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Ethiopian Water Technology Institute (EWTI)

Guidelines for Training Operation and Management Vol. I

(Third Edition)

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The Project for Strengthening Capacity for Training Operation and Management for EWTI

Abbreviation

CC	Competence Certificate
CD	Course Design
CoC	Centre of Competence
EWTI	Ethiopian Water Technology Institute
DDG	Deputy Director General
DG	Director General
DT	Drilling Technology
EOS	Ethiopian Occupational Standard
JICA	Japan International Cooperation Agency
LAP	Learning Activity Performance
LM	Learning Module
LO	Learning Outcome
MoU	Minutes of Understanding
OHS	Occupational Health and Safety
TMC	Training Management Committee
ToT	Training of Trainers
TRB	Trainee's Record Book
TTLM	Training Teaching and Learning Material
TVET	Technical and Vocational Education and Training
UNICEF	United Nations Children's Fund
WTETD	Water Technology Education and Training Directorate

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1 Introduction

As per the Regulation No 293/2005 of the Council of Ministers, the Ethiopian Water Technology Institute (EWTI) has the power and duties to support the expansion of the provision of adequate water supply for drinking water and irrigation in the country by conducting practical short-term training courses in water technology, carrying out studies and research in the sector's key problem areas and undertaking the transfer of technology as well as providing technical support to Water TVET.

In order to execute its short-term practical training courses in a better systematic and standardised manner, EWTI has prepared the Guidelines for training operation and management in accordance with the mission of EWTI and in consideration of the experience of other similar institutions.

The Guidelines, by providing details in activities of the training operation and management, create clarity of operation regarding the rights and obligations of the implementing actors so that the education and training will be properly implemented without having any significant problems.

Therefore, the Guidelines are prepared with details of the components that are necessary for conducting training, which includes training principles, standards, training types, the process for training preparation and approval, the procedures for course announcements, selection and admission, assessment and evaluation, certification, training participants' regulations, training related services as well as the roles and responsibilities of the different actors.

1.1 Rational for the Need for the Guidelines and Process of its Development

The experience of the training implementation, both during the project period of EWTEC and with the present status of EWTI, has shown the severe lack of uniformity and standards from planning up to implementation phases. There have been no clear and documented official procedures for formulation and approval of training courses, Learning Module and Training, Teaching and Learning Materials; also, there have been no clearly defined assessment methods and certification procedures for awarding certificates to training participants; and there have been no clearly defined roles and responsibilities for the various actors or organisational units that are involved in the operation and management of short-term trainings in EWTI. In this respect, these Guidelines are deemed to be responsive to the above-mentioned constraints.

The Guidelines were drafted by a group of selected EWTI experts with the support of the EWTI/JICA Project. The process involved drafting and discussion in three consecutive workshops and the presentation and discussion with the whole expert and management staff of EWTI on two occasions.

1.2 Purpose of the Guidelines

The purpose of the Guidelines is to provide standards and uniformity from planning up to implementation of short-term training courses.

1.3 Scope of the Guidelines

The scope of the Guidelines covers the various short-term training courses that are planned and conducted in EWTI.

1.4 Characteristics of EWTI's Guidelines

The Guidelines for Training Operation and Management, besides provision of the standard four level training evaluation, promote the continuous training improvement by conducting:

- Daily reflection - the training participants at the end of the daily training session provide written comment regarding issues of the most interesting, challenging and the way forward for the next day.
- Recapitulation - every morning, based on forwarded comments from the training participants, the trainer discusses with the training participants the previous day's training session performance.
- Weekly reflection - at the end of the weekly training period, the training participants provide written comments on the most interesting, challenging and the way forward for next day.
- End course review - the course leader and other trainers who participated in the training, together with the department head, discuss the strengths and weaknesses of the training and build a consensus on the recommendations that need action for improvement in the training in the next programme.

1.5 Applicability and Revision

- The Guidelines should be operational after being approved by the Director General of EWTI.
- The Guidelines should be checked and revised every three years and whenever necessary.

1.6 Definitions of Key Terms

Assistant trainer: a staff member of EWTI employed as an assistant technician to provide assistance to a trainer while he/she is conducting practical demonstrations in workshops or field practices and during the conducting of LAP tests.

CC (Competence Certificate): a document issued by CoC, on behalf of the Federal TVET Agency, to individuals who were assessed as competent in a single unit or cluster of related units of competence, but this certificate may not cover all areas that are required in a qualification.

CoC (Centre of Competence): Autonomous government organisations delegated by the Federal TVET Agency to properly and effectively implement assessment and certification.

Training Course Design (CD): a form that describes the content of a training course which is usually submitted to the TMC along with the learning modules as part of the approval process for any new training course.

Course leader: a staff member of EWTI who is employed as a trainer to provide training and who is selected by the department leader to coordinate the implementation of a training course.

Customer: EWTI's customers are individuals or organisations (government, public enterprise, NGO or private) that send training participants to be trained at the EWTI.

EOS (Ethiopian Occupational Standard): a standard that defines the competences that a person must possess to be able to perform and be productive in the world of work in Ethiopia.

Learning Activity Performance (LAP) test: a practical test (of formative assessment) given to training participants, as individuals or groups, to assess participants' acquisition of the competency at the end of each LO during the training course. The LAP test comprises skill demonstration and oral questions.

Learning Module: an organised collection of training contents presented together under each learning outcome. Learning Module describes module title, module code number, module contents, methods, and assessment criteria.

Learning Outcomes (LOs): the statements that describe the significant and essential learning that training participants have achieved and can reliably demonstrate at the end of a course or learning guide. In other words, Learning Outcomes identify what the training participants will know and be able to do by the end of the training course or each learning guide.

Occupational Standard: a standard defined by experts of the world of work indicating the competences that a person must possess to be able to perform up to the expected level and be productive in the world of work. It is composed of units of competence that define a particular scope of work resulting in a product, service or decision.

Performance Evaluation Guide (PEG): a guide for trainers to prepare (necessary inputs and settings for assessment), execute and record performance evaluation of individuals or groups of training participants in a standard and an orderly manner for consecutive assessments through demonstration and oral questioning (of LAP tests).

Stakeholder: EWTI's stakeholders are management and non-management staff of EWTI, its customers, Ministry of Water and Energy, Ministry of Finance, Parliament members of concerned Committees, Development Partners such as JICA, UNICEF, King Mohammed IV Morocco Foundation, etc.

Trainer: a staff member of EWTI who is employed to provide training and subsequently assigned by the concerned training department on one or more of EWTI's training courses which are directly related to his/her academic profession and skills gained through his/her work experience.

Training Course: is a course which is composed of one or more training modules for theoretical and practical skills development related to a particular job or activity.

Training Participant: a person undergoing training on a training course given by EWTI.

TTLM (Training, Teaching and Learning Material): a trainer-made instructional aid that supplements the trainer's oral and visual instructions. It is a well-designed and carefully developed learning aid that provides detailed instructions to the training participants.

Unit of Competence: a coherent and explicit grouping of performance specifications within an occupational profile, which involves the application of knowledge, skills and any other ability required in the workplace.

1.7 Reference Sources

The following documents are referenced to formulate the Guidelines.

- Training Guideline, Leather Industry Development Institute
- TVET Training - Curriculum - Requirements, 2017 (Ethiopian Standards Agency)
- TTLM Development Manual, July 2011 (MoE)

- EOS Development Guideline, July 2009 (MoE)
- Occupational Assessment and Certification, December 2010 (MoE)

2 Principles of EWTI's Training Provision

2.1 Basic Principles

- EWTI training management committee shall be established and will approve, direct, control, monitor and evaluate the overall training operation and management activities of EWTI under the Director General and Deputy Director Generals of EWTI.
- Learning process shall be focused on outcomes that are linked to the workforce needed, as defined by employers and the profession.
- Learning shall be competency based and modular in structure.
- Training delivery shall be learner-centered and promoting self-learning.
- Training materials must be compatible with the national competency standards (EOS: Ethiopian Occupational Standards) and/or well recognised by international practices in the sector.
- Assessment of training participants shall be based on the collection of evidence of work performance conducted before, during and after the training.
- The training delivery system recognises the prior learning of participants.
- The system allows for training participants to re-enter a programme at different times if he/she obtained an unsatisfactory result in his/her previous assessment.
- Approved training courses must be nationally accredited.
- EWTI's training courses should fulfil international standards.
- Trainers can be assigned either from EWTI or external sources.
- The training system shall promote an equitable and inclusive learning process (inclusive of all genders, disability, ethnic groups, political perception etc.)
- The learning process shall be designed with consideration of the demands and the satisfaction of customers.
- Every training programme must include as its 1st LG; the introduction of Teamwork, Kaizen and OHS principles and practices.
- Every short-term training course must be designed based on the combination of the unit of competency but may not necessarily cover all units of competency under one level of the EOS.

2.2 Definition of Short-term Training

For the purpose of the Guidelines, short-term training is defined as follows:

- It is an activity of learning or teaching the skills, knowledge, and the right attitude of specific competencies for a particular job or activity.
- Its duration shall not be more than three months.
- For regular training, the minimum training duration should not be less than 3 days.

2.3 Types of Short-term Training

a) EWTI's short-term training course can be classified into two parts, as a Regular training course and as an On-demand training course as defined below:
   - A Regular training course is a training course planned to be conducted on a regular basis as per the annual training plan of EWTI.
   - An On-demand training course is a training course that can be conducted based on a request from customers (local or abroad) outside the schedule of the annual training plan of EWTI. An On-demand course is subdivided into either a tailor-made training course designed to

be conducted based on the specific requests from customers or a ready-made training course that has the same contents as a regular training course but is to be given in addition to the annual training plan.

b) Based on the location where the training shall be conducted, EWTI's short-term training course can be further classified as:
   - In-compound training - taking place inside the classrooms and workshops of EWTI with demonstrations and self-practices.
   - On-site/field training - taking place in the place where the real work environment prevails.
   - On-the-job training - training to be given at a place of work while the trainee is doing the actual job; usually a professional trainer (or sometimes an experienced employee) serves as a course instructor, often supported by an additional classroom lecturer.
c) Based on the level of training, EWTI's short-term training courses can be classified as basic and advanced:
   - Basic training courses are those EWTI training courses which are introductory and very basic in their provision of theoretical and practical skills in their respective fields;
   - Advanced training courses are those EWTI training courses which deal with relatively high level and complex issues in their provision of theoretical and practical skills in their respective fields.

2.4 Modality of Training

EWTI's training programme aims at achieving the highest degree of harmony between what the training participants study and what is required in the actual work sites through the cooperation of the educational institutions and the business enterprises/organisations.

2.5 Trainers Profile

2.5.1 EWTI Trainers

EWTI's permanent trainers are expected to have the following profile:

a) Fulfilling minimum educational background - graduated from a recognised college or university with degree or above in a related profession as well as having proven practical experience in the related field. In some exceptional practical training cases, the minimum criteria can be modified with the approval of the department concerned.
b) Attendance of ToT session on Kaizen principles is a precondition for trainer(s) to be assigned as a trainer on common modules.
c) Understanding EWTI's Guidelines for Training Operation and Management – every trainer should attend orientation on the operation and management procedures before being assigned as a trainer.
d) National certification (skills, how to teach) - if the training is based on a unit of competency as defined in the Ethiopian occupational standards, an assigned trainer must have:
   - Competency Certificate (CC) in that particular competency - EWTI shall arrange the assessment programme for CC with the concerned Centre of Competency (CoC).
   - Training methodology certificate - trainers must take a training methodology course given for TVET trainers and must be certified, and EWTI should arrange the training and assessment programme for methodology certification of its trainers.

2.5.2 EWTI's Guest Trainers

EWTI's guest trainers who are hired to serve a particular service related to EWTI's training are expected to have the following profile:

a) Fulfilling minimum educational background - graduated from a recognised college or university with a degree or above in a related profession as well as having proven practical experience in the related field. In some exceptional practical training cases, the minimum criteria can be modified with the approval of the department concerned.
b) Understanding EWTI's Guidelines for Training Operation and Management – every guest trainer should attend an orientation on the operation and management procedures before being assigned as a guest trainer.

2.6 Training Management Committee (TMC)

a) Training Management Committee (TMC) should be established in EWTI to approve the annual training plan, new training programme and evaluation (quarterly and annually) of training implementation for the short-term training courses of EWTI. TMC can be chaired by the Director General of EWTI or any other ranked person assigned by the Director General.
b) TMC consists of the following members:
   - Director General (DG) ..... Chairperson
   - Deputy Director Generals (DDGs) ..... Members
   - Water Technology Education and Training (WTETD) Director .. Member / Secretary
   - Water TVET Support and Competency Assessment Director..... Member
   - Registrar ..... Member
   - Finance and Procurement Director ..... Member
   - General Service and Property Administration Director..... Member
   - Planning, Monitoring and Evaluation Director ..... Member
   - Corporate Communication Director……Member
   - All Training Departments Team Leaders of WTETD..... Members
c) In the absence of the Director General, the designated Deputy Director General for the WTETD should be the chairperson for the meeting of TMC.
d) Despite the above article 2.6 b), EWTI Top Management (DG and DDGs) can include both internal and external experts who can contribute to the successful implementation of training operation and management activities as non-voting members of the committee.
e) TMC members perform their assigned roles and responsibilities as stated in 10.2 of the Guidelines; and they are expected to consider the overall activities of the committee as their accounted task.
f) TMC members should meet every quarterly every year. However, whenever necessary, the chairperson can call for a meeting before the regular meeting time.
g) For proper execution of its responsibilities, TMC should establish the following sub-committees to perform review and recommendation whenever direction is given by the chairperson of TMC:

1) Review and Recommendation of New Training Course / Learning Module Sub-committee:
   - WTETD Director — Chairperson
   - Training departments Team Leaders concerned — Members
   - Registrar — Member / Secretary

2) Annual Training Plan Review Sub-committee:
   - Planning, Monitoring and Evaluation Director — Chairperson

▪ WTETD Director	Member
▪ Property Administration & General Service Director	Member
▪ Water TVET Support and Competency Assessment Director	Member / Secretary

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3 Planning and Approval of EWTI Annual Training Plan

Category	Task	Output	Timing	Responsible
Demand assessment	▪ Assessing the skill gap or needs of the industry ▪ Reviewing current training courses	Preparing studies report	Every three year	Training and Education Directorate
Pre-planning document review	▪ Reviewing the demand assessment ▪ Reviewing last physical year performance feedback ▪ Reviewing strategic plan of EWTI.	Data, Figures, inputs for the plan	Before June 30	Head of All departments. Education and Training Directorate
Training plan programme/ schedules	▪ Identify the list of courses to be offered throughout the physical year ▪ Set time schedule (duration) for each course ▪ Numbers of training participant for each course ▪ Name of target organisation (s) ▪ Decide options of the sites where field practice will be conducted	Annual training schedule which Comprises numbers of training participants, target organisations and selected sites for field practices	August	Head of All departments. Education and Training Directorate
Training materials / facilities preparation	▪ Revision of TTLM, module, handout, PowerPoint, reference materials ▪ Preparation of necessary training facilities (machinery, materials, classrooms, workshops, IT rooms etc.…)	Updated training materials and other resources	August	Heads of All Departments
Assign a course leader	▪ Department should assign a course leader for each training round which is under the department	Assigned course leaders for each training round	August	Heads of Department
Assign trainers for each LOs of the training courses	▪ According to their academic level and experience, the department head should assign the trainers for all LOs after consultation with the course leaders	Trainers assigned for all LOs	August	Heads of Department
Compile all departments annual plan to prepare the EWTI academic plan	▪ Collecting each department's training plan ▪ Compiling and Organising EWTI's annual training plan ▪ Internal discussion with the implementers	EWTI draft annual academic plan	Before mid-August	Education Training directorate TVET support directorate
Approval of Annual training plan	▪ Training Management Committee will approve plan after discussion	Approval	Mid-September	Training Management Committee
Notification of annual training plan	▪ Announce, notify or dispatch approved programme to all stakeholders	Annual training plan finalised	Immediately after approval	Registrar's Office

4 Formulation, Approval and Evaluation of Training Course, Curriculum (Learning Module) and TTLM

4.1 Training Course Preparation, Approval, Evaluation, Revision and Cancellation

4.1.1 Training Course Formulation

a) Training course formulation should follow the following steps:
   - Reviewing the existing training needs assessment or conducting an assessment.
   - Checking access to training in other training institutions.
   - Identifying the resources needed for the training.
   - Formulating the training course document.

b) Since EWTI training courses are outcome-based; they should follow similar forms to those outlined in the documents of the Ethiopian Standards Agency which comprise the following:
   - Training Course Design (CD, TG-1)
   - Learning Module (LM, TG-2)
   - Resource Requirements (TG-4)

c) Training course design should fulfill the following requirements:
   - Course title
   - Course code
   - Qualification level and certification
   - Unit of competence
   - Course description
   - Course learning outcomes
   - Duration of the course
   - Target groups
   - Entry requirements
   - Mode of delivery
   - Institutional assessment
   - Trainer profile

4.1.2 Training course approval

a) Proposal of new training course (CD and LM) must be submitted at least three weeks before the TMC meeting, and dispatched to all members.

b) The department or the person who prepared the Training course proposal should provide a presentation to the committee members.

c) TMC can approve the training course by checking all requirements mentioned below:
   - If the market-demand survey (training needs assessment) findings show there is adequate training demand for the specified course.
   - If there is no or limited access to get training in local Universities, TVET and other public or private training institutions for the specified course.
   - If the training course has achievable objective/s, appropriate methodology, clear alignment with sector policy and strategy.
   - If EWTI has human and material capacity to deliver the training as per these Guidelines.

d) If needed, TMC can decide to get advice from external experts working in the water industry.

e) If needed, TMC can arrange and organise a validation workshop among stakeholders to further check the criteria mentioned in 4.1.2 (c).
f) TMC members should approve or recommend for further studies and or improvement.
g) An approved training course must be tested and improved at least twice through pilot training courses to become a permanent annual training course.
h) Any training course should be implemented after the approval of the TMC.

