following information is desirable in a sample register:

- Each sample is given a unique number, which is recorded sequentially in the sample register.
- The date on which the sample is received.
- The owner of the sample (person responsible)
- Details of the origin of the sample (road no, depth of sample, position in road, geographical area etc.)
- The type of material, if this known
- The location where the sample is stored

Table below is an example of a page in a typical sample register.

The sample register may be a book into which the sample details are entered or a computer may be used for this purpose. The time taken to record the data in a computer is probably

slightly more than is the case with a sample book. However, computer records can be accessed in a number of ways, which makes this a more advantageous system than a simple sample ledger. Computer records are not only accessible by sample number but generally by any of the other data contained in the sample record, e.g. all the samples belonging to a certain individual may be called up or all the samples in a certain shelf may be listed or even all samples pertaining to a specific material type can be listed.

Samples must be adequately stored on arrival where they are protected from the elements or inadvertent damage. An efficient sample storage facility must allow for ease of sample storage and retrieval and orderly storage of samples. There should be sufficient space in which to handle samples. Samples may be large (50 kg) or small (a few kg's) or anywhere in between and the system must cater for the various sizes.

A storage facility must have provision for the temporary or short-term, storage of samples and also storage for longer periods. Samples that are to be tested soon after arrival should preferably be stored at a location close to the sample preparation area. Samples that have been tested and are awaiting disposal should be stored at a different location. Figure 4 shows the flow of samples between the various storage areas in the laboratory.

Supporting instructions and forms

An example of a page in a typical sample register is given in Table 3.

Figure 4 shows the typical flow of samples between stores and storage areas.

Table 3: Example of sample register

Sample No	Date Received	Recorded By	Owner	Owner's Sample No	Details	Material Type	Storage Location		Quantity (approx.)
							Store	Shelf	
1358	9/12/2015	Jimmy	Contractor A	A238	Km 17.1, Road 258, Base, LHS, OWT	Calcrete	1	B10	50 kg
1359	9/12/2015	Jacob	Contractor B	A259	Km 17.1, Road 258, Subbase, LHS, OWT	Quartzite	1	D13	200kg
1360	3/1/2010	Sam	CML	163	Km 25.8, Road 26 Shoulder, Road 151D,	Basalt	2	A1	80kg
1361	8/6/2012	Peter	SV Consult	53	Ex borrow pit 25, Road P178, km 15.3,	Tillite	2	C19	20kg
1362									
1363									