4.1.3 Training course evaluation, revision, and cancellation

a) Every training course must be evaluated as per 7.2 of these Guidelines.
b) All training courses should be evaluated and revised following a change in national qualification standards, a major shift in the use of specific technology or working procedures.
c) The respective department will be responsible to conduct evaluation, revision, and submission of a revised training course to the TMC.
d) A revised training course should be shared with all stakeholders.
e) A training course should be dropped out of the annual training plan based on adequate analysis and by the decision of the TMC when there is absence of the minimum number of participants.
f) A cancelled training course can be reserved as a potential training course and may be reactivated following the results of a recent demand assessment.

4.2 Preparation, Approval, Evaluation and Revision for Learning Module (Curriculum)

4.2.1 Learning Module (LM) preparation

a) LM should be produced by the respective department or any other stakeholders based on labour market demand and/or training needs assessment findings of the sector.
b) LM should be prepared using a standard form that is compatible with national TVET qualification framework.
c) Initially the draft curriculum should be evaluated at a department level, and if needed, external experts can be invited to conduct a further evaluation.
d) LM will be prepared during the formulation of a training course.
e) Quality of the training LM should be measured with reference to its ability to consistently comply with the applicable regulatory requirements and for it to conform to the requirements of the Ethiopian Standards Agency.
f) LM should be designed based on the national occupational standards and/or international practices to address the demands of stakeholders and interested parties.
g) LM should be focused on outcomes that are linked to workforce needs, as defined by employers and the profession.
h) LM may address inclusive training.

4.2.2 Learning Module approval

a) Proposal for the initiation of a new LM should be submitted to the TMC for approval by the respective department.
b) Final draft of revised LM after the development of TTLM should be submitted by the department concerned for approval by TMC.
c) TMC should assess, discuss, and approve the curriculum (LM).

d) TMC will make decision based on general and specific criteria of standard LM listed in the Ethiopian standards document.
e) TMC should invite experts from specific professional area(s) to review LM if necessary.
f) Any training curriculum should be implemented after the approval of TMC.

4.2.3 Learning Module evaluation and revision

a) Approved training LM by TMC should be revised following a change in national qualification standards, a major shift in the use of specific technology or working procedures.
b) Course leaders and trainers are responsible to evaluate LM and identify the necessity of revision.
c) When the course leader and trainers agree to make revision(s), they can make them by themselves.
d) Course leader and trainers should submit the revised LM to their respective department for approval.
e) The department head should approve and submit the revised LM for final approval to the TMC.
f) LM should be revised annually, if TMC confirms the necessity following customers' feedback or any other unforeseen circumstances.

4.3 Training Teaching and Learning Materials (TTLM)

4.3.1 TTLM preparation

a) TTLM shall be prepared by the course trainer/s, as per the required quality as set out in the Quality Requirement Table (Annex 2). TTLM generally has three components, namely: Learning Guide, Trainer's Guide and Assessment Package.
   i. **Learning Guide** has the following contents:
      - ✓ Instruction sheet
      - ✓ Self-check
      - ✓ Information sheet
      - ✓ Operation sheet
      - ✓ LAP-test
      - ✓ Reference/source
   ii. **Trainer's Guide** has the following contents:
      - Training Course Design (TG-1)
      - Learning Module (TG-2)
      - Performance Evaluation Guide (TG-3)
      - Resource Requirements for Learning Module (TG-4)
      - Training Course Announcement (TG-5)
      - Training Schedule (TG-6)
      - Session Plan (TG-7)
      - Learning Guide:
        - ✓ Instruction sheet
        - ✓ Self-check (with sample answers)
        - ✓ Information sheet
        - ✓ Operation sheet
        - ✓ LAP-test
        - ✓ References/sources
      - Pre/post Test (TG-8, TG-9)

- Pre/post-training Questionnaire (TG-10,TG-11)

iii. **Assessment packet** has the following contents:

- Performance Evaluation Guide (PEG:TG-3)
- Formative assessment (LAP test)
- Evidence plan
- Summative assessment (Written test or Post-test, TG-11)

b) TTLM should be prepared using a standard form, as annexed in this document, which was adopted from the national TVET qualification framework (Annex 3).
c) TTLM may either be "resource based" or "self-contained".
d) Based on TTLM, Course trainer/s should prepare PowerPoint as per the standards listed in these Guidelines.

4.3.2 Main Distinctive Features of EWTI TTLM

EWTI TTLM has to be developed by ensuring that it is as compatible as possible with the national TVET qualification framework; however, EWTI's short term courses cannot be fully compatible with Unit of Competencies listed under EOS developed for water works; due to this reason, EWTI TTLMs have to be developed within its own unique environment. The main distinctive feature of EWTI TTLM are:

- Self-check First approach instead of information sheet before a Self-check.
- Common LM in all training courses with teamwork, OHS and Kaizen practice.
- Assessment method with Post-test (knowledge test) and LAP tests which are only for practical test with demonstration and oral questioning.
- Standardised Session Plan and Training Schedule.

4.3.3 TTLM approval

a) LM proposal must be first developed by the department concerned and to be submitted for approval by the TMC before the development of TTLM.
b) Final draft TTLM must be prepared as per approved LM by the department concerned.
c) The respective department shall assess, discuss, and approve TTLM except LM.
d) If LM is revised during TTLM development, it should be submitted to the TMC for approval.
e) The department will make decision based on general and specific criteria of standard TTLM listed in the Ethiopian standards document.
f) The department should invite experts from specific professional areas to review the TTLM if necessary.
g) Any TTLM except for CD and LM should be implemented after the approval of the department.

4.3.4 TTLM evaluation and revision

a) TTLM should be revised annually, if the department has confirmed the necessity following customers' feedback or any other unforeseen circumstances.
b) TTLM should be revised following a change in the contents of LM.
c) Course leaders and trainers are responsible to evaluate TTLM and identify the areas for revision.
d) When the course leaders and trainers agree to make revisions, they can revise them by themselves.

e) Course leaders and trainers should submit the revised TTLM to their respective department for approval.
f) The respective department should assess, discuss, and approve the revised TTLM except CD and LM.

5 Course Announcement, Selection and Admission

5.1 Course announcement

a) The Registrar's office makes training course announcement to target organisations one and a half months prior to the start of the training, using Training Course Announcement (TG-5).
b) Training Course Announcement for institutional invitation includes as a minimum the following information and instructions:
   - Course title and contents (learning module)
   - Course schedule (date, training contents, lecture hours, practical hours, trainer,TG-6)
   - Entry requirements (qualifications)
   - Statement for automatic rejection of candidates not fulfilling the requirement
   - Statement for encouraging women applicants
   - Maximum number of training participants expected from the invited organisations
   - Service provisions provided by EWTI for the training
   - Costs to be covered by training participant's organisation
   - Language to be used in the course
   - Working clothes and other safety materials to be brought by the training participants
   - Candidate application form, which includes full name of the participant, educational background, work experience, salary, job position etc. (AP-1)
   - Deadline for notification of applicants from invited organisations (one week before the commencement of the training course)
   - Schedule for notification of acceptance from EWTI
   - Deadline for registration
c) Training Course Announcement for private applicants:
   - Individual applicants are expected to fill the application form (AP-2)
   - Application can be done physically or online.

5.2 Medium/mechanism of announcement

EWTI announces its scheduled training programme to invite training participants using one or a combination of the following announcement mechanisms:

- P.O Box, Fax, telephone
- Mass media such as radio, TV, newsletter, etc.
- Electronic media such as e-mail, web site, social media, etc.

5.3 Criteria for selection and notification of training participants

a) Criteria for selection of training participant/s from invited institutions are:
   A. Fulfillment of the entry requirements (qualifications)
   B. The number of training participants to be admitted are within the allocated figure for the particular invited organisation
   C. The number of training participants to be on the waiting list may be accepted, considering the available spaces
b) Invited organisations notifies the profile of the potential training participants using the specified form before the deadline.
c) Invited organisations are expected to write official notification letters to confirm that they will cover the cost described in the announcement.

d) Participant's official notification letters must include:
   - Full name of the participant
   - Educational background
   - Work experience
   - Salary
   - Job position
   - Course title to be attended

e) Criteria for selection of training participant for Individual applicants:
   - Fulfillment of the entry requirements (qualifications)
   - Private training participants can be selected based on allocated space for private applicants
   - When the number of applicants becomes greater than the space provided, training participants should be selected on a first come, first served basis
   - Female and disabled applicants should get priority during selection
   - Individual applicants are expected to cover their own accommodation costs, EWTI will provide training services for free, and also field training per diem as per government allowance directives

5.4 Admission process

5.4.1 Notification of Acceptance or Rejection

The Registrar's office notifies the invited organisations for acceptance or rejection of the candidates based on the profile sent back by the invited organisations.

5.4.2 Registration and tuition fees

a) Registration payment
   - No registration fees for regular training courses
   - Registration fees are paid when the training is an on-demand training course
   - The amount of the registration fees should be Birr 55.00 per training participant

b) Tuition fees
   - No tuition fees for regular training courses
   - Tuition fees should be paid if the training is on-demand with the amount agreed by the requesting organisation and the Institute

c) The Registrar's office makes registration of those training participants who arrive before or upon the deadline after first checking the fulfillment of the following:
   - Target training participants should bring an official letter (that describes acceptance or agreement for conditions stated in the announcement) from the invited organisations; and
   - Settlement of registration fees if the training is an on-demand training course.
   - Target training participants should bring the requested list of working clothes and other safety materials.

d) Training participants who come after registration day will not be admitted. However, if a training participant's lateness has a justifiable reason he/she may be admitted so long as he or she is not delayed by more than one day late.

e) The Registrar should prepare a list of participants (TM-3).

6 Training Operation

6.1 Training period

6.1.1 Training annual plan

a) Implementation of the annual training plan after being approved in August should start from the 2nd week of September.
b) Implementation of the annual training programme should end on July 7.
c) On-demand training can be implemented throughout the year so long as suitable times are arranged that do not affect the smooth implementation of the regular training programme.
d) The period from July to the last week of August should be used as preparation time for reorganising workshops on Kaizen principles, and for the maintenance of training equipment/materials such as drilling rigs, compressors, cranes, generators, pumps, etc.

6.1.2 Training Schedule

a) Training schedule must be prepared for each training course by the course leader with the approval of the department concerned.
b) The training schedule should be prepared by specifying in detail the activities with their allocated times as per the attached standard training schedule form.

6.1.3 Duration of daily training session

The training programme should be conducted with a morning and an afternoon session for a total of 5 hours excluding 30 minutes break in the morning and afternoon sessions. The details are as shown in the Table below.

No	Activities	Hour
1	Morning training session	09:00 am - 10:30 am
2	Tea break	10:30 am - 11:00 am
3	Morning training continuation	11:00 am - 12:00 am
4	Lunch break	12:00 am - 02:00 pm
5	Afternoon training session	02:00 pm - 03:30 pm
6	Tea break	03:30 pm - 04:00 pm
7	Afternoon training continuation	04:00 pm - 05:00 pm

a) The details of any training session, as shown in the above table, should be applicable for regular or on-demand training courses to be conducted in classrooms, workshops, and field practices or for any training courses that may be implemented inside or outside the Institute's compounds.
b) The normal training days in the Institute should be the government working days, i.e., from Monday to Friday; and with the agreement of the trainer with the training participants, Saturday may be used in addition to the normal working days. However, during field practices and when conducting on-demand training courses, training may be conducted on Saturday and Sunday on a conditional basis.

6.2 Training postponement and cancellation

a) If the number of registered training participants for a single training programme except for training under Drilling Technology is less than five, this training programme should be cancelled or postponed until another time. In case of training courses under the DT package, the training course should be cancelled if the number of registered training participants is less than seven.
b) If it is found necessary to cancel or postpone the training programme due to other serious problems, the TMC must discuss and notify its decision before announcement of the training is made.

6.3 Conducting orientation

a) Orientation should be given for registered training participants for a period of not more than 30 minutes on the next day after the day of registration.
b) During the conduct of the orientation programme, the TMC chairperson or representative, the course leader, the team leader concerned or training officer and representatives from the General Service and Finance Directorates should be present.
c) The Registrar must modulate the orientation process; the course leader should make brief explanation of the training course; and training participants' rights and obligations as well as other service provisions should be explained.
d) Responses and explanations to questions raised by the training participants should be given by the officials concerned or representatives presented in this orientation.

6.4 Training delivery system

6.4.1 General

- The training delivery system of the Institute is comprised of two parts: theoretical and practical exercises. The theoretical part of the training covers 30 % of the total training duration whereas the practical exercises cover 70 % of the training duration, excluding field trips outside the curriculum.
- The theoretical part of the training can be given in classrooms and workshops or in the Institute's laboratories; however, if the training is an on-demand training course, the theoretical training may be given in a place that is agreed between the requesting organisation and the Institute.
- The practical training can be carried out in the Institute's workshops and laboratories as well as in the industries that are outside the Institute.
- Appropriate sights or places for practical exercises or field practices should be identified annually before the end of the 1st week in August.
- MoU should be signed between the Institute and selected organisations where practical exercises should be carried out.
- One week before the start of the field practice, the department concerned should make contact to make sure that the selected organisation is ready to accept the training participants for the practical exercise.
- As per the schedule of the training, the trainer/s should take the training participants to the field site and conduct the practical exercises.

6.4.2 Training Delivery

EWTI's training delivery gives special emphasis for effective implementation of the following:

- Course orientation (general and course specific guidance) with the opening of the training programme; and following course orientation, pre-test and pre-training questionnaire will be given to training participants on the same day and these will be administered by the Registrar
- The 1st LO of every training course deals with Teamwork and communication, Kaizen principles and practices, OHS principles and practices
- Self-check exercise should be conducted before a lecture of every information sheet
- Conduct daily reflection through a written comment at the end of every day's training session and recapitulation the next day before the start of the next session
- Conduct of weekly reflection at the end of every week's training programme
- LAP test implementation at the end of every LO of the training course
- Daily Kaizen principles exercise by training participants during the whole training period. (Assessment of training participant's Kaizen practice as part of LO1's LAP test will be carried out through all other remaining LOs of the training course)
- Post-test, post-training questionnaire and training programme evaluation will be carried out after the end of the training course
- After the end of training course, post-test, post-training questionnaire and training evaluation, each training participant should prepare an Action Plan
- Final reflections on Kaizen and training course should be carried out with training participants before the closing ceremony
- End of course review should be carried by participating trainers with the training department head and a representative from the TMC present

6.5 Forms

Forms that should be used by trainers during training implementation are the following:

a) Attendance Sheet for Training Participants and Attendance Sheet for Guest Trainers should be made as per TM-4 and TM-5.
b) Trainee's Record Book (TRB, TM-6) should be prepared based on the approved LO for all training courses; the Education and Training Team under WTETD should collect from all departments concerned and make sure to put the EWTI logo; and after getting approval from the TMC, send for printing with an adequate quantity enough for one year.
c) Training Participants Progress Chart should be prepared in accordance with the national TVET implementation standards (TM-7).
d) Training Participants Assessment Data Sheet should be used to record the training participants' detailed assessment results including LAP test under each LO and Post Test (TM-8).
e) Training Participants Progress Chart should be posted by the course leader or trainer in a suitable or easily observable place in the classroom and write/record the necessary information (assessment result) from the start of the training up to its completion.
f) PowerPoint presentation material: every trainer for his/her assigned course should prepare a PowerPoint presentation depending on the necessity. The training department concerned is responsible to supervise the proper preparation of PowerPoint presentations as per the Guidelines.
g) The Power Point prepared in EWTI (for those who do not have operation sheet, software training, and clarification and Q&A) should fulfill the following criteria:

- Every slide must have the EWTI logo
- One slide should have no more than 6 lines and 30 words
- Font size for title and details should be 32 pt. and 24 pt. respectively
- Font type should be either Arial or Times New Roman
- The first four slides should be used to reflect the following issues:
  - Introducing the trainer and training participants to each other
  - Training schedule
  - Objectives of the training

h) Training participants' expectations from the training, etc. A Session Plan should be prepared for each Learning Guide during the TTLM preparation. (TG-7)

i) Pre-test and post-test (TG-8 and TG-9) which comprise theoretical tests should be prepared covering all LOs with agreement reached among all involved trainers; and the prepared test (soft/hard copies) should be kept with the head of the department concerned. One day before the start of the training, the course leader should make the necessary number of copies. The pre-test will be given to training participants on the 1st day of training and the results should be recorded on the Training Participants Progress Chart; and the post-test implementation should be carried out in the final stage of the training.

j) Up on the completion stage of the training programme, training participants are asked to prepare an action plan for activities they are going to implement when they return to their respective work places using the Action Plan Preparation Form (TM-9).

6.6 Language

The language of the training delivery in EWTI should be English.

6.7 Preparation for field practice

a) At least one week before the training course announcement, the course leader should prepare a Field Practice Proposal (TM-1) with clearly stated objectives, selected field sites, list of activities, duration and expected out puts.

b) One day after the registration of training participants, the Education and Training Team should confirm by communicating with letter or getting an MoU signed by organisations selected for the field practices.

c) One day after the registration of training participants, based on the Field Practice Proposal, the assigned training officer should prepare a financial proposal and follow-up the process.

d) Two days before the start of a field trip, the course leader should make sure the completion of every necessary preparation. One day before the start of the field trip, the Finance Directorate should pay per diem for training participants and other payments for assigned persons for expenses such as fuel and lubricants based on the submitted request. EWTI should pay per diem for course coordinator, trainers, training participants and assigned support staff based on government directives; and the general service should assign vehicles and drivers for the planned field trip and announce the same two days before the field trip. All trainers assigned for the specific leaning objective may participate in the field practice exercises. The course leader in consultation with the trainers who participated in the field practice exercises should prepare the Field Training Completion Report (TM-2).

e) Field training schedule and some information regarding the site as well as background and the purpose of field training should be explained to training participants by the course leader at the latest one day before the field trip.

6.8 Provision of training materials and boarding services for training participants

a) Notebook, pen, and other related materials should be purchased by EWTI at the beginning of the fiscal year. The Training and Education Team should request and receive these materials from the store before the reception of the training participants and distribute the same to the training participants during the orientation time.
b) The trainer should distribute TTLM, handouts and other prepared documents to training participants on the first day of the training and the course leader should confirm the same.
c) General Service Directorate should provide bedrooms, soft paper, soap, and other materials for the bedrooms for those training participants who completed registration for the training programme.
d) General Service Directorate should maintain good sanitation/hygiene of the classrooms, dormitory blocks, toilets and bathing facilities.

7 Training Assessment, Evaluation and Reporting

Assessment takes place before, during and after the learning process and is both qualifying and focused on the competence development of students.

7.1 Training participants assessment

The assessment process in EWTI should be as follows:

a) The training participants should be assessed both in knowledge and practical skills, according to the assessment criteria on LM.
b) The training participants should be assessed using the Performance Evaluation Guide.
c) There will be a pre-test (at the beginning of the training), LAP tests at the end of every LO and a post-test at the end of the training.
d) LAP tests and post-tests are the key assessment tools, which are compulsory for all the training participants. The minimum pass mark for each LAP test (practical) is 100% and for post-test (for knowledge /written test) is 50% and above.
    i. Method of assessment for LAP tests are two ways: demonstration and oral questions.
    ii. Both demonstration and oral questions can be arranged in a group or on an individual basis but evaluation should be on an individual level.
e) If a training participant cannot pass the LAP test on his/her first trial, he/she has a second chance to take the LAP test.
f) Tests should be properly marked by the trainers.
g) Test results should be properly recorded in a Trainee's Record Book (TRB, TM-6), Training Participant's Progress Chart (TM-7) and Training Participant's Assessment Data Sheet (TM-8).
h) TRB must show the detailed results of the tests of all LO.
i) The course leader and other assigned trainers are responsible for compiling a pre/post-test questionnaire from already prepared self-check questionnaires found in TTLM.

7.2 Training evaluation

a) As per internationally accepted training evaluation systems, EWTI training programmes will be evaluated in four levels of evaluation (Reaction, Learning, Behaviour and Result).

Level of Training Evaluation	What to evaluate	When to evaluate	Who will evaluate
Level I	Reaction: What is the reaction of participant to the training?	During the training process	Course leader and trainers
Level II	Learning: What kind of knowledge and skills were acquired by the trainee?	During the training process	Course leader and trainers
Level III	Behavior: How do participants apply the knowledge and skills acquired to their work?	Six months after the end of the training	Department members and Education and Training Team Participants' organisations
Level IV	Result: What is the impact of the training to the goal of the organisation?	In the third year	Department members and Education and Training Team Participants' organisations

b) Training participants are given the opportunity to evaluate the training throughout the training course period as well as at the end of the training course.
Everyday training participants will give feedback to the trainer at the end of daily sessions orally or in written form (Daily Reflection Sheet, TM-10).

- At the beginning of every daily lesson, training participants should provide a recapitulation presentation of the last day's training session. The approach will be by group.
- At the end of every week, the trainer and the course leader should evaluate the weekly progress together with training participants; this will be applicable only for those learning modules of more than one-week's duration (Weekly Reflection Sheet, TM-11).
- At the end of the training programme, training participants are expected to evaluate the entire learning process, with respect to trainers and administrative services provided by the Registrar's office. (Training Evaluation Form, TM-12).
- The result of evaluation should be summarised and compiled by the Registrar with the support of the course leader (TM-13).

c) The course leader and the trainer with the oversight of the department head must facilitate the conduct of daily reflection, weekly reflection, end course review and training evaluation.

7.3 Reporting

7.3.1 Responsibility of writing report

Upon the completion of every training programme, the course leader should prepare the training completion report and submits it to the head of the department concerned.

7.3.2 Contents of report

a) The training completion report should have at least the following points (Training Completion Report, TM-14):
- Name of the training course and its objectives
- Duration and period of the training implementation
- List of training participants and trainers who participated in the training programme
- Assessment results of the training participants
- Difficulties encountered and measures taken during the implementation of the programme
- Recommendations or suggestions for a better future implementation

b) Following documents should be attached:
- List of Participants (TM-3)
- Training Participants Progress Chart (TM-7)
- Summary of Training Evaluation (TM-8)
- Summary of Pre/Post-training Questionnaire (TG-10, TG-11)

7.3.3 Deadline of report submission

The training completion report should be prepared and submitted within 10 days after the completion of the training course to the department head.

7.3.4 Approval of report

a) The department team leader should check and approve the training completion report and submit the same to WTETD.

b) Notwithstanding the provision of 7.3.4 (a), the department team leader should submit the assessment result, which is part of the training completion report, to the Registrar's office one day before the end of the training course programme.

8 Certification

Based on the summary results scored by the training participants on the consecutive assessments made on completion of each LO, EWTI should prepare and issue one of the two types of certificates for each training participant who completed the short-term training course. The Registrar is responsible to prepare the certificates for all short-term training courses conducted by EWTI.

8.1 Type of certificates

a) Certificate of Successful Completion
This type of certificate is awarded to a training participant who scores satisfactory or more on the summary result of the consecutive assessment by attending at least 85 % of the training period (TM-15).

b) Certificate of Participation
This type of certificate is awarded to a training participant who attends at least 85 % of the training period but obtained an unsatisfactory score on the summary result of the consecutive assessment (TM-16).

c) If the training is on-demand, issues to do with logos will be decided in consultation with the financing organisation to cover the cost of certificate printing.

8.2 Process of certification

a) A training participant can be awarded a certificate only if he/she attended at least 85 % of the total allocated training time.
b) With the fulfillment of attendance rate, if the submitted training participant's assessment result (on theoretical and practical tests) by the department concerned showed SATISFACTORY, the certificate to be prepared and awarded should be a "certificate of successful completion".
c) With the fulfillment of attendance rate, if the submitted assessment result (on theoretical and practical tests) by the department concerned showed UNSATISFACTORY, the certificate to be prepared and awarded should be "certificate of participation".
d) The training certificates must clearly show the training participant's performance on completion of the training as well as create conditions that promote more attentiveness and effort among training participants.

8.3 Preparation and awarding of the certificates

a) Based on the assessment results and the training participants' attendance records submitted by the department concerned, within a half a day, the Registrar should identify those training participants who should be awarded "Certificate of Successful Completion" and those training participant/s who should be given "Certificate of Participation".
b) The Registrar, based on the submitted results and the attendance records, should prepare the certificates within one day of receiving the results.
c) The Registrar, on the same day that the certificate preparation is completed, should submit the prepared certificates to the Director General of EWTI to get approval and signature.
d) The training participants should be awarded their training certificates alongside their TRBs on an occasion with the presence of trainers, course leaders, and top officials (or their representatives) of EWTI.

e) The following information should be included in both types of certificates:
- Logo of EWTI
- Description of the training
- Duration of the training
- Name of the training participant
- Description of the training accomplishment (participation or successful completion)
- Signature of the Registrar on the left side at the bottom of the page
- Signature of the Director General on the right side at the bottom of the page

9 Type of Training Related Services for Training participants

9.1 Training fees

a) EWTI provides regularly planned training programmes for water sector institutions free of charge.
b) At the request of on-demand training from stakeholders, training fees will be charged. The amount of the payment will be prepared and approved by the government as per the EWTI establishment regulation No. 293/2013.
c) On-demand training will be delivered after the signing of an agreement between EWTI and the client.

9.2 Dormitory service

a) EWTI will provide dormitory service for training participants who attend training in its compound.
b) Blanket and mattress will be provided by EWTI.

9.3 Services for Inclusive Training

a) EWTI will arrange separate dormitory, bathroom as well as toilet rooms for men and women
b) EWTI will arrange suitable dormitory rooms for disabled persons
c) EWTI will arrange a babysitter for training participants who are women taking care of their child(ren)
d) EWTI will arrange special assistance by its trainers for disabled persons

9.4 Health service

a) During EWTI's compound training, EWTI should provide health services for emergencies either in the EWTI clinic or in the governmental health centre.
b) EWTI cannot provide health service other than for emergencies.
c) EWTI will not provide insurance and compensation for a health-related damage during the training programme.
d) EWTI will provide basic sanitation and hygiene materials, like soap, soft paper etc.
e) While there is pandemic (like Covid 19) EWTI will provide protective materials such as hand-sanitiser or alcohol, face masks, etc.

9.5 Transport service

a) EWTI should provide transport vehicles and fuel and lubricant costs for field practical training programmes.
b) The training officer and the course leader should facilitate the transportation service.

9.6 Library service

a) The library can provide its services during office working hours.
b) Training participants can borrow books and periodicals from the library until the last date of their stay at EWTI.

c) Training participants must return books and periodicals they borrowed before the last date of the course's completion and obtain a clearance signature.

9.7 Financial service

a) EWTI will provide per diem as per government directives for training participants during their stay out of Addis Ababa for field practices and visits.
b) Transportation costs and a travel allowance from participants' workplace to EWTI and the reverse are not covered by EWTI.

9.8 Entertainment service

EWTI should arrange entertainment opportunities for training participants. (Television, table tennis, volleyball etc.)

9.9 Insurance coverage

EWTI should not provide insurance coverage for training participants.

10 Role and Responsibility of the Different Actors

10.1 Director General

- Responsible for timely preparation of the education and training plan and necessary budget; provide direction for fulfillment of necessary training facilities.
- Place on the agenda of the TMC meeting and obtain decisions concerning the education and training activities that require the decision of this committee.
- Sign on the certificates which are prepared by the Registrar.

10.2 Deputy Director General (Training and TVET Sectors)

- Perform oversight of the implementation of the Guidelines.

10.3 Training Management Committee (TMC)

- Review and approve the annual training plan.
- Perform evaluation of annual training programmes, implementation and take corrective action.
- Approve proposed new training programme and LM.
- Make a decision on cancelation and postponing the training programme.
- TMC members should meet regularly every quarter of the year. However, when there is a necessary situation, the chairperson can call for a meeting before the regular meeting date.

10.4 Director of Water Technology Education and Training Directorate

- Plan, direct, monitor and implement the education and training activities of EWTI.
- Execute or ensure the execution of activities related to education and training along with different organisations or offices by having discussion with top management of EWTI.
- Provide orientation on the Guidelines for Training Operation and Management for the newly assigned trainers and assistant trainers.
- Ensure that each new trainer has the CoC certificate, Training Methodology Certificate and Attendance of ToT for Common Module.
- Along with the head of the department concerned, provide, or get solution to problems that may be faced by trainers and /or training participants during training implementation.
- Identify the procurement needs of the directorate, provide support and follow-up for the timely procurement in order to fulfill the training and teaching materials and facilities.
- Pass the list and related information of registered training participants submitted by the Registrar's office to the department concerned and other offices of EWTI.
- Submit training completion reports to TMC and the Director General of EWTI.
- Capacitate the trainers and assistant trainers in short- and long-term training.

10.5 Registrar

- Perform the distribution of the approved annual training plan of EWTI to its stakeholders; and receive from the same the training needs or demands and handle them in an organised way for their implementation.
- Allocate a quota for the number of training participants to be invited for each training programme based on the demands from the Institute's stakeholders and private applicants;

make announcement for each training programme; and ensure the participation of invited organisations and private applicants.

- Responsible to make course announcements one and half months before the start of the training.
- Perform registration on registration day by checking the documents submitted by each training participant.
- Conduct orientation to training participants.
- Prepare and provide ID cards for training participants.
- Submit the list of registered training participants for each training programme to the Education and Training Directorate.
- Keep and handle the assessment results of training participants in an organised system.
- Prepare certificates of accomplishment or participation depending on the result of training participant's assessment and attendance.
- Provide response to requests that may come from the Institute's stakeholders or anyone concerning training participation.
- Prepare and provide a certificate as a replacement of the original when it is lost based on the request of an applicant and after performing the necessary check-up of records.

10.6 Department Team Leader

- Prepare a plan of the department's annual short-term practical training courses; direct its implementation, monitor and coordinate its implementation.
- Each department team leader assigns a course leader from trainers assigned for each training programme under the department based on the consensus reached among the trainers assigned for the course. And the trainer assigned as a course leader:
    - Should participate as a trainer for the training course.
    - Should have adequate knowledge and experience of this particular course.
    - Should be selected as far as possible with the acceptance all trainers participating in the course.
- In accordance with EWTI's training schedule, assign trainers for the training programme; and in case of a lack of a trainer for the course, try to cover the programme by employing an external trainer.
- Ensure that LM, TTLM and training participants' assessment tools prepared for the training courses under the department are done in accordance with these Guidelines; approve and submit those to be approved by the TMC.
- Identify and submit the department's needs of training and teaching materials and facilities; provide support and follow-up for timely purchase of the same.
- Participate in the orientation programme of the training participants.
- In consultation with both the assigned course leader and the director of the Education and Training Directorate, provide solutions to problems encountered by trainers and/or training participants during the course of training implementation.
- Check and approve training participants' assessment results and submit the same to the Registrar.
- Check and approve the training field practice report and training completion report submitted by the course leader which is prepared upon the completion of each training programme (both in-compound and field training) and submit the same to the Education and Training Directorate.
- Check and approve the field technical proposal and submit to the Education and Training Directorate.
- Ensure that necessary equipment/instruments and other facilities (including the selection of field sites) are ready for the start of a training course and implementation of field practice.

10.7 Course Leader

- One week before the start of the training course, in consultation with the department team leader, call a meeting to review the completion of training preparation; and prepare a list of training materials/facilities as well as a detailed schedule of the training programme.
- Provide support and perform monitoring and evaluation of the performance of external trainers in order to ensure that the Institute is getting the required service from their employment.
- Prepare a detail technical proposal (with clearly stated objectives, selected field sites, list of activities, duration and expected outcomes) of a field training programme; and upon its approval, implement the programme in coordination with the concerned offices of EWTI;
- Coordinate and direct the assigned field training team; provide solution for problems that may be encountered during the field practice by consulting the department team leader.
- Upon the completion stage of the training programme, make explanation and provide support on preparation of an action plan (TM-9) by each training participant for activities they are going to implement when they return to their respective work places; and collect copies of these plan for the department.
- Prepare both Field Practice Completion Report (TM-2) and Training Completion Report (TM-14) when they are completed.