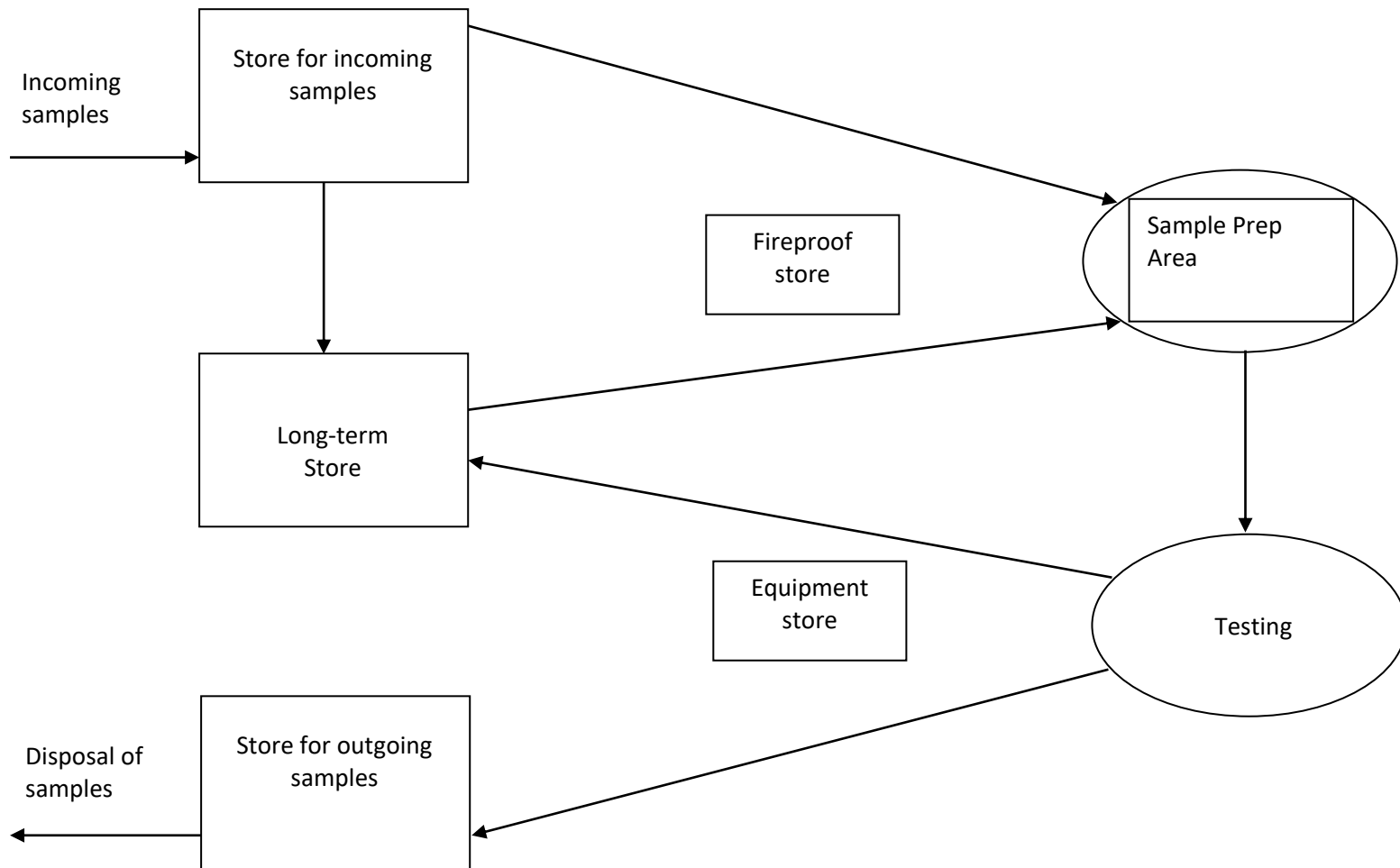


Figure 4: Typical sample flow between the various stores and work areas in the laboratory.

LoGITReC LABORATORY

Procedure LoGITReC-LAB-5

Review of requests, tenders and contracts

Purpose

This procedure covers review of requests, tenders and contracts. It includes receipt of instructions for testing and maintenance of the electronic job and sample log system.

When

This procedure will be followed for all testing requested from the laboratory and subsequent processing of incoming work.

Responsibility

It is the responsibility of all personnel designated to accept incoming work to follow this procedure. The laboratory manager will ensure that a hard copy of the job log and the sample log is printed out each week and filed as a backup.

Scope

A service request Form will be completed for all incoming work. Once the service request has been completed and the request is fully understood by the relevant staff member, the samples will be registered in the electronic sample register (to be supplied). Sample numbers are automatically allocated by the system.

The job will then be logged on the electronic job log system (to be supplied) which will assign a job number. A paper file will be opened and given the number supplied by the job log system. All relevant documentation from start to completion of the testing will be included in the file (including work sheets, testing instructions, results, etc.).

Each week a hard copy of the job log is printed out and filed as a backup to the electronic system.

The sample retains the sample number for life, but a sample could be linked to more than one job. For example, if further testing is requested on a sample previously tested further down the line, a new job will be logged, but the sample number remains the same.

Supporting instructions and forms

1. Service Request Form.

LoGITReC LABORATORY

LABORATORY SERVICE REQUEST

Form No:	Revision No:1	Date:06/03/2017
----------	---------------	-----------------

Grad		AL+LS		MDD		CBR		UCS	refere	AIV					
Client:								Project:							
Sample Description:															
Sample Numbers:															
Background to study / request:															
TESTS REQUESTED PER SAMPLE															
Number of samples:								Location / site:							
Grad		AL+LS		MDD		CBR		UCS		AIV					
Other tests:															
Special instructions:															
Results required:		All work sheets + summary						Summary only							
Sample disposal:		Return original / discard tested						Return original + tested in separate bags							
		Discard all material						Store for x months							
Date required:				Manager								Project leader			
Date agreed:															
Quoted price:															

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY
Procedure LoGITREC-LAB-6

Testing of Certified and In-house Reference Samples

Purpose

This procedure deals with the testing of certified and in-house reference samples as a means to ensure the quality of results in the laboratory.

When

This procedure will be followed for setting up a reference sample programme. Reference samples will be analysed at least every 6 months.

Responsibility

It is the responsibility of the laboratory manager to draw up a reference sample programme and to ensure that the programme is carried out. The laboratory manager shall also analyse the data generated from reference samples to assess the quality of the results.

Scope

At the beginning of the year, the laboratory manager will draw up a reference sample programme for the rest of the year. This programme will consist of reference samples to be analysed for the routine tests conducted in the lab by all technicians running the test method. Reference samples will be run at least every 6 months, within the first week of the month.

The laboratory manager and/or supervisors will ensure that a variety of reference samples are available. Where no certified reference materials are available, internal reference samples will be identified. This will consist of samples kept in bulk for repeated retesting as part of the reference sample testing scheme.

Evaluation of results will be analysed by comparing the testing results obtained by the technicians with the historical values of the reference sample.