10.8 Trainer

- Prepare TTLM for his/her assigned training course; revise TTLM and upon approval by the department, implement it.
- Provide training using the standards and forms which are attached in this Guidelines.
- Record, keep and monitor the attendance of training participants during the conducting of the training.
- Select the sites for the field training at the beginning of the year in consideration of the field practice for the particular training course and the expected result from each training programme.
- Participate in the conduct of the orientation programme for training participants.
- Perform study and research that will help to improve the quality of the training; periodically update himself/herself with the latest technologies.
- Participate in training needs assessment, labour market survey, training impact survey and other related studies.
- Participate in the preparation of field training completion reports.
- Perform assessment of training participants as per the training programme and notify the results to training participants in accordance with these Guidelines.
- Upon the completion stage of the training programme, make explanation and provide support on preparation of Action Plan (TM-9) by each training participant for activities they are going to implement when they return to their respective work places; and collect copies of these plans for the department.
- Submit the attendance sheet, TRB and the training participants' assessment results to the department when the training programme is completed.
- Throughout the training period the trainer must take proper and necessary safety measures to protect himself/herself as well as training participants from accidents, pandemic, etc.
- Provide counselling and guidance to training participants in their respective professions.

10.9 Assistant Trainer

- Receive and properly handle equipment and materials issued for the training department.

- Ensure that equipment and instruments are properly placed and cleaned.
- Assist the trainer while conducting practical training in workshops, laboratories, and computer labs and on field work.
- Assist trainer in evaluating training participants while they exercise Kaizen in workshops, laboratory, and computer lab and on field work.
- Assist trainer in evaluating training participants with other LAP tests.
- Provide other assistance to trainers as per instructions given by the training department concerned.

10.10 Training participant

- Must register at the Registrar's office on the date and scheduled time of registration by submitting the required documents.
- Attend the orientation programme that is organised by the Registrar's office and the department concerned.
- Attend the training as per the schedule of the training programme and sign the daily attendance sheet.
- Discuss with the trainer or course leader or training officer to get solution for any problem/s encountered; if no solution is obtained, submit the issue to the Director General to get a solution.
- The training participant is expected to attend 85 % and above of the classroom training and 100 % of the practical training.
- Upon completion of the training programme, prepare Action Plan (TM-9) for activities he/she is going to implement when he/she returns to his/her workplace.
- The training participant should wear the proper working clothes, shoes and other protective gear whilst training in workshops and during field practices.
- Training participants' discipline should be as per Annex 3.

10.11 Support units

10.11.1 Property Administration and General Service

- Provide dormitory service, fulfilling all necessary materials including soft paper and soaps.
- Provide clinical service including transport service for emergencies.
- Provide and administer recreational facitilies.
- Make ready and timely assigning of vehicles for field practice training.
- Perform basic maintenance and repair of training instruments and machines.

10.11.2 Procurement and Finance

- Expedite the timely disbursement of financial requests for per diem and fuel as per the approved proposal prepared by the department.
- Expedite the timely procurement of training materials, equipment, and maintenance services.
- Controll and managing the financial flow and resources allocated for the training provision.

10.11.3 Library and Printing Service

- Collect data on the needs of appropriate reference books from the departments for each training programme and ensure that they are available by procurement or if possible, by donation.

- Collect and organise the curriculum and TTLM (both in hard and soft copies) which are prepared by the department concerned and get approval as per this Manual; and make them available for the users.
- Keep the library open for service during government working hours.
- Submit a list of requirements to the Education and Training Directorate to fulfill facilities for the library.
- Perform photo coping and binding of documents that are necessary for education and training implementation.

10.11.4 Customers

- Send training participants as per notified criteria.
- Cover those costs of the training participant that should not be covered by EWTI.
- Send the training participants to EWTI with the necessary work clothes and safety shoes.
- When the training participants return to their workplace after the completion of the training, provide them support and cooperation so that they can apply the skills and knowledge they gained on their assigned tasks.

10.11.5 Education and Training Team

Education and training team is composed of a team leader and training officers and their responsibilities are as follows:

a) Education and Training Team Leader
   - Collect the training programme from each department and compile the annual training programme of EWTI.
   - Perform coordination tasks during the joint planning and preparation of TTLM by the training staff of the department concerned with the training course.
   - Assign a training officer for preparing financial proposal and follow-up of the process.
   - Coordinate and participate in the training needs assessment, labour market survey, training impact survey and other related studies.
   - Communicate and prepare an MoU with the selected organisation for field practice based on the suggestion of the department concerned with the training programme.
   - Responsible to make sure that the classrooms are ready for the conduct of the training programme.
   - Participate in the conduct of the training participants' orientation programme.
   - Perform regular monitoring and follow-up during the conducting of training courses to ensure the proper implementation of the training as per these Guidelines; and submit the monitoring report to the Director of WTETD.
   - Provide solutions when problems are encountered by discussing with the offices and persons concerned; the encountered problems and solutions should be reported on the monitoring report.
   - From 3 to 6 months after completion of the training programme, carry out a performance survey of the training participants on the implementation of their action plans that they prepared after the completion of their training programme; and if the results of the survey indicate the need for further support to the former training participants, then make a report to the department concerned.

b) Training Officer

- Participate in the compilation of the annual training programme which are prepared by each training department.
- Prepare request for training inputs (such as stationery items) and prepare financial proposal for field training based on the field technical proposal prepared by the training course leader.
- Participate in the training needs assessment, labour market survey, training impact survey and other related studies.
- As per the instructions of the Education and Training Team Leader, prepare draft MoU to be signed with the selected organisation for field practice based on the suggestion of the department concerned with the training programme.
- Make sure that the classrooms are ready for the conduct of the training programme.
- As per the instructions of the Education and Training Team Leader, perform monitoring and follow-up during the conduct of the training programme to ensure the proper implementation of the training as per these Guidelines; prepare and submit monitoring report to the Team Leader.
- Between 3 to 6 months after the completion of the training programme, participate in carrying out a performance survey of the training participants on the implementation of their action plans that they prepared upon the completion of their training programme; make a report to the department concerned if the results of the survey indicate the need for further support to the former training participants.

10.11.6 Water TVET Support and Competence Assessment Directorate

- Plan, direct, monitor and coordinate the implementation of training programmes for water TVET colleges.
- Identify the training needs of the water TVET colleges; and submit the identified training needs to the department concerned with implementation.
- Coordinate the conduct of training courses planned for water TVET colleges and ensure that the implementation of the training programme is done as per procedures of these Guidelines.
- Execute and ensure the execution of tasks related to the implementation of training courses for water TVET colleges alongside the different organisations and offices by discussing with the top management of EWTI.
- Alongside the head of the department concerned, provide solutions to problems that may be encountered by trainers and/or training participants during training implementation planned for water TVET colleges.
- Provide pass lists and related information of registered participants which are submitted by the Registrar's office to the department concerned and other offices of EWTI.
- Submit training implementation reports to the TMC and to the Director General of EWTI.

10.12 Communication Affairs Directorate

- Promote training programmes to the public.
- Announce the periodic training schedule in coordination with the Registrar Office.
- Perform public relations activities during opening and closing ceremonies.

11 Training participants' Disciplinary Issues

Details concerning training participants' disciplinary procedures and related issues are listed in Annex 3.

12 Operational Procedures Manual for International Training

Operational Procedures Manual for International Training, based on the cases funded by JICA, with procedures of invitation, application, screening, implementation, etc. is attached as Annex 4.

ANNEX 1
FORMS

FORMS
TG
(Trainers Guide)

TG-01

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**TRAINING COURSE DESIGN**
Course title	
Course code	
Qualification level and certification	
Unit of Competence	
Course description	
Modules	■
Duration	*days*
Target group	■
Entry requirements	■

Mode of delivery		
	☐ Lecture	☐ Group work
	☐ Self-check	☐ Presentation
	☐ Question and answer	☐ Game and simulation
	☐ Demonstration	☐ Self-study
	☐ Case Studies	☐ Seminar
	☐ Project work	☐ Tutorial
	☐ Workshop practice	☐ Role playing
	☐ Field work	☐ Assessment and feedback

Measures for inclusive training	■
Trainer(s) profile	■

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**TRAINING COURSE DESIGN**
Course title	*Performing Drilling Fluid Engineering*
Course code	*WRDDT/DT/001/25 /10/2019*
Qualification level and certification	*Water well drilling and construction Level II*
Unit of Competence	*Performing Mud Rotary Drilling*
Course description	*The course aims to provide the trainees with the knowledge, skills and right attitudes required to identify mud drilling equipment, measuring and maintaining mud drilling fluid to adjust the required desirable property of mud.*
Modules	■ *Teamwork, OHS and Kaizen* ■ *Performing Fluid Engineering*
Duration	*15 days*
Target group	■ *Hydrogeologist* ■ *Geologist* ■ *Drilling engineer* ■ *Water related experts*
Entry requirements	■ *MSc, BSc and Diploma water related fields .*
Mode of delivery	☐ Lecture ☒ Self-check ☒ Question and answer ☒ Demonstration ☐ Case Studies ☐ Project work ☐ Workshop practice ☐ Field work ☒ Group work ☒ Presentation ☐ Game and simulation ☒ Self-study ☐ Seminar ☐ Tutorial ☐ Role playing ☒ Assessment and feedback
Measures for inclusive training	■

Trainer(s) profile	■ *Mr.ABC, Hydrogeologist* ■ *Mr.DFG, Chief driller* ■ *Mr.XYZ, Hydrogeologist* ■ *Ms.TVW, Geologist*

LEARNING MODULE

MODULE TITLE:

MODULE CODE:

NOMINAL DURATION:

MODULE DESCRIPTION:

This module aims to provide the trainees with the essential knowledge, skills, and right attitudes to ----------.

LEARNING OUTCOME:

At the end of the module the learner will be able to:

LO1:

LO2:

LO3:

LO4:

MODULE CONTENTS:

LO1 _____

1.1.
1.2.
1.3.
1.4.

LO2 _____

2.1.
2.2.
2.3.
2.4.

LO3 _____

3.1
3.2
3.3
3.4

LO4 _____

4.1
4.2

4.3
4.4

LEARNING METHODS: *(Learning methods may use one or more among the list)*

☐ Lecture	☐ Group work
☐ Self-check	☐ Presentation
☐ Question and answer	☐ Game and Simulation
☐ Demonstration	☐ Self-study
☐ Case Studies	☐ Seminar
☐ Project work	☐ Tutorial
☐ Practical exercise	☐ Role Playing
☐ Field work	☐ Assessment and feedback

ASSESSMENT METHODS: *(Assessment methods may use one or more among the list)*

- ☐ Written Test
- ☐ Practical exam
- ☐ Oral questions
- ☐ Attendance

ASSESSMENT CRITERIA: (Assessment Criteria derived from Contents covered under specific LO)

LO1. _____

- _____
- _____
- _____
- _____
- _____

LO2 _____

- _____
- _____
- _____
- _____
- _____
- _____

LO3 _____

- _____
- _____

- _____

LO4

- _____
- _____
- _____
- _____

LEARNING MODULE

COURSE TITLE: *Performing Drilling Fluid Engineering*

MODULE TITLE: *Utilizing drilling fluids for mud drilling*

MODULE CODE: *WRDDT/DT/001/25 /10/2019*

NOMINAL DURATION: *10 days (two weeks)*

MODULE DESCRIPTION:

This module aims to provide the trainees with the essential knowledge, skills, and right attitudes to *identify mud drilling equipment, measuring and maintaining mud drilling fluid to adjust the required desirable property of mud.*

LEARNING OUTCOME:

At the end of the module the learner will be able to:

LO1: *Prepare and operate mud drilling equipment and mud pits*

LO2: *Measure and maintain mud drilling fluids*

MODULE CONTENTS:

LO1 ***Preparing and operating mud drilling equipment and mud pits***

Identifying mud drilling equipment

- 1.1.1 Understanding types and functions of mud drilling equipment
- 1.1.2 Assembling and disassembling filter press

1.2 Inspecting and operating mud pumps

- 1.2.1 Inspecting mud pumps
- 1.2.2 Operating mud pumps

LO2 ***Measuring and maintaining mud drilling fluids***

2.1 Identifying types and functions of mud drilling fluids

2.2 Identifying major properties, and measuring and maintaining drilling fluids

2.3 Identifying types and functions of drilling fluid additives

2.4 Identifying contamination prevention and treatment of mud drilling fluids

LEARNING METHODS: *(Learning methods may use one or more among the list)*

☐ Lecture	☒ Group work
☒ Self-check	☐ Presentation
☐ Question and answer	☐ Game and Simulation
☐ Demonstration	☒ Self-study
☐ Case Studies	☐ Seminar
☐ Project work	☐ Tutorial
☒ Practical exercise	☐ Role Playing
☒ Field work	☒ Assessment and feedback

ASSESSMENT METHODS: *(Assessment methods may use one or more among the list)*

- ☒ Written Test
- ☒ Practical exam
- ☒ Oral questions
- ☒ Attendance

ASSESSMENT CRITERIA: (Assessment Criteria derived from Contents covered under specific LO)

LO1 *Preparing and operating mud drilling equipment and mud pits*

- *Identifying mud drilling equipment*
- *Inspecting and operating mud pump*
- *Preparing mud pits*

LO2 *Measuring and maintaining mud drilling fluids*

- *Identifying types and functions of mud drilling fluids*
- *Identifying major properties, and measuring and maintaining drilling fluids*
- *Identifying types and functions of drilling fluid additives*
- *Identifying contamination prevention and treatment measures of mud drilling fluids*

TG-03

PERFORMANCE EVALUATION GUIDE

This is a guide for individual or group performance evaluation. Based on given design of the performance evaluation, trainers must prepare necessary equipment, materials and consumables and its setting. During the actual performance evaluation, the trainers must fill-in in the consecutive Rating Sheet.

The results of the 1st trial, if participants failure, the trainers can give a chance for the 2nd trial and its results will be filled-in using “Training Participants’ Assessment Data Sheet” (TM-08 of the Guidelines for Training Operation and Management).

Course Title	
Learning Guide number and title	
Venue of assessment	☐Classroom ☐Workshop ☐Machine site ☐Practice Field ☐Others:
Preparation and setting for the performance assessment	

Necessary material and equipment

No	Material, consumables and equipment	Quantity
1	(Specify the material, consumable or equipment its quantities)	
2		
3		
4		
5		
6		

TG-03

RATING SHEET FOR DEMONSTRATION

This is a guide for the rating of the performance evaluation of the learners. The results of the evaluation shall be recorded on the Training Participants' Assessment Data Sheet (TM-08).

Assessment	☐Individual ☐Group
Date of 1st Trial	
Date of 2nd Trial	
Instruction for demonstration	

No	During the demonstration of skills, did the trainee (Circle Y for Yes and N for No)	1st trial	2nd trial
1		Y/N	Y/N
2		Y/N	Y/N
3		Y/N	Y/N
4		Y/N	Y/N
5		Y/N	Y/N
The trainee's demonstration was:		☐Satisfactory ☐No	☐Satisfactory ☐No

TG-03

ORAL QUESTIONS

This is a guide for the rating of the oral questions to be asked during the LAP test. The results of the evaluation shall be recorded on the Training Participants' Assessment Data Sheet (TM-08).

Q	The trainee should answer the following questions	Satisfactory response	
		1st Trial	2nd Trial
1			
2			
3			
4			
5			
6			
The trainee's knowledge was		☐Satisfactory ☐No	☐Satisfactory ☐No
Feedback to trainee *To be filled on the Training Participants' Assessment Data Sheet (TM-08)*			

The trainee's overall performance was:	1st Trial	2nd Trial
	☐Satisfactory ☐Not Satisfactory	☐Satisfactory ☐Not Satisfactory

Recommended answers for oral questions

Q	Recommended Answer
1	
2	
3	
4	
5	
6	

TG-03

PERFORMANCE EVALUATION GUIDE

This is a guide for individual or group performance evaluation. Based on given design of the performance evaluation, trainers must prepare necessary equipment, materials and consumables and its setting. During the actual performance evaluation, the trainers must fill-in in the consecutive Rating Sheet.

The results of the 1st trial, if participants failure, the trainers can give a chance for the 2nd trial and its results will be filled-in using "Trainees' Assessment Data Sheet" (TM-08 of the Guidelines for Training Operation and Management).

Course Title	*Operating and maintaining a Gen-set*
Learning Guide number and title	*LG #02 Identify operation and supporting systems of diesel engine*
Assessment	☒Individual ☒Group
Venue of assessment	☐Classroom ☒Workshop ☐Machine site ☐Practice Field ☐Others:

Preparation and setting for the performance assessment

- *Prepare or avail the gen-set and cut models related with its components for the assessment*
- *Ensuring if there is suitable area for the assessment*
- *Avail the necessary tools, material, instruments*
- *Avail the rating sheet for demonstration per each trainee*

Necessary material and equipment

No	Material, consumables and equipment	Quantity
1	*Personal Protective Equipment (PPE)*	*1/Trainee*
2	*First aid kit*	*1set/LG*
3	*Fire extinguisher*	*1pcs/LG*
4	*Wrenches (open, close & adjustable)*	*1set/trainee*
5	*Pliers (combination, long nose, cutter)*	*3 pcs/trainee*

6	*Insulated & mechanical screw drivers (flat & Philips)*	*2set/LG*
7	*Allen keys (hexagonal & star)*	*2set/LG*
8	*cleaning rag*	*2kg/LG*
9	*Genset with battery*	*2set/LG*
10	*Engine cut model*	*1set/LG*

TG-03

RATING SHEET FOR DEMONSTRATION

This is a guide for the rating of the performance evaluation of the learners. The results of the evaluation shall be recorded on the Training Participants' Assessment Data Sheet (TM-08).

Assessment	☐Individual ☒Group
Date of 1st Trial	*DD/MM/YYYY*
Date of 2nd Trial	*DD/MM/YYYY*

Instruction for demonstration

The following instructions shall be given at the site.

- *Read the instruction written on the LAP test*
- *Open the canopy*
- *Identify and explain engine assembly of the Gen-set*
- *Identify and explain the purpose of engine components (components found in cylinder head assembly, in cylinder block assembly, oil sump)*
- *Identify and locate parts of engine supporting/auxiliary systems (starting system, air intake and exhaust system, fuel system, cooling system, lubrication system, charging system)*
- *clean the work area and return the materials taken*

No	During the demonstration of skills, did the trainee (Circle Y for Yes and N for No)	1st trial	2nd trial
1	*Select and use the necessary tools and PPE?*	Y/N	Y/N
2	*Identify and locate engine assembly of the gen-set?*	Y/N	Y/N
3	*Identify and locate main engine components?* *(Satisfactory when 4-1~4-6 marks are "Y")*	Y/N	Y/N
3-1	*-cylinder head assembly*	Y/N	Y/N
3-2	*-cylinder block assembly*	Y/N	Y/N

3-3	-oil sump	Y/N	Y/N
4	Identify and locate parts of engine supporting / auxiliary systems? (Satisfactory when 3-1~3-3 marks are "Y")	Y/N	Y/N
4-1	-starting system	Y/N	Y/N
4-2	-air intake and exhaust system	Y/N	Y/N
4-3	-fuel system	Y/N	Y/N
4-4	-cooling system	Y/N	Y/N
4-5	-charging system	Y/N	Y/N
4-6	-lubricating system	Y/N	Y/N
5	Clean the working area, removing unnecessary things and return the materials taken?	Y/N	Y/N
The trainee's demonstration was:		☐Satisfactory ☐No	☐Satisfactory ☐No

TG-03

ORAL QUESTIONS

This is a guide for the rating of the oral questions to be asked during the LAP test. The results of the evaluation shall be recorded on the Training Participants' Assessment Data Sheet (TM-08).

Q	The trainee should answer the following questions	Satisfactory response	
		1st Trial	2nd Trial
1	*When you open the gen-set hood/cover what are the things that you should care for?*	Y/N	Y/N
2	*Can you indicate, mention the names of components found in the cylinder head assembly and explain their functions?*	Y/N	Y/N
3	*Can you indicate, mention the names of components found in the cylinder block assembly and explain their functions?*	Y/N	Y/N
The trainee's knowledge was		☐Satisfactory ☐No	☒Satisfactory ☒No
Feedback to trainee *To be filled on the Training Participants' Assessment Data Sheet (TM-08)*			

The trainee's overall performance was:	1st Trial	2nd Trial
	☐Satisfactory ☐Not Satisfactory	☐Satisfactory ☐Not Satisfactory

Recommended answers for oral questions

Q	Recommended Answer
1	*Satisfactory when the trainee answers two or more things listed below.* - *Remove unnecessary things away from the gen-set* - *open the hood/cover using proper tools* - *be careful not to make a short the positive and negative terminals of the battery* - *protect cables & sensitive devices from damage*
2	*Satisfactory when the trainee answers three or more things listed below.* - *Intake valves – opens at the proper time to let in air. Open and seal the*

	intake ports. - *Exhaust valves – open at the proper time to release the exhaust. Open and seal the exhaust ports.* - *Valve springs – both close the valves and hold them open* - *Spring retainers – hold the springs on the end of the valves* - *- Camshaft – which will be found either in cylinder head or block and it rotates to open and close the intake and exhaust valves in correct sequence.*
3	*Satisfactory when the trainee answers three or more things listed below.* - *Piston - transmits the gas pressure which occurs during combustion to the connecting road and hence to the crankshaft.* - *Connecting rod - connects the piston to the crankshaft* - *Cylinder – hollow, stationary, in which piston moves up and down within it* - *Crankshaft - is the main shaft of an engine which converts the reciprocating motion of the piston into rotary motion of the flywheel.* - *Flywheel – It stores up energy to help the engine over idle strokes of the piston i.e., suction, compression and exhaust.*

RESOURCE REQUIREMENTS FOR LEARNING MODULE

Module Title	
Module Code	

Item No.	Category/ Item	Description/ Specification	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1	TTLM			
2	Reference Book			
3	Journals			
B	**Learning Facilities and Infrastructure**			
1				
2				
3				
C	**Consumable Materials**			
1				
2				
3				
D	**Tools and Equipment**			
1				
2				
3				

RESOURCE REQUIREMENTS FOR LEARNING MODULE

Module Title	*Operating and Maintaining a Gen-set*
Module Code	*EIS EMM GOM2 1218*

Item No.	Category/ Item	Description/ Specification	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1	TTLM			*1:1*
2	Reference Book	*See last pages of LG 1, LG 2, LG 3 & LG 4*	*1*	
3	*Operation and service manuals*	*Available nearby the generator*	*1*	
B	**Learning Facilities and Infrastructure**			
1	*Lecture room*			*1:20*
2	*Workshop room*			*1:20*
3	*Audio visual room*	*To be provided in the future*		*1:20*
C	**Consumable Materials**			
1	*First aid kit*		*1*	*1:20*
2	*Fuel, oil, grease, tephlon*			
3	*Insulation tape & connectors*			
4	*Cable*			
5	*Baking soda*	*To be provided in the future*		
6	*Distilled water*	*To be provided in the future*		
7	*Rag*			
8	*Filters (fuel and oil)*			*1:20*

9	Printing paper			100:1
10	Notebook			1:1
11	Pen			1:1
12	Ink (printer tonner)			
13	Battery acid	To be provided in the future		
D	**Tools and Equipment**			
1	Wire stripers			1:5
2	Wrenches and Screw drivers of different size			1:2
3	Pliers (long nose, combination, cutter)			1:2
4	Electrician knife			1:2
5	Disassembled Generator set parts			1:5
6	Digital multi-meter and clamp-meter			1:2
7	Hydrometer			1:4
8	Tachometer			1:20
9	Open container for battery solution preparation			
10	Battery load tester			
11	Fire extinguisher			
12	Printer			
13	Computer set			1:5

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**TRAINING COURSE ANNOUNCEMENT**
Course Title	
Learning Outcomes	Module title: LO1: LO2: LO3: LO4: Module title: LO1: LO2: LO3: LO4:
Training period	From to (days/weeks)
Entry requirement (qualification)	■
Maximum number of trainees expected from your organization	
Provisions by EWTI for the training	■
Costs to be covered by trainee's organization	■
Necessary materials that trainees have to bring	■ Working cloths ■ Gloves ■ Working shoes
Language to be used in the course	English
Required documents	■ Candidates application/notification format ■ Supporting letter
Deadline for notification of applicants	Date: (One week before the commencement of training course)
Notification of acceptance	Date:
Deadline of registration	Date:
Attachment	■ Training Course Design ■ Learning Module

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**TRAINING COURSE ANNOUNCEMENT**
Course Title	*Installing, operating and maintaining Gen-set*
Learning Outcomes	**Module title:** *Teamwork, OHS and KAIZEN* LO1: *Performing teamwork, OHS and KAIZEN* **Module title:** *Installing, operating & maintaining Gen-set* LO1: *Identifying operation and supporting systems of Gen-set* LO2: *Operating a gen-set* LO3: *Performing generator maintenance*
Training period	From *Tikimit 09/2013 E.C (October 19, 2020)* to *Tikimit 20/2013 E.C.(October 30, 2020)* (*10* working days/ *2* weeks)
Entry requirement (qualification)	■ *Minimum of TVET graduates in Electromechanical / Electrical* ■ *Having at least 1year practical work experience*
Maximum number of trainees expected from your organization	*3*
Provisions by EWTI for the training	■ *Training* ■ *Training materials (TTLM)* ■ *Dormitory*
Costs to be covered by trainee's organization	■ *Per-diem of trainee* ■ *Transportation fee*
Necessary materials that trainees have to bring	■ Working cloths ■ Gloves ■ Working shoes
Language to be used in the course	English
Required documents	■ Candidates application/notification format ■ Supporting letter
Deadline for notification of applicants	Date: *Tikmt 02 / 2013 (October 12, 2020)* (One week before the commencement of training course)
Notification of acceptance	Date: *Tikmt 02 / 2013 (October 12, 2020)*
Deadline of registration	Date: *Tikmt 09 / 2013 (October 12, 2020)*
Attachment	■ Training Course Design ■ Learning Module

Training Schedule

Module Title										
Duration	From Month, XXth to XXth, 202X									
Date	Day	Time	Training Content	Trainer	Assistant Trainer	Knowledge	Skill	Others	Total Hrs.	Remarks
Day1	M/D	9:00-11:00	Registration	Mr/Ms. XX	Mr/Ms. XX			2:00		
		11:00-11:30	Pre-Test/Pre-Questionnaire	-	-			0:30		
		11:30-12:00	LGs Distribution	Mr/Ms. XX	Mr/Ms. XX			0:30		
		12:00-14:00	Lunch break	-	-					
		14:00-15:30	Registration	Mr/Ms. XX	Mr/Ms. XX			1:30		
		15:30-16:00	Pre-Test/Pre-Questionnaire	-	-			0:30		
		16:00-17:00	LGs Distribution	Mr/Ms. XX	Mr/Ms. XX			1:00	6:00	
Day2	M/D	9:00-9:30	General Orientation	Mr/Ms. XX	Mr/Ms. XX			0:30		
		9:30-10:00	Course Guidance	Mr/Ms. XX	Mr/Ms. XX	0:30				
		10:00-10:30	LG1 : Self-check1, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:30				
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	LG1 : Self-check1, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:10	LO1: Self-check2&3, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:10				
		15:10-15:30	LO1: Demo. & Practice				0:20			
		15:30-16:00	Tea break	-	-					
		16:00-16:40	LO1: Demo. & Practice	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX	0:10				
		16:50-17:00	Recap / Daily Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day3	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30		Mr/Ms. XX	Mr/Ms. XX	0:30	0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00		Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:30		Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40					0:40			
		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Recap / Daily Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day4	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30		Mr/Ms. XX	Mr/Ms. XX	0:30	0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00		Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:30		Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40					0:40			
		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Recap / Daily Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day5	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30		Mr/Ms. XX	Mr/Ms. XX	0:30	0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00		Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:30		Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40					0:40			

		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Recap / Weekly Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day6	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30		Mr/Ms. XX	Mr/Ms. XX	0:30	0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00		Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:30		Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40					0:40			
		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Recap / Daily Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day7	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30		Mr/Ms. XX	Mr/Ms. XX	0:30	0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00		Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:30		Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40					0:40			
		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Recap / Daily Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day8	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30		Mr/Ms. XX	Mr/Ms. XX	0:30	0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00		Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:30		Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40					0:40			
		16:40-16:50	LO1: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Recap / Daily Reflection	Mr/Ms. XX	Mr/Ms. XX		0:10		5:00	
Day9	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30	Preparation for Post-test	Mr/Ms. XX	Mr/Ms. XX			1:20		
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	Preparation for Post-test	Mr/Ms. XX	Mr/Ms. XX			1:00		
		12:00-14:00	Lunch break	-	-					
		14:00-15:00	Post-Test/Post-Questionnaire	Mr/Ms. XX	Mr/Ms. XX			1:00		
		15:00-15:30	Course Evaluation Sheet	Mr/Ms. XX	Mr/Ms. XX			0:30		
		15:30-16:00	Tea break	-	-					
		16:00-17:00	KAIZEN Reflection session	Mr/Ms. XX	Mr/Ms. XX		1:00		5:00	
Day10	M/D	9:00-10:00	Action Plan Session	Mr/Ms. XX	Mr/Ms. XX		1:00			
		10:00-10:30	Presentation of Action Plan	Mr/Ms. XX	Mr/Ms. XX		0:30			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	Presentation of Action Plan	Mr/Ms. XX	Mr/Ms. XX		1:00			
			Certificate preparation							
		12:00-14:00	Lunch break	-	-					
		14:00-15:00	Course Reflection Session	Mr/Ms. XX	Mr/Ms. XX			1:00		
		15:00-15:30	Tea break	-	-					
		15:30-17:00	Course Closing Ceremony	Mr/Ms. XX	Mr/Ms. XX			1:30	5:00	
				Total Hours		13:30	24:40	12:50	51:00	
				Percentage		26%	48%	25%	100%	

Training Schedule

Module Title	Dignosing and Revising TTLM
Duration	From September 14th to 18th, 2021

Day No.	Date	Time	Training Content	Trainer	Duration	Knowledge	Skill	Others	Total Hrs.	Remarks
Day9	9/14	Morning	Move from Addis to Adama		0:00					
		9:30-10:00	Orientation and overview of status of 1st round WS	Mr. Zewdu	0:30			0:30		Zoom
		10:00-10:30	LG5: Self-check1 Self-learning	(Mr. Zewdu)		0:30				Individual work Moodle
		10:30-11:00	Tea break							
		11:00-11:30	LG5: Question and Answer session for Self-check contents and Information sheet	Mr. Zewdu		0:30				Zoom
		11:30-12:30	LG5 : Operation sheet (Task 1-1)	Mr. Zewdu	1:00		1:00			Zoom/ Face-to-Face
		12:30-14:00	Lunch break							
		14:00-14:40	LG5 : Operation sheet (Task 1-1) (con't.)	Mr. Zewdu	0:40		0:40			Zoom/ Face-to-Face
		14:40-15:00	LG5 : Operation sheet (Task 1-2)	Mr. Zewdu			0:20			Zoom/ Face-to-Face
		15:00-15:30	LG5 : Operation sheet (Task 2&3)	Mr. Zewdu	0:30		0:30			Zoom/ Face-to-Face
		15:30-16:00	Tea break							
		16:00-16:30	LG4 : LAP test, Oral question	Mr. Zewdu			0:30			Zoom/ Face-to-Face
		16:30-17:20	LG5: LAP Test	Mr. Zewdu	0:50		0:50			Zoom/ Face-to-Face
		17:20-17:25	LG1: LAP Test 1 (KAIZEN)	Mr. Zewdu	0:05		0:05			Zoom
		17:25-17:30	Daily Reflection	Mr. Zewdu	0:05			0:05	5:30	Zoom
Day10	9/15	8:30-8:45	Recap Session & Daily Reflection	Mr. Zewdu	0:15	0:15				Zoom
		8:45-10:30	LG5: LAP Test (con't.)	Mr. Zewdu	1:45		1:45			Zoom/ Face-to-Face
		10:30-11:00	Tea break							
		11:00-12:30	LG5: LAP Test (con't.)	Mr. Zewdu	1:30		1:30			Zoom/ Face-to-Face
		12:30-14:00	Lunch break							
		14:00-15:30	LG5: LAP Test (con't.)	Mr. Zewdu	1:30		1:30			Zoom/ Face-to-Face
		15:30-16:00	Tea break							
		16:00-17:20	LG5: LAP Test (con't.)	Mr. Zewdu	1:20		1:20			Zoom/ Face-to-Face
		17:20-17:25	LG1: LAP Test 1 (KAIZEN)	Mr. Zewdu	0:05		0:05			Zoom
		17:25-17:30	Daily Reflection	Mr. Zewdu	0:05			0:05	6:30	Zoom
Day11	9/16	8:30-8:45	Recap Session & Daily Reflection	Mr. Zewdu	0:15	0:15				Zoom
		8:45-9:45	LG5: LAP Test (con't.)	Mr. Zewdu	1:00		1:00			Zoom/ Face-to-Face
		9:45-10:30	LG6: Self-check1 Self-learning	(Mr. Zewdu)	0:45	0:45				Individual work Moodle
		10:30-11:00	Tea break							
		11:00-11:30	LG6: Question and Answer session for Self-check contents and Information sheet	Mr. Zewdu	0:30	0:30				Zoom
		11:30-12:30	LG6: Operation Sheet (Task 3)	Mr. Zewdu	1:00		1:00			Zoom/ Face-to-Face
		12:30-14:00	Lunch break							
		14:00-14:50	LG6: Operation Sheet (Task 3)	Mr. Zewdu	0:50		0:50			Zoom/ Face-to-Face
		14:50-15:30	LG6: LAP Test	Mr. Zewdu	0:40		0:40			Zoom/ Face-to-Face
		15:30-16:00	Tea break							
		16:00-17:20	LG6: LAP Test (con't.)	Mr. Zewdu	1:20		1:20			Zoom/ Face-to-Face
		17:20-17:25	LG1: LAP Test 1 (KAIZEN)	Mr. Zewdu	0:05		0:05			Zoom
		17:25-17:30	Daily Reflection	Mr. Zewdu	0:05			0:05	6:30	Zoom