Supporting instructions and forms

1. Reference sample testing program should be drawn up at the beginning of the year by the Laboratory manager.

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY
Procedure LoGITReC-LAB-7

Declaring Personnel Competent

Purpose

This procedure handles the competence of all personnel involved in the use of specific equipment and performance of specific test methods.

When

This procedure will be followed when the competence of personnel need to be assessed and when they are declared competent to perform tests.

Responsibility

It is the responsibility of the laboratory manager to ensure all personnel involved in testing has been assessed and declared competent before they will be allowed to conduct testing or use certain equipment unsupervised.

All personnel should only conduct testing for which they have been declared competent.

Scope

Technical personnel in the laboratory will be declared competent to perform testing after all of the following actions/assessments have been completed:

1. Training for the relevant test method has been undergone and proof thereof is available on file. Proficiency scheme participation or reference sample standard testing has been conducted by the relevant personnel member for the specific test method
2. The relevant personnel member has been witnessed by a qualified auditor.

Proof has to be included of each of the above conducted and included in the personnel member's file. All members of the laboratory, technical or administrative, shall have a personal file containing all the information on the staff member, such as; qualifications, years of experience, tests for which he has been approved, etc.

Once the above has been successfully completed the laboratory manager will declare the technician competent to perform the test and record this in his/her personnel file. This will be done on a form which states the date on which the personnel member is declared competent and that authority is given by the laboratory manager to the technician to perform the test.

The personnel member has to sign that he/she acknowledges competency of the test methods involved.

Supporting instructions and forms

1. Form for the purpose of declaring the technician competent to do a given test and showing the manager's authorization.

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY
Procedure LoGITReC-LAB-8

Safe Working Procedures in the workplace

Purpose

This procedure deals with the safety of personnel working in the Laboratory.

When

This procedure will be followed at all times when work or testing is being carried out in the laboratory or in the field.

Responsibility

It is the responsibility of the laboratory manager and senior personnel to ensure all personnel involved in testing are following adequate safety standards and wearing the appropriate personal protective clothing (PPE).

Personnel should only conduct testing when it is safe to do so.

Scope

This procedure pertains to testing in the laboratory and field work on the roads.

It also covers the types of personal protective equipment (PPE) that is required for the various activities.

Safety Requirements

Housekeeping

Basically good housekeeping means having a place for everything and keeping everything in its proper place. Typical examples of poor housekeeping are:

- Floors cluttered with objects that are in the way and over which people can trip.
- Too few and overflowing waste bins.
- Materials and objects poorly stacked on shelves.
- Aisles and exits cluttered or blocked with objects.
- Liquids spilt on floors not cleaned up.

Accidents in the workplace that are typical of poor housekeeping include: people tripping over loose objects on floors; articles falling on people; people slipping on greasy, wet or dirty floors; workers bumping against projecting, poorly stacked or badly placed materials. Fires can also result from poor housekeeping. Some of the reasons why good housekeeping is important and desirable are:

- It cuts down the time spent looking for articles, tools etc.
- Space is saved when everything is stacked away tidily.
- Injuries are avoided when gangways and working areas are kept clear of superfluous material.
- Fire hazards are reduced if combustible materials are kept in proper receptacles.

It is also true that good housekeeping improves the working environment. This means more pleasant working conditions, which arouses a desire in workers for greater efficiency. The end product is increased production.

Guards for machines

Machines that have moving parts (gears, pulleys, driving belts etc.) must have guards covering these to protect personnel from accidental injury. Injuries caused by machines are usually severe and permanent but the danger they pose is usually reduced or removed altogether by mechanical safeguards. Well-designed guards will not affect the efficient operation of the machine.

Personal protective equipment

Many types of personal protective equipment are available. The worker should be provided with protective equipment if the situation warrants it. The most commonly used types of protective equipment are:

- Hard hats to protect the head from falling objects.
- Goggles for the protection of eyes. These should be used when the worker is doing any work that may pose a threat to his eyes (e.g. - sawing rock)
- Overalls to protect the workers clothing from damage.
- Different types of gloves to protect the hands (e.g. from hot bitumen or acids).
- Safety boots and shoes to protect feet from heavy objects falling on them.
- Dust masks for working in dusty environments.
- Earmuffs or earplugs to protect workers in noisy environments.

The personnel member has to sign that he/she acknowledges competency of the test methods involved.

Gas cylinders

Special precautions must be taken when handling or storing gas cylinders. Because of their shape large gas cylinders are awkward to carry. They may be rolled but never dragged. The laboratory shall have a purpose built trolley to move the cylinders. Cylinders should also be prevented from falling or bumping against each other.

Cylinders should be stored in a well-ventilated area away from heat or direct sunlight and on a level fireproof surface. Racks and/or chains shall be provided for securing cylinders individually in an upright position.