Day12	9/17	8:30-8:45	Recap Session & Daily Reflection	Mr. Habtamu	0:15	0:15				Zoom
		8:45-10:45	LG6: LAP Test (con't.)	Mr. Zewdu	2:00		2:00			Zoom/ Face-to-Face
		10:45-11:15	Tea break							
		11:15-11:35	LG6: Operation Sheet (Task 2)	Mr. Zewdu	0:20		0:20			Zoom/ Face-to-Face
		11:35-12:30	LG6: LAP Test (con't.)	Mr. Zewdu	0:55		0:55			Zoom/ Face-to-Face
		12:30-14:00	Lunch break							
		14:00-14:20	LG6: Operation Sheet (Task 4-1)	Mr. Zewdu	0:20		0:20			Zoom/ Face-to-Face
		14:20-15:10	LG6: LAP Test (con't.)	Mr. Zewdu	0:50		0:50			Zoom/ Face-to-Face
		15:10-15:30	LG6: Operation Sheet (Task 4-2)	Mr. Zewdu	0:20		0:20			Zoom/ Face-to-Face
		15:30-16:00	Tea break							
		16:00-16:50	LG6: LAP Test (con't.)	Mr. Zewdu	0:50		0:50			Zoom/ Face-to-Face
		16:50-17:20	LG3: LAP Test	Mr. Atikilt	0:30		0:30			Zoom/ Face-to-Face
		17:20-17:25	LG1: LAP Test 1 (KAIZEN)	Mr. Atikilt	0:05		0:05			Zoom
		17:25-17:30	Daily Reflection	Mr. Atikilt	0:05			0:05	6:30	Zoom
Day13	9/18	8:30-8:45	Recap Session & Daily Reflection	Mr. Habtamu	0:15	0:15				Zoom
		8:45-9:15	LG3: LAP Test (cont.)	Mr. Atikilt	0:30		0:30			Zoom/ Face-to-Face
		9:15-9:45	Revision of Diagnosis	Mr. Zewdu			0:30			
		9:45-10:30	Action Plan preparation by Learnsers/ Assessment by Trainers	Mr. Atikilt	0:45		0:45			Zoom/ Face-to-Face
		10:30-11:00	Tea break							
		11:00-11:30	Post-test/ Post-questoinnaires	Mr. Habtamu	0:30	0:30				Zoom
		11:30-11:50	Course evaluation sheet	Mr. Habtamu	0:20			0:20		Zoom
		11:50-12:30	KAIZEN reflection	Mr. Habtamu	0:40		0:40			Zoom
		12:30-14:00	Lunch break							
		14:00-15:00	Action Plan presentation (5 min for each group)	Mr. Atikilt	1:00		1:00			Zoom
		15:00-15:30	Course reflection and closing	Mr. Atikilt	0:30			0:30		Zoom/ Face-to-Face
		15:30-16:00	Tea break							
		16:00	Move from Adama to Addis						5:00	
				Total Hours	29:10	3:45	24:35	1:40	30:00	
				Percentage		13%	82%	6%	100%	

Training Session Plan

Course Title	
Learning Outcome	
Session Objectives	At end of the session, the trainee will be able to: 1. XXXXX 2. XXXXX 3. XXXXX
Trainers	

Day 1

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-:11:00	Registration	120min	Administration		
11:00-11:30	Tea break	30min			
11:30-12:00	Pre-Test/Pre-Questionnaire	30min			
12:00-14:00	Lunch break	120min			
14:00-15:30	Pre-Test/Pre-Questionnaire	90min			
15:30-16:00	Tea break	30min			
16:00-17:00	LGs distribution	45min			

Day 2

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:30	General Orientation	30min	Presentation		
9:30-10:00	Course Guidance	30min			
10:00-10:30	LG1 : Self-check1, Q&A	30min			
10:30-11:00	Tea Break	30min			
11:00-12:00	LG1 : Self-check1, Q&A	60min			
12:00-14:00	Lunch break	120min			
14:00-15:10	LO1: Self-check2&3, Q&A	70min			
15:10-15:30	LO1: Demo. & Practice	20min			
15:30-16:00	Tea break	30min			
16:00-16:40	LO1: Demo. & Practice	40min			
16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Daily Reflection	10min			

Day 3

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30		80min			
10:30-11:00	Tea break	30min			
11:00-12:00		60min			

12:00-14:00	Lunch break	120min			
14:00-14:30		30min			
14:30-15:00		30min			
15:00-15:30		30min			
15:30-16:00	Tea break	30min			
16:00-16:40		40min			
16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Daily Reflection	10min	Training Evaluation		
Day 4					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30		80min			
10:30-11:00	Tea break	30min			
11:00-12:00		60min			
12:00-14:00	Lunch break	120min			
14:00-14:30		30min			
14:30-15:00		30min			
15:00-15:30		30min			
15:30-16:00	Tea break	30min			
16:00-16:40		40min			
16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Daily Reflection	10min	Training Evaluation		
Day 5					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30		80min			
10:30-11:00	Tea break	30min			
11:00-12:00		60min			
12:00-14:00	Lunch break	120min			
14:00-14:30		30min			
14:30-15:00		30min			
15:00-15:30		30min			
15:30-16:00	Tea break	30min			
16:00-16:40		40min			
16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Weekly Reflection	10min	Training Evaluation		

Day 6					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30		80min			
10:30-11:00	Tea break	30min			
11:00-12:00		60min			
12:00-14:00	Lunch break	120min			
14:00-14:30		30min			
14:30-15:00		30min			
15:00-15:30		30min			
15:30-16:00	Tea break	30min			
16:00-16:40		40min			
16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Daily Reflection	10min	Training Evaluation		
Day 7					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30		80min			
10:30-11:00	Tea break	30min			
11:00-12:00		60min			
12:00-14:00	Lunch break	120min			
14:00-14:30		30min			
14:30-15:00		30min			
15:00-15:30		30min			
15:30-16:00	Tea break	30min			
16:00-16:40		40min			
16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Daily Reflection	10min	Training Evaluation		
Day 8					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30		80min			
10:30-11:00	Tea break	30min			
11:00-12:00		60min			
12:00-14:00	Lunch break	120min			
14:00-14:30		30min			
14:30-15:00		30min			
15:00-15:30		30min			
15:30-16:00	Tea break	30min			
16:00-16:40		40min			

16:40-16:50	LO1: LAP test (KAIZEN)	10min			
16:50-17:00	Recap / Daily Reflection	10min	Training Evaluation		
Day 9					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap session	10min	Presentation		
9:10-10:30	Preparation for Post-test	80min			
10:30-11:00	Tea Break	30min			
11:00-12:00	Preparation for Post-test	60min			
12:00-14:00	Lunch break	120min			
14:00-15:00	Post-Test/Post-Questionnaire	60min			
15:00-15:30	Course Evaluation Sheet	30min			
15:30-16:00	Tea break	30min			
16:00-17:00	KAIZEN Reflection session	60min			
Day 10					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-10:00	Action Plan Session	60min	Presentation		
10-00:10:30	Presentation of Action Plan	30min			
10:30-11:00	Tea Break	30min			
11:00-12:00	Presentation of Action Plan	60min			
	Certificate preparation				
12:00-14:00	Lunch break	120min			
14:00-15:00	Course Reflection Session	60min			
15:00-15:30	Tea break	30min			
15:30-17:00	Course Closing Ceremony	90min			

EWTI	Training Session Plan
Module Title	**Diagnosing and Revising TTLM**
Learning Outcome	**LO2: Diagnosing TTLM**
Session Objectives	At end of the session, the trainee will be able to: 1. Understand the EWTI way of TTLM 2. Understand quality of TTLM components 3. Extract what elements are missing and not necessary 4. Rate TTLM components to be improved 5. Understand how to diagnose TTLM components 6. Conduct diagnosis of the current TTLM for revision
Trainers	Main: Habtamu Tesfaye / Assistant: Atikilt Abriha, Zewdu Assefa

Day 1 (Wednesday, September 1, 2021)

Model Time	Activities	Nominal Duration	Training Method	Trainer's Role	Training Materials
9:30-9:40	Registration and distribution of workshop materials/ Setting up the PC and connect to the internet	10 min.	Administration	- Guiding how to fill out the registration form - Reminding the setup of PC and internet - Measuring the body temperature and instructing the use of hand sanitizer	Registration form LG2&3
9:40-10:00	Pre-questionnaire/Pre-test	20 min.	Individual work	Guiding how to conduct Pre-questionnaire/Pre-test and respond to questions if any for clarification	Pre-questionnaire and Pre-test form
10:00-10:15	General orientation, including brief overview of whole training schedule & structure	15 min.	Presentation	Explaining the schedule and structure of training and respond to questions if any for clarification	Presentation PPT (Schedule)
10:15-10:30	Log in to individual Moodle/ Briefing on how to conduct Self-check and use Information Sheet in Moodle	15 min.	Lecture and demonstration	Providing information and assisting learners if there is any problem	LG2: Moodle (E-learning)
10:30-11:00	Tea break	30 min.			
11:00-12:30	LG2: Self-check 1 & 2 Self-learning (Self-check and Information Sheet)	90 min.	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	LG2: Moodle (E-learning)
12:30- 14:00	Lunch break	90 min.			
14:00-14:30	LG2: Question and Answer session for Self-check contents and Information sheet	30 min.	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG2: Self-checks, sample asnwers, Information Sheet
14:30-15:30	LG2: Operation Sheet > Task-1: Practice of TTLM Diagnosis Scoring > Task-2:Diagnosis of the status of the current TTLM	60 min.	Individual or group exercise	- Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips) *ONLY 1LG of **Item 7 to 9 (a~g)** on TTLM Diagnosis Form to be done during Operation Sheet (the rest of LGs to be done in LAP Test)	LG2: Operation sheet (Task 1 & 2) (including Quality Requirement Table)
15:30 – 16:20	LG2 : LAP test (up to Raiting Sheet) >Task-1:Diagnosis of the status of the current TTLM	50 min.	Test administration	Observing the process of group work and keeping records according to PEG (but NOT giving any assistance)	TG2: PEG LG2: LAP Test (including Diagnosis Format)
16:20-16:25	LG1: LAP test 1 (KAIZEN)	5 min.	Self-evaluation and scoring	Evaluating the group and scoring	KAIZEN sheet
16:25-16:30	Daily Reflection	5 min.	Training evaluation	Collecting and compiling the filled sheets	Daily reflection sheet
16:30-17:00	Tea break	30 min.			

EWTI	Training Session Plan
Module Title	**Diagnosing and Revising TTLM**
Learning Outcome	**LO3: Preparing/ Revising Learning Module and Resource Requirements for Learning Module**
Session Objectives	At end of the session, the trainee will be able to:
	1. Prepare/revise draft Learning Module
	2. Prepare/revise draft Resource Requirements for Learning Module
Trainers	Main: Atikilt Abriha / Assistant: Habtamu Tesfaye, Zewdu Assefa

Day 2 (Thursday, September 2, 2021)

Model Time	Activities	Nominal Duration	Training Method	Trainer's Role	Training Materials
9:30-9:35	Recap	5 min.	Presentation	Coordinating and facilitating the session	
9:35-10:30	LG2: LAP Test (Oral questions) / LG3: Self-check1 & 2 Self-learning (Self-check and Information Sheet)	55 min.	Oral questions/ Individual work	- Asking the questions to Learners/ - Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	TG2: PEG, submitted Diagnosis Formats/ LG3: Moodle (E-learning)
10:30– 11:00	Tea break	30 min.			
11:00-11:15	LG3: Question and Answer session for Self-check contents and Information sheet	15 min.	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG3: Self-checks, sample asnwers, Information Sheet
11:15-12:15	LG3: Operation Sheet >Task-1:Preparation/ revision of Learning Module >Task-2:Preparation/ revision of Resource Requirement for Learning Module	60 min.	Individual / group exer	- Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and tips)	LG3: Operation sheet (Task 1 & 2) (including Quality Requirement Table)
12:15- 13:45	Lunch break	90 min.			
13:45-14:15	LG3: Operation Sheet (con't.) >Task-1:Preparation/ revision of Learning Module >Task-2:Preparation/ revision of Resource Requirement for Learning Module	30 min.	Individual or group exercise	- Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips) ***LG3: LAP Test to be conducted at the end of LM**	LG3: Operation sheet (Task 1 & 2) (including Quality Requirement Table)
14:15 – 14:55	LG4: Self-check1 Self-learning (Self-check and Information Sheet)	40 min.	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	LG4: Moodle (E-learning)
14:55-15:10	LG4 : Question and Answer session for Self-check contents and Information sheet	15 min.	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG4: Self-checks, sample asnwers, Information Sheet
15:10-15:45	LG4 : Operation Sheet > Task 1: Exercise for revision of PEG 15min for Task 1-1 (Individual quiz) 20min for Task 1-2 (Group discussion)	35 min.	Individual or group exercise	- Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	LG4: Operation Sheet (Task 1) (including Quality Requirement Table)
15:45-16:20	LG4 : Operation Sheet > Task 2-1, 2: Demonstration and practice of revision of PEG (for 1 LG)	35 min.	Individual or group exercise	- Demonstrating how to revise the document step by step, using the format - Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	LG4: Operation Sheet (Task 2) (including Quality Requirement Table)

16:20-16:25	LG1: LAP test 1 (KAIZEN)	5 min.	Self-evaluation and scoring	Evaluating the group and scoring	KAIZEN sheet
16:25-16:30	Daily Reflection	5 min.	Training evaluation	Collecting and compiling the filled sheets	Daily reflection sheet
16:30-17:00	Tea break	30 min.			

	Training Session Plan
Module Title	**Diagnosing and Revising TTLM**
Learning Outcome	**LO4: Preparing/ Revising PEG, Operation Sheet, and LAP Test**
Session Objectives	At end of the session, the trainee will be able to:
	1. Prepare/revise draft PEG
	2. Prepare/revise draft Operation Sheet
	3. Prepare/revise draft LAP Test
Trainers	Main: Zewdu Assefa/ Assistant: Habtamu Tesfaye, Atikilt Abriha → Main: Habtamu Tesfaye / Assistant: Atikilt Abriha

Day 3 (Friday, September 3, 2021)

Model Time	Activities	Nominal Duration	Training Method	Trainer's Role	Training Materials
	Heading to Adama & Checking in				
10:30- 11:00	Tea break	30 min.			
11:00-12:00	LG4 : Operation Sheet > Task 2-2: Practice of revision of PEG (for 1 LG by Learners) (con't.)	60 min.	Individual or group exercise	- Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	LG4: Operation Sheet (Task 2) (including Quality Requirement Table)
12:00-13:30	Lunch break	90 min.			
13:30-13:35	Recap	5min	Presentation	Coordinating and facilitating the session	
13:35-15:05	LG4 : Operation Sheet > Task 2-2: Practice of revision of PEG (for 1 LG by Learners) (con't.)	90 min.	Consultation & revision by group	Consulting and providing technical advice to each group on the revised PEG (*This process can be repeated several times until reaching the standard of quality requirement)	LG4: Operation Sheet (Task 2) (including Quality Requirement Table)
15:05-15:30	LG4 : Operation Sheet >Task 2-3,4: Plenary session for sharing and discussion of findings on PEG (con't.)	25 min.	Discussion	Sharing and discussing good examples and common issues of PEG	LG4: Operation Sheet (Task 2) (including Quality Requirement Table)
15:30– 16:00	Tea break	30 min.			
16:00-17:20	LG4 : Operation Sheet >Task 3: Demonstration and practice of revision of Operation Sheet & LAP Test (for 1LG) 20 min for Task 3-1(Demonstration by trainers) 60 min for Task 3-2 (Revision practice by Learners)	80 min.	Individual or group exercise	- Demonstrating how to revise the document step by step, using the format - Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	LG4: Operation Sheet (Task 3) (including Quality Requirement Table)
17:20-17:25	LG1: LAP test 1 (KAIZEN)	5 min.	Self-evaluation and scoring	Evaluating the group and scoring	KAIZEN sheet
17:25-17:30	Daily Reflection	5 min.	Training evaluation	Collecting and compiling the filled sheets	Daily reflection sheet

POST-TEST QUESTION SHEET
(Written test)

Name: _____ Date: _____

Time started: _____ Time fished: _____

***Use the Answer Box at the end of this sheet to fill out your answers.**

Directions-1: Answer all the questions listed below:

Check *True/False* and make corrections if the statement is *false.*

1. The purpose of Oral Questions in PEG is to observe and assess if the learners memorized all the information provided during the training.
2. Instruction Sheet gives enough information for learners what to do with Learning Guide as a support for self-learning.
3. In Training Schedule with time calculation, each session should be classified by different training categories which are “Knowledge” and “Skill.”
4. Rating Sheet for Demonstration in PEG includes the list of output of the LAP test to be performed by each learner in the form of question.
5. Information Sheet is placed before the corresponding Self-check in Learning Guides, NOT Self-check first then Information Sheet
6. A Learning Module is used as a guide to design the module contents, methods of training, methods, and criteria for the assessment.
7. Training activity which includes demonstration by trainers but does not involve actual practice by trainees is considered as “knowledge” session.
8. Information Sheet must include “nice-to-know” information because the learners should be knowledgeable to all related information.
9. PEG will be shared with learners only when the LAP Test is completed, and the results is informed to them to get their signature.

10. Pre/post Questionnaires will be administered both at the very beginning and at the very end of the training course, to be used how much the learners' subjective perception increased, due to the training.
11. Session Plan is a general guide for trainers to manage time and training quality, which is prepared for all LOs together.
12. Operation sheet and LAP Test should be prepared and revised before PEG.
13. Learning Module should be prepared in line with the basic principles of EWTI's training; Output-oriented and Practice-based.
14. Post-test result can NOT be used to evaluate theoretical understanding of trainees on the intended learning outcomes.
15. Resource Requirements is used for the implementation of the training only, so the trainers should not have a look at it until the training starts.
16. Learning Activity Performance Test (LAP Test) is a set of instructions for practical skills test which is conducted at the end of each LG to assess if learners can demonstrate what they have learned from the training and learning guide with correct understanding.
17. Self-check covers key questions whose answers can NOT be found in the corresponding Information Sheet.

Directions-2: Answer all the questions listed below:

Matching: choose the right corresponding match for the components of learning guide listed under item A, with their possible quality parameters listed under item B.

Item A	Item B
1. Pre/Post-questionnaires 2. Self-check sheet 3. References / Sources 4. Information sheet 5. Pre/Post-tests 6. Session Plan 7. Training Schedule 8. Instruction Sheet	A. Includes the time spent for practical skill and theoretical knowledge B. Covers all major job-related practical skills from all LGs C. Presents "must-to-know" basic knowledge, required to perform the intended job skills D. Covers representative knowledge questions, taken from all Self-checks in all LGs E. Covers key questions whose answers can be found in the corresponding Information Sheet. F. Contains citation of all the related resources and reference materials used for the revision of Learning Guide. G. Includes all activities with model time, nominal duration, training method, trainer's role, and training materials H. Gives enough information for learners what to do with Learning Guide

POST-TEST ANSWER SHEET

Answer Box for Direction 1

No.	Your answer	Correct answer if false	No.	Your answer	Correct answer if false
1	*False*	*Training participants should not memorize all information written on Information Sheet.*	10	*True*	
2	*True*		11	*True*	
3	*True*		12	*False*	*Operation sheet and LAP Test should be prepared and revised after PEG*
4	*True*		13	*True*	
5	*False*	*Information Sheet is placed after the corresponding Self-check.*	14	*False*	*Post-test result can be used to evaluate theoretical understanding of trainee*
6	*True*		15	*False*	*Resource Requirements is used for both the preparation and implementation of the training.*
7	*True*		16	*True*	
8	*False*	*Information Sheet must include "must-to-know" information.*	17	*False*	*Self-check covers key questions whose answers can be found in the corresponding Information Sheet.*
9	*True*				

NOTE: Only used for progress chart

Score: _____

Rating: _____

Answer Box for Direction 2

1	2	3	4	5	6	7	8
B	*E*	*F*	*C*	*D*	*G*	*A*	*H*

NOTE: Only used for progress chart

Score: _____

Rating: _____

Pre-training Questionnaire

Training Course Title	
Duration	*YYYY/MM/DD - YYYY/MM/DD*
Name of Training Participant	
Date	*YYYY/MM/DD*

Please thick (✓) the appropriate colums.

LO1:

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior	performed by myself without help	supervised someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO1) now.		<50%	>50%	>70%	>80%	>90%

LO2:

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior	performed by myself without help	supervised someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO2) now.		<50%	>50%	>70%	>80%	>90%

LO3:

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior	performed by myself without help	supervised someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO3) now.		<50%	>50%	>70%	>80%	>90%

LO4:

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior	performed by myself without help	supervised someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO4) now.		<50%	>50%	>70%	>80%	>90%

LO5:

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior	performed by myself without help	supervised someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO5) now.		<50%	>50%	>70%	>80%	>90%

Post-training Questionnaire

Training Course Title	
Duration	*YYYY/MM/DD - YYYY/MM/DD*
Name of Training Participant	
Date	*YYYY/MM/DD*

Please thick (✓) the appropriate colums.

LO1:

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO1) now.		<50%	>50%	>70%	>80%	>90%

LO2:

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO2) now.		<50%	>50%	>70%	>80%	>90%

LO3:

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO3) now.		<50%	>50%	>70%	>80%	>90%

LO4:

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO4) now.		<50%	>50%	>70%	>80%	>90%

LO5:

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	Tasks	1	2	3	4	5
1						
2						
3						
4						
Q2: Overall, I think I am …% confident to do this job (LO5) now.		<50%	>50%	>70%	>80%	>90%

FORMS
AP
(Application Forms)

APPLICATION FORM FOR EWTI TRAINING COURSE
(For Institutional Candidates)

Registration No. (For office use only) .....

(To be filled by the candidate/organization neatly with Block Letters)

1) Training Course Applied: .....
2) Date of Admission: .....
3) Name of Organization: .....
4) Address for Communication

Region		Zone		Woreda		Town	
Telephone			E-mail				

5) Candidate's details

Name	Job title	Date of birth	Educational background		Year of work experience	Salary
			Profession	Level		
Mr./Ms.						
Mr./Ms.						
Mr./Ms.						
Mr./Ms.						

Date: .....

Name: ..... Position: ..... Signature: .....

APPLICATION FORM FOR EWTI TRAINING COURSE
(For Institutional Candidates)

Registration No. (For office use only) .....

(To be filled by the candidate/organization neatly with Block Letters)

1) Training Course Applied: *Drilling Technology*
2) Date of Admission: *15/03/2019*
3) Name of Organization: *SNNP WWCE*
4) Address for Communication

Region	*SNNPR*	Zone	*Sidama*	Woreda	*01*	Town	*Hawassa*
Telephone	*xxxx-xx-xxxx*			E-mail	*xxxx.zzzz@gmail.com*		

5) Candidate's details

Name	Job title	Date of birth	Educational background		Year of work experience	Salary
			Profession	Level		
Mr./~~Ms.~~ *Zzzzz Xxxxx*	*Driller*	*dd/mm/yyyy*	*Electro-mechanic*	*III*	*7*	*5,500 ETB*
Mr./~~Ms.~~ *Yyyy Vvv*	*Driller*	*dd/mm/yyyy*	*Driller*	*III*	*6*	*5,000 ETB*
Mr./Ms.						
Mr./Ms.						

Date: *15/03/2019*

Name: *Vxyz Klmn* Position: *HR Administration Head* Signature: .....

APPLICATION FORM FOR EWTI TRAINING COURSE (For Individual Candidate)

Registration No. (For office use only) ……

(To be filled by the candidate/organization neatly with Block Letters)

Training Course Applied: .....

Date of Admission: .....

1) Name in full (in BLOCK LETTERS)

   Mr./Mrs./Ms. .....

2) Name of his/her organization: .....

3) Date of Birth: .....

4) Sex: Male ..... Female .....

5) Nationality: .....

6) Address for Communication

Region	
Zone	
Woreda	
Town	
Telephone	
E-mail	

7) Qualification

   a. Academic qualification

Name of High School	
Name of Technical College/TVET	
Name of University	
Grade level:	
Profession:	

b. Experience

Job Position	Experience in Years

(If space is not enough, please use the back paper)

8) Payment details of registration fee (Not Applicable for Government Office Sponsored Applicant)

Deposit slip no	
Date	
Amount	
Name of the bank/post office	

9) Any other particulars:

……..

I certify that the information given in item above is correct to the best of my knowledge and belief. In the event of my selection for admission to the institute, I undertake to abide by the rules, regulations and discipline of the institute.

Date…..……

Signature of the candidate……

APPLICATION FORM FOR EWTI TRAINING COURSE (For Individual Candidate)

Registration No. (For office use only) ……

(To be filled by the candidate/organization neatly with Block Letters)

Training Course Applied: *Drilling Technology*

Date of Admission: *15/03/2019*

1) Name in full (in BLOCK LETTERS)

Mr./~~Mrs./Ms.~~ *Abebe Mekonnen*

2) Name of his/her organization: *ABC Well Drilling Company*
3) Date of Birth: *08/03/1998 (G.C.)*
4) Sex: Male ✓ Female
5) Nationality: *Ethiopian*
6) Address for Communication

Region	*Addis Ababa*
Zone	*Bolo Sub City*
Woreda	*12*
Town	*Addis Ababa*
Telephone	*xxxx-xx-xxxx*
E-mail	*xxxx.yyyy@gmail.com*

7) Qualification

a. Academic qualification

Name of High School	*Bulbula High School*
Name of Technical College/TVET	*General Winget*
Name of University	*N/A*
Grade level:	*10+3*
Profession:	*Assistant Driller*

b. Experience

Job Position	Experience in Years
Assistant Driller	*3*

(If space is not enough, please use the back paper)

8) Payment details of registration fee (Not Applicable for Government Office Sponsored Applicant)

Deposit slip no	*0001*
Date	*14/03/2019*
Amount	*55 ETB*
Name of the bank/post office	*Commercial Bank of Ethiopia*

9) Any other particulars:

…….*Abebe Mekonnen*……..

I certify that the information given in item above is correct to the best of my knowledge and belief. In the event of my selection for admission to the institute, I undertake to abide by the rules, regulations and discipline of the institute.

Date *14/03/2019*

Signature of the candidate *Abebe Mekonnen*

FORMS
TM
(Training Management)

TM-01

Date of Proposal.....

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**FIELD PRACTICE PROPOSAL FORM**
Course Title	
Course Leader	
Field Duration	From DD/MM/YY to DD/MM/YY
Name of Selected Field Site	
Field Objective	Objective Description: ----------
List of Major Activities at the Field	
Logistics Requirement for the Field	Transport:
	Equipment:
	Per Diem: (To be separately prepared by Education & Training Team based on this proposal)
	Other requirements:
Expected Outputs	
Attachment	☐ List of trainees ☐ List of EWTI trainers/gust, assistants

Prepared by: Name.....Position..... Signature.....

Approved by: Name.....Position..... Signature.....

TM-02

Date of Report.....

FIELD PRACTICE COMPLETION RREPORT

Course Title	
Course Leader	
Field Duration	From DD/MM/YY to DD/MM/YY
Name of Field Site	
Field Objective	Objective Description: ---------- --- Level of Objective Accomplishment Very Good ☐ Saiisfactory ☐ Not Satisfactory ☐

Number of Trainees

	Male	Female	Total
Registered for field			
Completed field training			
Not completed field training			

Difficulties Encountered and Measures Taken

Difficulties encountered	Measures taken

Points of Successful Action	
Points of Failures	
Lesson Learned	
Attachment	Photos/Video List of trainees List of EWTI trainers/gust, assistants

Prepared by: Name.....Position..... Signature.....

TM-03

LIST OF PARTICIPANTS

Course Title:	
Duration (GC):	From To

	Name	Region	Zone	Woreda	Town	Sex	Age	Organization		Job position	Educational background		Year of work experience	Tel	Remarks
								Category	Name		Academic level	Profession			
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															

ATTENDANCE SHEET FOR TRAINEEING PARTICIPANTS

Course Title _____

Date From_____20…..G.C. to_____20….G.C.

Name of Course Leader _____Attendance Duration_____

	Name																				
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					

Checked by _____Date_____/_____20… G.C

Signature_____

TM-05

ATTENDANCE SHEET FOR GUEST TRAINER

Course Name: _____

Duration of the Course: From _____to_____/20….G.C

Name of Guest Trainer: _____

No	Date	Signature		Total duration per day in hour
		Morning	Afternoon	
1				
2				
3				
4				
5				
6				
7				
			Total hours	

Trainer _____ Approved by _____

Signature: _____ Signature: _____

ETHIOPIAN WATER TECHNOLOGY INSTITUTE

EWTI

TRAINEE'S RECORD BOOK

Training Title _____

Duration: From _____ To:_____

Photo

Trainee's Name: _____

Organization: _____

Job title/Position: _____

INSTRUCTION

- Morning session is from 8:30 am to 12:30 pm
- Morning break is from 10:00 am to 10:30 am
- Lunch break is from 12:30 to 2:00pm
- Afternoon session is from 2:00pm to 5:00pm
- Afternoon break is from 3:00-3:15pm
- All trainees are expected to complete all the modules
- Trainees shall let the trainer sign on the TRB for every session, no signature of the trainer shall mean the trainees are absent or did not attend the scheduled session
- Maintain the cleanliness of the training room-Workshop at all times
- Attendance is a must.

LEARNING OUTCOME:

LO 1: _____

LO 2: _____

LO 3: _____

LO 4: _____

ASSESSMENT OF LEARNING OUTCOME

	Assessment Result			Remarks
	Score	Satisfactory	Not Satisfactory	
Pre-Test				
Post-Test				
LO 1				
LO 2				
LO 3				
LO 4				
LO 5				

WORK ETHICS AND VALUES

Ethics	Satisfactory	Not Satisfactory	Remarks
Resourcefulness			
Creativity			
Initiative			
Cooperation			
Punctuality			

TRAINING RESULTS

Completion of _____ Learning Outcome

Endorsement for Training Certificate

☐ Successful ☐ Participation ☐ No Certificate

Feedback to Trainee from Trainer:

_____

_____

_____

_____

Sig. _____ _____

Trainer: Date

Sig. _____ _____

Trainee: Date

Sig. _____ _____

Dept. Head: Date

ATTENDANCE

Date	Time	Trainee's signature	Trainer's signature	Comments
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			

Date	Time	Trainee's signature	Trainer's signature	Comments

	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			
	AM			
	PM			

TRAINING PARTICIPANTS PROGRESS CHART

Department	
Course Title	
Duration	From ..... To .....