Fire prevention equipment

Fires in the work place are dangerous to lives and damaging to property. Fires can to a large extent be prevented by good housekeeping practices. Materials that are flammable (wood, paper, oily rags etc.) shall not be left lying around. Most fires start in a small way and if they can be extinguished at this stage property and human lives can be saved. It is obviously much easier to extinguish a small fire than to allow it to spread and later have to extinguish a major blaze.

The Laboratory shall be equipped with some form of firefighting equipment to deal with incipient fires immediately before they spread and become major fires. The most common firefighting appliances are different types of Fire extinguishers. Extinguishers should be placed close to likely fire hazards but not so close that they can be damaged or cut off from use by fires. They should be located outside entrances to danger areas, never inside where they might become inaccessible. Extinguishers should be placed at conspicuous places.

First Aid

Owing to the nature of the work done in laboratories it is more likely that accidents will occur than say in an office environment. It is thus desirable that the laboratory has a person that has been trained in First Aid techniques. The laboratory shall have at least two trained first aiders and a well-stocked First Aid box shall also be kept in the laboratory.

Safety Representative

There are many more safety issues that need to be considered than those discussed above. It is imperative that the laboratory manager appoints one of the lab staff to deal with safety matters. Apart from his normal duties in the laboratory it will also be this person's responsibility to ensure that safety standards are being adhered to. The person shall attend relevant training courses and shall inspect the laboratory on a weekly basis. This should not take more than a few hours of his/her time per month.

Field Work

Apart from the normal personal protective equipment, personnel working on or near a road should always wear reflective vests to ensure that they are easily visible to traffic.

Sufficient cones should be used to demarcate the working area which may be on or adjacent to the road surface. Apart from this, on roads that carry higher volumes of traffic the use of a flagman is advised to alert oncoming motorists. Road signs warning motorists of work being done on the road ahead shall also be placed on the road shoulder at a distance from the working area, which will give the motorist sufficient time to react to the possible obstruction ahead. Where it is necessary to close off a section of road a stop/go system with flagman and signalling must be introduced.

Approved by:	Capacity:	Date:
--------------	-----------	-------

LoGITReC LABORATORY
Procedure LoGITReC-LAB-9

Proficiency Testing

Purpose

This procedure deals with the proficiency of testing by laboratories to determine whether the test is being carried out correctly. This is to ensure that the equipment used is in a good working order and that the personnel doing the testing are performing the test acceptably according to the prescribed test method.

When

This procedure will be carried out once a year and shall cover all the relevant test methods.

Responsibility

It is the responsibility of the laboratory manager to ensure that proficiency testing is carried out on all the key test methods, i.e. Compactions, CBR, Sieve analysis, Atterberg Limits, etc. The manager shall decide which tests are relevant to his particular laboratory.

Scope

Multi-laboratory precision (Proficiency) testing is usually carried out using not less than 8 laboratories. This is not always possible as there may not be that number of laboratories in the region which are carrying out the test method under investigation.

Samples that are used in these investigations shall be prepared by one laboratory and distributed to the other laboratories for testing so that the test method is examined and not the method of sample preparation, unless the sample preparation method is being investigated. The test results received from the participating laboratories are then statistically analysed. These values may be used to identify laboratories whose test results are not within acceptable limits. After further investigation, steps may be taken to rectify errors within those laboratories, whether these are procedural or equipment related.

Methodology

Samples that are used in these investigations shall be prepared and distributed by one laboratory, ensuring that the various participants receive representative samples.

The result from the various participating laboratories shall be collated by the laboratory distributing the samples. This laboratory should also do the statistical analysis of the results.

The calculations are best done using an electronic spreadsheet that can calculate means; Standard deviation; do outliers test, etc. (such as EXCEL).

Evaluation of Results

Statistics Employed

A widely accepted statistical method for analyzing test results is to calculate a z-score for each laboratory's result. A z-score is a normalized value which gives a "score" to each result, relative to the other numbers in the data set.

The calculation of z-scores is given by:

$$z_i = \frac{x_i - \bar{x}}{s}$$

(x_i) is the i th result and (\bar{x}) is the assigned value (e.g. mean or median)

s is an estimate of the spread of all results (e.g. robust standard deviation or fitness for purpose criteria)

A z-score value close to zero therefore means that the result agrees well with those from the other laboratories.

In order to use as many results as possible and not have to make decisions with regard to outliers, robust indicators were used. The Robust indicators include both a Robust Mean and Robust Standard Deviation.

The H15 robust mean and H15 robust standard deviation are used to analyse the data due to their ability to include outliers in the data set as analysed while applying a weighting to each value. This weighting allows the data values wider of the H15 mean to have less of an effect on the results both for the mean and the standard deviation resulting in a more accurate mean and standard deviation determination that better identifies the consensus mean and z-score analysis of the data set.

Results are evaluated using the standard z-score as detailed in the AASHTO Materials Reference Laboratory (AMRL) method.

AMRL Method of Evaluation

A more stringent rating is used by AMRL is laid out below which may be a more acceptable rating scale than the standard z-score rating.

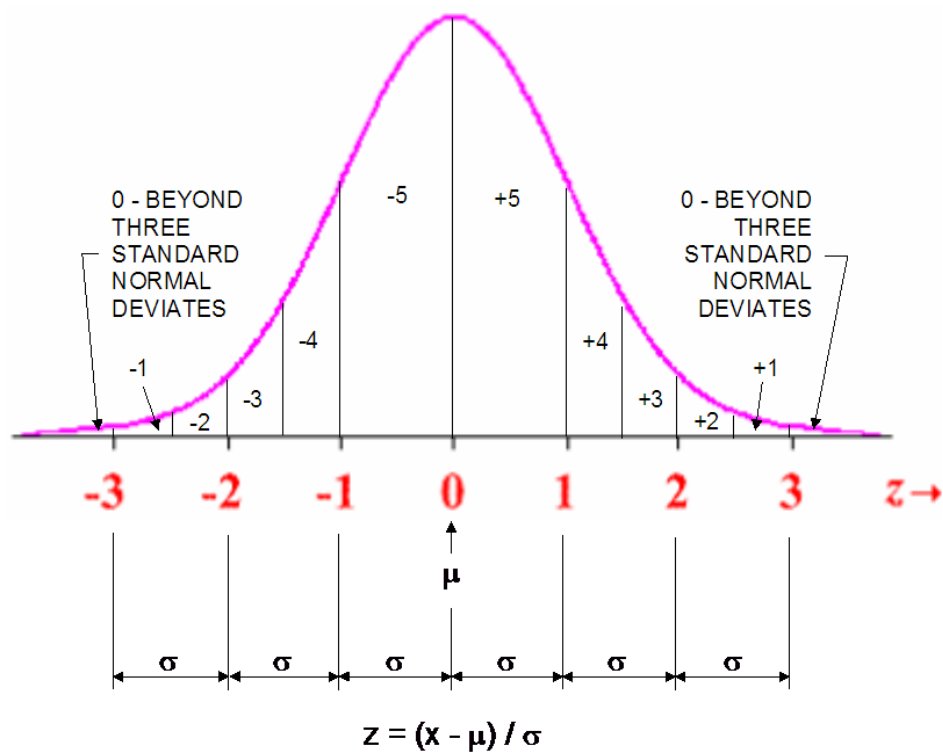
The laboratory Rating calculation is based on the absolute value of the Z-Score (or number of standard deviations from the average). The laboratory Rating is as follows:

- **If Z-Score ≤ 1 Then Rating = 5**
- **If Z-Score > 1 And ≤ 1.5 Then Rating = 4**
- **If Z-Score > 1.5 And ≤ 2 Then Rating = 3 – needs investigation**
- **If Z-Score > 2 And ≤ 2.5 Then Rating = 2 - problematic**
- **If Z-Score > 2.5 And ≤ 3 Then Rating = 1 – needs in-depth investigation**
- **If Z-Score > 3 Then Rating = 0 – unacceptable**

A negative sign on a Z-Score or Rating indicates that the laboratory's result was below the average, while a positive Z-Score or Rating indicates that the laboratory's result was above the average.

SCORING OF PROFICIENCY SAMPLES BY AMRL

Scoring of proficiency test samples is determined by fitting a standard normal distribution to the data from all laboratories (with outliers eliminated). Laboratories whose results fall within one standard normal deviation from the mean are assigned a numerical score of "5." Laboratories whose results fall between 1 and 1½ standard normal deviations from the mean are assigned a score of "4," and the ratings are further decreased one point for each half standard normal deviate thereafter. A positive sign (+) indicates the lab result is above the mean, and a negative sign (-) indicates the lab result is below the mean. This system can be depicted graphically, as follows:



Sample Calculation

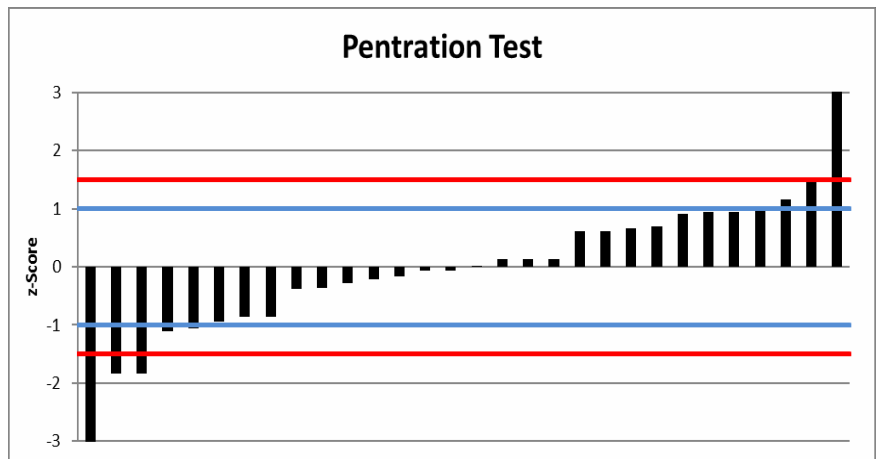
1. Assume mean, $\mu = 20,73$ and standard deviation, $\sigma = 0,65$ with lab result, $x = 19,8$
2. Standard normal deviations from mean = (lab result – mean)/(standard deviation)
= $(19,8 - 20,7)/0,65 = -1,38$
3. Note that negative sign here indicates the lab result is below the mean.
4. The lab result is between 1 and 1½ standard normal deviations below the mean, so that the lab rating for this particular result, according to the figure shown above, would be -4.

TEST RESULTS EXAMPLE CALCULATION

EN 1426 Penetration test

	Lab id	Avg dmm	z-score
1	f2peh	54,3	-3,095
2	npxm4	67	-1,845
3	whf7j	67	-1,845
4	j5pg5	75	-1,107
5	dzk3j	75	-1,057
6	rghr4	76,2	-0,939
7	kps8t	77	-0,860
8	xsh2p	77	-0,860
9	8apve	81,9	-0,378
10	fsbt9	82	-0,368
11	tjd3d	82,9	-0,280
12	bs8gh	84	-0,221
13	awmsy	84	-0,171
14	jcpt9	85	-0,073
15	t67me	85	-0,073
16	epmj9	85,8	0,006
17	ce5nz	87	0,124
18	dck4d	87	0,124
19	wz55t	87	0,124
20	epdkm	92	0,616
21	hywqx	92	0,616
22	jgx5k	93	0,665
23	ysmrd	92,8	0,691
24	akz6k	95	0,911
25	kmqwt	95,3	0,936
26	xg3mr	95,4	0,951
27	ndc6z	96	0,961
28	hqwps	97,6	1,162
29	d3dhr	101	1,453
30	hyx2g	120,1	3,377

Estimate	dmm
Median	85,4
H15 mean	85,74
H15 Std Dev	10,159
Total Range	65,8
Range z-score < 1	19,3
CV	0,118
% z-score ± 1	73,3%



Comments – EN 1426 Penetration test

Number of participants = 30 Non-participants = 1 OB = Nil
 Correct reporting format 67 % reported accurate to 1 dmm while the balance reported to 0,1 dmm.

The results crossed three penetration grade specifications with two of the results being outside of any specification. Five of the results fell outside of the specification for the 70/100 binder as supplied.

Approved by:	Capacity:	Date:
--------------	-----------	-------

APPENDIX B

Screen Shots of LoGITReC Lab Work Management System

Capacity Building at LoGITReC in Tanzania

LoGITReC Lab Work Management System

File View Jobs/Samples Manage Help

Jobs Samples

Find: Show All

Job Num	Created By	Date In	Date To	Technicians	Requested	Company	Order Num	Description	Testing	BIND	AGG	SOIL	ASPH	SampleN	DateReq	EstCompl	CompDate	Date2Clie	InvoiceA	InvoiceR	InvoiceP	Completext	Upfront Pay
5920	Jack	19 January 2...	19 Januar...	A. Smith	Mr A	Acme	60632	1 m on binder	RTFO, JNR	Yes	-	-	-	15225	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5921	Jack	19 January 2...	13 Januar...	A. Smith	Mr A	Acme		PMB Binder	New SA spec	Yes	-	-	-	15226	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5922	John	19 January 2...	19 Januar...	B. Jones; A...	Ms B	Acme		Tanzania specs	New specs	Yes	-	-	-	15227	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5923	John	20 January 2...	20 Januar...	B. Jones	Ms C	ABC	013158	14 mm seal stones	Polishing Stone Value	-	Yes	-	-	11972, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5924	Jill	24 January 2...	24 Januar...	B. Jones	Ms C	ABC		9 x 1 litre Binder	Force Ductilities	Yes	-	-	-	15266, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5925	Jill	26 January 2...	26 Januar...	A. Smith	Ms Z	Acme		2 x Recovered Emuls...	Force Ductility	Yes	-	-	-	15275, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5926	Jill	01 February ...	01 Febru...	A. Smith	Mr X	Acme	B1HE207	Mixing concrete mixe...	Concrete Beams Stre...	-	Yes	-	-	15296	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5927	Jane	02 February ...	02 Febru...	B. Jones; A...	Mr X	Acme		2 x 1 litre SE-1	Force Ductility	Yes	-	-	-	15297, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5928	Jane	06 February ...	06 Febru...	B. Jones	Mr X	ABC				-	-	Yes	-	15299, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5929	Jack	19 July 2016	19 July 20...	B. Jones	Mr A	ABC		Base, Sub Base end...	Grading, Atterberg, O...	-	-	Yes	-		N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5930	Jack	14 February ...	14 Febru...	A. Smith	Mr A	Acme	NLA001	1.1 litre of Penetration	Before and After RTF...	Yes	-	-	-	15363	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5931	John	20 February ...	20 Febru...	A. Smith	Ms B	Acme		Aggregate from Tanz.	PSV, AV, ACV, 10% Fa...	-	Yes	-	-	15364, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5932	John	20 February ...	20 Febru...	B. Jones; A...	Ms C	Acme		Aggregate from Tanz.	Grading, TPV, ACV, AI...	-	Yes	-	-	15369, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5933	John	20 February ...	20 Febru...	B. Jones	Ms C	ABC		Aggregate from Tanz.	Sand equivalent Clay	-	Yes	-	-	15406, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5934	John	20 February ...	20 Febru...	B. Jones	Ms Z	ABC		Aggregate from Tanz.	TPV, ACV, AV, Gradin...	-	Yes	-	-	15425, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5935	John	20 February ...	20 Febru...	A. Smith	Mr X	Acme		Aggregate from Tanz.	TPV, ACV, AV, LAA, Gr...	-	Yes	-	-	15444, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5936	John	20 February ...	20 Febru...	A. Smith	Mr X	Acme		Aggregate from Tanz.	Grading analysis, Ma...	-	Yes	-	-	15453, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5937	Jane	17 February ...	20 Febru...	B. Jones; A...	Mr X	Acme		Soils	Grading Analysis (So...	-	-	Yes	-	15481, 15...	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5938	Jack	21 February ...	21 Febru...	B. Jones	Mr A	ABC	CL/0161	Binder content, Gradin...	Binder content Gradin...	-	-	-	Yes	15486	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5939	Jack	21 February ...	21 Febru...	B. Jones	Mr A	ABC		Road Cores	BRB, MTRD, Stab & fl...	-	-	-	-	15485	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5940	John	22 February ...	22 Febru...	A. Smith	Ms B	Acme		Filler from Tanzania		-	-	-	-	15487	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5941	John	22 February ...	22 Febru...	A. Smith	Ms C	Acme		1 x 1 litre of AE2 Binder	Force Ductility of 5 Ce...	Yes	-	-	-	15488	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5942	Jill	28 February ...	28 Febru...	B. Jones; A...	Ms C	Acme	013170	10 mm Stones	Polishing Stone Value	Yes	-	-	-	15492	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00
5943	---	01 March 2017	01 March...	B. Jones	Ms B	ABC	0000000000	1 x Binder test	Back-splat, RTFO, DA...	Yes	-	-	-	15493	N/A	N/A	N/A	N/A	0.00	N/A	No	No	0.00

Ready

LoGITReC Lab Work Management System

File View Jobs/Samples Manage Help

Jobs Samples

Find: Show All

Sample No	Material type	Date in	Recorded ...	JR Number	Owner	Owner's No	Owner's No	Container Condit...	Sample Ori...	Storage St...	Shelf	Quantity approx (k...	Remarks
15458	Aggregate	20 Februar...	John	5936	Mr X	6-13	6-13	Plastic bag	Tanzania(K...	SOILS	SOILS	2.2	AggregateBailey m...
15459	Aggregates	20 Februar...	John	5936	Mr X	0-5	0-5	Plastic bag	Tanzania (...	SOILS	SOILS	1	SP12.5Notes: NO Q...
15460	Aggregates	20 Februar...	John	5936	Mr X	9.5/4.75	9.5/4.75	Plastic bag	Tanzania (...	SOILS	SOILS	1.1	SP12.5Methylene bl...
15461	Aggregates	20 Februar...	John	5936	Mr X	9.5/4.75	9.5/4.75	Plastic bag	Tanzania (...	SOILS	SOILS	1.1	SP12.5Magnesium ...
15462	Aggregates	20 Februar...	John	5936	Mr X	10-14	10-14	Plastic bag	Tanzania (...	SOILS	SOILS	14.3	SP12.5TFV.ACVAIV
15463	Aggregates	20 Februar...	John	5936	Mr X	14-20	14-20	Plastic bag	Tanzania (...	SOILS	SOILS	57	SP12.5Aggregates
15464	Aggregates	20 Februar...	John	5936	Mr X	7	7	Plastic bag	Tanzania (...	SOILS	SOILS	95	SP12.5Aggregates
15465	Aggregates	20 Februar...	John	5936	Mr X	10-14	10-14	Plastic bag	Tanzania (...	SOILS	SOILS	22	SP12.5Bailey metho...
15466	Aggregates	20 Februar...	John	5936	Mr X	7	7	Plastic bag	Tanzania (...	SOILS	SOILS	95	SP12.5Aggregates
15467	Aggregates	20 Februar...	John	5936	Mr X	Passing 5	Passing 5	Plastic bag	Tanzania (...	SOILS	SOILS	1.1	SP12.5Sand Equiva...
15468	Aggregates	20 Februar...	John	5936	Mr X	12.5/9.5	12.5/9.5	Plastic bag	Tanzania (...	SOILS	SOILS	2.75	SP12.5Los Angeles ...
15469	Aggregates	20 Februar...	John	5936	Mr X	14-20	14-20	Plastic bag	Tanzania (...	SOILS	SOILS	3.3	SP12.5Grading Anal...
15470	Aggregates	20 Februar...	John	5936	Mr X	0-5	0-5	Plastic bag	Tanzania (...	SOILS	SOILS	3.3	SP12.5Grading Anal...
15471	Aggregates	20 Februar...	John	5936	Mr X	10-14	10-14	Plastic bag	Tanzania (...	SOILS	SOILS	3.3	SP12.5Grading Anal...
15472	Aggregates	20 Februar...	John	5936	Mr X	0-5	0-5	Plastic bag	Tanzania (...	SOILS	SOILS	1.1	SP12.5Clay Content
15473	Aggregates	20 Februar...	John	5936	Mr X	0-5	0-5	Plastic bag	Tanzania (...	SOILS	SOILS	8.8	SP12.5Fine Aggreg...
15474	Aggregates	20 Februar...	John	5936	Mr X	0-5	0-5	Plastic bag	Tanzania (...	SOILS	SOILS	22	SP12.5Bailey metho...
15475	Aggregates	20 Februar...	John	5936	Mr X	14-20	14-20	Plastic bag	Tanzania (...	SOILS	SOILS	22	SP12.5Bailey metho...
15476	Aggregates	20 Februar...	John	5936	Mr X	10-14	10-14	Plastic bag	Tanzania (...	SOILS	SOILS	33.25	SP12.5Aggregates
15477	Aggregates	20 Februar...	John	5936	Mr X	0-5	0-5	Plastic bag	Tanzania (...	SOILS	SOILS	133	SP12.5Aggregates
15478	Aggregates	20 Februar...	John	5936	Mr X	19/12.5	19/12.5	Plastic bag	Tanzania (...	SOILS	SOILS	2.75	SP12.5Los Angeles ...
15479	Aggregates	20 Februar...	John	5936	Mr X	7	7	Plastic bag	Tanzania (...	SOILS	SOILS	3.3	SP12.5Grading Anal...
15480	Aggregates	20 Februar...	John	5936	Mr X	7	7	Plastic bag	Tanzania (...	SOILS	SOILS	5.5	SP12.5Bailey metho...

Ready

APPENDIX C

Statement of Satisfaction on “LoGITReC Lab Work Management System”

15th August, 2017

Subject: LoGITReC Lab Work Management System

The “LoGITReC Lab WorkList Management System” is serving the purpose of job and sample management system for the administration of incoming work and the samples for specific projects.

With the use of the system, we are able to track the progress of jobs through the laboratory.

The software was installed on 10th April, 2017 by the project Materials Specialist, Mr Dave Ventura of the CSIR as the project service provider. The software was tested and demonstrated to the LoGITReC-CMRL Manager after installation. Subsequently, the Laboratory Manager demonstrated the software to all the technicians. All can now use the system without any problem.

So far, fourteen projects have been registered and can also be retrieved. All functionalities of the software have been tested and function as expected. Other than the problem of changing the Password, there have been no problems encountered since installation. This however does not limit the functionality of the software. Mr Dave Ventura is scheduled to visit mid-August at which time, he will address the problem.

The software currently can only be accessed on two computers in the Laboratory as LoGITReC-CMRL is not yet connected to the PO-RALG network to enable to be accessed by others on the network.

At the meeting held on 26 April 2017 at PO-RALG in Dodoma between the Project Leader, Dr Mgangira, Dr Magafu and Engineer Vincent Lwanda, the Project Leader indicated that in their proposal they had proposed inclusion of Kiswahili. It was pointed out that it was not necessary as the people expected to use the system will be competent in the use of English.

LoGITReC is satisfied with the “LoGITReC Lab WorkList Management System”.

Yours sincerely,



Eng V.C Lwanda
(LoGITReC-CMRL Manager)