No	Training Participant Name	Pre-Test	LO1	LO2	LO3	LO4	LO5	Group work and Presentation	Project work or Filed report	Post-Test	Remark
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

S: Satisfactory, NS: Not satisfactory

TRAINING PARTICIPANTS PROGRESS CHART

Department	Water Resource Development and Drilling Technology Department
Course Title	GIS AND REMOTE SNESING
Duration	From 23/02/ 2013 To 11/04/29

No	Training Participants Name	Pre-Test	LO1	LO2	LO3	LO4	Group work and Presentation	Project work or Filed report	Post-Test	Remark
1	Yassin Mohammed Abdula	21/20	√	√	√	√	√	√	30/30	S
2	Alemayehu Yadesa Emana	26/30	√	√	√	√	√	√	30/30	S
3	Gemeda Abarra Misiru	25/30	√	√	√	√	√	√	30/30	S
4	Bekele Bezuwerk	22/30	√	√	√	√	√	√	30/30	S
5	Kokobe Reta	23/30	√	√	√	√	√	√	30/30	S
6	Mesret Habte Debela	20/30	√	√	√	√	√	√	30/30	S
7	Haimanot Siyoum	21/30	√	√	√	√	√	√	30/30	S
8	Solomon Tsegaw	22/30	√	√	√	√	√	√	30/30	S
9	Astawaregn Kerito	24/30	√	√	√	√	√	√	30/30	S
10	Hamdi Abdulhafiz	23/30	√	√	√	√	√	√	30/30	S
11	Restom Merwan	20/30	√	√	√	√	√	√	30/30	S
12	Lukas Mengistu Menuyelet	22/20	√	√	√	√	√	√	30/30	S
13	Mulualem Dufera Gudeta	20/30	√	√	√	√	√	√	30/30	S
14	Yetnayet Zeleke	23/30	√	√	√	√	√	√	30/30	S
15	Workeneh Gashie Jeldeti	24/30	√	√	√	√	√	√	30/30	S
16	Selamawit Fekadu	25/30	√	√	√	√	√	√	30/30	S
17	Solomwork Hailu	24/30	√	√	√	√	√	√	30/30	S

S: Satisfactory, NS: Not satisfactory

Training Participants' Assessment Data Sheet

Module Title :	AAAA
Trainer :	Mr. XXX YYY
Date (1st Trial) :	2021/10/25-27
Date (2nd Trial) :	2021/11/10-11

No.	Participants	LAP Test for LO1		LAP Test for LO2		LAP Test for LO3		LAP Test for LO4		LAP Test for LO5		LAP Test for LO6		LAP Test for LO7		Oral Question		Result	
		1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial	1st Trial	2nd Trial
		S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS	S / NS
1	Mr. A	NS														NS		NS	S
2	Mr. B			NS													NS	NS	NS
3	Mr. C					NS										NS		NS	S
4	Mr. D							NS										NS	S
5	Mr. E									NS								NS	S
6	Mr. F											NS						NS	S
7	Mr. G													NS				NS	S
8	Ms. H															NS		NS	S
9	Ms. I																	S	S
10	Ms. J																	S	S
11	Ms. K																	S	S
12	Ms. L																	S	S
13	Ms. M																	S	S
14	Ms. N																	S	S
15	Mr. O																	S	S
16	Mr. P																	S	S
17	Mr. Q																	S	S
18	Mr. R																	S	S
19	Mr. S																	S	S
20	Mr. T																	S	S

TM-09

ACTION PLAN PREPARATION FORM

Course Title: _____

Name of Training Participant: _____

Date: _____

Name of organization: _____

No.	List of activities	Schedule of action	Responsible person	Required resource

Additional Remark:

_____

_____

_____

_____

_____

Prepared by: _____ Signature: _____

Assisted by: _____ Signature: _____

This form shall be prepared in three copies: First copy to the training participant, the second copy to the department and the third copy to training participant's organization

TM-09

ACTION PLAN PREPARATION FORM

Course Title: *Performing Fluid Engineering*

Name of Training Participant: *XXX* Date: *5 December 2019*

Name of organization: *YYY Regional Water Bureau*

No.	List of activities	Schedule of action	Responsible person	Required resource
1	Briefing and report presentation to the management	Dec. 2019	Mr.XXX	Stationeries
2	Introduction of KAIZEN Principle.	Dec. 2019 - Jan. 2020	Mr.XXX	Stationeries
3	Procurement of Mud Drilling Measurement Equipment	Jan. 2020 - April 2020	Finance Section YYY Regional Bureau	Fund
4	First Step Down Training in the Agency.	Jan. 2020	Mr.XXX	Statoneries, Refreshment, Measurement equipment
5	Monitoring and Evaluation	May 2020 - continuous	Mr.XXX, hydrogeologist, drillers	Travel cost, vehicle, fuelstationeries

Additional Remark:

Refreshment training course shall be planned, according to the results of monitoring and evaluation, depending on the availability of the resources.

Prepared by: *Mr. XXX* Signature: _____

Assisted by: _____ Signature: _____

This form shall be prepared in three copies: The first copy to the training participant, the second copy to the department and the third copy to trainees' organization

TM-10

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**DAILY REFLECTION SHEET**
Course Title	
Date	
Today's activity	

1. What was the most interesting part of the training in today's lesson?
2. What was the most challenging part of the training in today's lesson?
3. The way forward (or recommendation for tomorrow)

Thank you for your comments to improve our training program!!!!!

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**DAILY REFLECTION SHEET**
Course Title	TTLM Revision Workshop
Date	XX/YY/2019
Today's activity	Discussion on STD schedule and common LO1/ Reivison of Guidelines/Discussion on STD session plan/ PEG/LAP test/Operation Sheet compilation and refinement (DT), PEG/LAP test/Operation Sheet compilation and refinement (EMMT) / TOT Planning

1. What was the most interesting part of the training in today's lesson?

- The way developing daily reflection sheet format and way of discussion (recap of daily reflection sheet.
- How we develop standard schedule based on guidelines and acceptable procedures
- Interpretation or discussion on the schedule
- Discussion on what way doing schedule
- Making the common course easy and applicable as well as easy to check or control.
- Finalising the Guideline edition except the template preparation.
- Progress with guidelines revision was good due to good work environment with separate syndicate room.
- TOT team effort to qualify the training materials.
- Preparing LO2 (removing same content from LO1 and transfer to LO2)
- Group discussion is interesting and fruitful.
- Proceeded good assistant from JICA Experts.

2. What was the most challenging part of the training in today's lesson?

- Morning session should be short.
- Shortage of time, in the afternoon.
- Lack to time to finalise
- Mobile ringing tone of one person

3. The way forward (or recommendation for tomorrow)

- Keep it up.
- To finalise the remaining activities morning session should be minimized or reduced.
- To have a clear division of labour for tomorrow because we need to finalise (TOT)

Thank you for your comments to improve our training program!!!!!

TM-11

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**WEEKLY REFLECTION SHEET**
Course Title	
Date	
This week's activity	

1. What was the most interesting experience of the week?
2. What was the most difficult experience of the week?
3. Comments and Suggestions

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**WEEKLY REFLECTION SHEET**
Course Title	*TTLM Revision Workshop*
Date	*XX/YY/2019*
This week's activity	*LAP Test, Operation Sheet, etc.*

1. What was the most interesting experience of the week?

- *Interested presentation given by the group*
- *Feedback by the group*
- *Operation sheet preparation*
- *Exercising according to training operation and management*
- *Self-check*
- *Way of presentation of the PEG operation sheet, and LAP test*
- *Trainer supporting is easy to work*
- *Since it was aimed to at revising the TTLMs it was productive as to systematically view the TTLMs and produce a very function TTLM*

2. What was the most difficult experience of the week?

- *Time management*
- *Preparation of TTLM according to the new guide line*
- *Preparation of operation sheet because it was tedious, needs more to reed for our care*

3. Comments and Suggestions

- *What we strdoing is very important for EWIT trainer to further replacement*
- *Continue on it*
- *Keep it up*
- *Keep up the group leading with the facilitators*
- *Think in advance that EWTI has to plans to monitor the revision on the entire TTLMs otherwise they will not be fruitful achievement*

TM-12

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**TRAINING EVALUATION FORM**
Course title	
Date	

YOUR FEEDBACK IS IMPORTANT for us to deliver quality training please forward your comment

A. Evaluation for Training Course

1. To what extent have your personal objectives for this training been achieved?

Fully | 5 | 4 | 3 | 2 | 1 | Not at all

If you have scored 2 or 1, please comment why you have given this rating.

_____

2. To what extent has your understanding of the subject improved or increased as a result of the training?

A lot | 5 | 4 | 3 | 2 | 1 | Little

If you have scored 2 or 1, please comment why you have given this rating.

_____

3. Would you recommend colleagues with similar needs, to attend this course?

Definitely | 5 | 4 | 3 | 2 | 1 | Unlikely

If you have scored 2 or 1, please comment why you have given this rating.

_____

4. The convenience of the training schedule.

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

5. What are your views on the quality of the Assessment tools used?

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

6. Was this training appropriate for your level of experience? Yes ☐ No ☐

7. Are there any other comments about the training event that you would like to make?

_____

_____

B. Evaluation for Trainers

8. Please rate the trainer for each aspect, from (a) to (e) Effective (5) and Ineffective (1)

Trainer's name:_____

a)	Subject knowledge	5	4	3	2	1
b)	Organization & preparation	5	4	3	2	1
c)	Delivery methods	5	4	3	2	1
d)	The way to encourage participation	5	4	3	2	1
e)	Class room management skill	5	4	3	2	1
f)	Quality of the handouts provided	5	4	3	2	1
g)	Quality of the PowerPoint	5	4	3	2	1

Trainer's name: _____

a)	Subject knowledge	5	4	3	2	1
b)	Organization & preparation	5	4	3	2	1
c)	Delivery methods	5	4	3	2	1
d)	The way to encourage participation	5	4	3	2	1
e)	Class room management skill	5	4	3	2	1
f)	Quality of the handouts provided	5	4	3	2	1
g)	Quality of the PowerPoint	5	4	3	2	1

Trainer's name: _____

a)	Subject knowledge	5	4	3	2	1
b)	Organization & preparation	5	4	3	2	1
c)	Delivery methods	5	4	3	2	1

d)	The way to encourage participation	5	4	3	2	1
e)	Class room management skill	5	4	3	2	1
f)	Quality of the handouts provided	5	4	3	2	1
g)	Quality of the PowerPoint	5	4	3	2	1

Trainer's name: _____

a)	Subject knowledge	5	4	3	2	1
b)	Organization & preparation	5	4	3	2	1
c)	Delivery methods	5	4	3	2	1
d)	The way to encourage participation	5	4	3	2	1
e)	Class room management skill	5	4	3	2	1
f)	Quality of the handouts provided	5	4	3	2	1
g)	Quality of the PowerPoint	5	4	3	2	1

9. What specifically did the trainer do well?

_____

_____

10. What recommendations do you have for the trainer to improve?

_____

_____

_____

C. Evaluation for General Service of EWTI

11. Training equipment & workshop

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

12. Dormitory

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

13. Cafeteria service

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

14. Library service

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

15. Clinic service

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

16. Transportation service during field visit

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

17. Registrar service

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

18. Per diem payment process

Excellent | 5 | 4 | 3 | 2 | 1 | Poor

19. What general recommendations do you have for the institute?

TM-13

Summary of Training Evaluation (by Training Participant)

Program Title: Duration:

A.	Evaluation for Training Course	Rating	5	4	3	2	1	No response
1.	To what extent have your personal objectives for this training been achieved?	Fully ↔ Not at all						
	If you have scored 2 or 1, please comment why you have given this rating.							
2.	To what extent has your understanding of the subject improved or increased as a result of the training?	A lot ↔ Little						
	If you have scored 2 or 1, please comment why you have given this rating.							
3.	Would you recommend colleagues with similar needs, to attend this course?	Definitely ↔ Unlikely						
	If you have scored 2 or 1, please comment why you have given this rating.							
4.	The convenience of the training schedule.	Excellent ↔ Poor						
5.	What are your views on the quality of the Assessment tools used?	Excellent ↔ Poor						
6.	Was this training appropriate for your level of experience?	Yes/No	Yes:		No:		No response	
7.	Are there any other comments about the training event that you would like to make?							

TM-13

Summary of Training Evaluation (by Training Participant)

Program Title: Duration:

B.	Evaluation for Trainers	Rating	5	4	3	2	1	No response
8.	Please rate the trainer for each aspect.							
	Trainer's name:							
	a) Subject knowledge	Effective ↔ Ineffective						
	b) Organization & preparation	Effective ↔ Ineffective						
	c) Delivery methods	Effective ↔ Ineffective						
	d) The way to encourage participation	Effective ↔ Ineffective						
	e) Class room management skill	Effective ↔ Ineffective						
	f) Quality of the handouts provided	Effective ↔ Ineffective						
	g) Quality of the PowerPoint	Effective ↔ Ineffective						
	Trainer's name:							
	a) Subject knowledge	Effective ↔ Ineffective						
	b) Organization & preparation	Effective ↔ Ineffective						
	c) Delivery methods	Effective ↔ Ineffective						
	d) The way to encourage participation	Effective ↔ Ineffective						
	e) Class room management skill	Effective ↔ Ineffective						
	f) Quality of the handouts provided	Effective ↔ Ineffective						
	g) Quality of the PowerPoint	Effective ↔ Ineffective						
	Trainer's name:							
	a) Subject knowledge	Effective ↔ Ineffective						
	b) Organization & preparation	Effective ↔ Ineffective						
	c) Delivery methods	Effective ↔ Ineffective						
	d) The way to encourage participation	Effective ↔ Ineffective						
	e) Class room management skill	Effective ↔ Ineffective						
	f) Quality of the handouts provided	Effective ↔ Ineffective						
	g) Quality of the PowerPoint	Effective ↔ Ineffective						
	Trainer's name:							
	a) Subject knowledge	Effective ↔ Ineffective						
	b) Organization & preparation	Effective ↔ Ineffective						
	c) Delivery methods	Effective ↔ Ineffective						
	d) The way to encourage participation	Effective ↔ Ineffective						
	e) Class room management skill	Effective ↔ Ineffective						
	f) Quality of the handouts provided	Effective ↔ Ineffective						
	g) Quality of the PowerPoint	Effective ↔ Ineffective						
9.	What specifically did the trainer do well?							
10.	What recommendations do you have for the trainer to improve?							

C.	Evaluation for General Service of EWTI	Rating	5	4	3	2	1	No response
11.	Training equipment & workshop	Excellent ↔ Poor						
12.	Dormitory	Excellent ↔ Poor						
13.	Cafeteria service	Excellent ↔ Poor						
14.	Library service	Excellent ↔ Poor						
15.	Clinic service	Excellent ↔ Poor						
16.	Transportation service during field visit	Excellent ↔ Poor						
17.	Registrar service	Excellent ↔ Poor						
18.	Per diem payment process	Excellent ↔ Poor						
19.	What general recommendations do you have for the institute?							

TM-13 (SAMPLE)

Summary of Training Evaluation (by Trainees)

A.	Evaluation for Training Course	Rating	5	4	3	2	1	No answer
1.	To what extent have your personal objectives for this training been achieved?	Fully ↔ Not at all	3	2				
	If you have scored 2 or 1, please comment why you have given this rating.							
2.	To what extent has your understanding of the subject improved or increased as a result of the training?	A lot ↔ Little	3	2				
	If you have scored 2 or 1, please comment why you have given this rating.							
3.	Would you recommend colleagues with similar needs, to attend this course?	Definitely ↔ Unlikely	3	2				
	If you have scored 2 or 1, please comment why you have given this rating.							
4.	The convenience of the training schedule.	Excellent ↔ Poor		5				
5.	What are your views on the quality of the Assessment tools used?	Excellent ↔ Poor	2	1				2
6.	Was this training appropriate for your level of experience?	Yes/No	Yes:	5	No:			
7.	Are there any other comments about the training event that you would like to make?							

B.	Evaluation for Trainers	Rating	5	4	3	2	1	No answer
8.	Please rate the trainer for each aspect.							
	Trainer's name: Zemenu Addis							
	a) Subject knowledge	Effective ↔ Ineffective	4	1				
	b) Organization & preparation	Effective ↔ Ineffective	3	1	1			
	c) Delivery methods	Effective ↔ Ineffective	4	1				
	d) The way to encourage participation	Effective ↔ Ineffective	3	2				
	e) Class room management skill	Effective ↔ Ineffective	5					
	f) Quality of the handouts provided	Effective ↔ Ineffective	4		1			
	g) Quality of the PowerPoint	Effective ↔ Ineffective	5					
9.	What specifically did the trainer do well?	• Good Knowledge • Good Knowledge and attractive training obtained						
10.	What recommendations do you have for the trainer to improve?							

C.	Evaluation for General Service of EWTI	Rating	5	4	3	2	1	No answer
11.	Training equipment & workshop	Excellent ↔ Poor	2		1			2
12.	Dormitory	Excellent ↔ Poor	1				1	3
13.	Cafeteria service	Excellent ↔ Poor					1	4
14.	Library service	Excellent ↔ Poor			1		1	3
15.	Clinic service	Excellent ↔ Poor					1	4
16.	Transportation service during field visit	Excellent ↔ Poor	4	1				
17.	Registrar service	Excellent ↔ Poor	5					
18.	Per diem payment process	Excellent ↔ Poor			1	3	1	
19.	What general recommendations do you have for the institute?	• Good polite and attractive training obtained from the institute by Zemenu • Per diem and training equipment and cafeteria is low • Within the training day time mode and there is limited practical times short measure for following time						

TM-14

TRAINING COMPLETION REPORT

Course Title	
Duration	
Course Leader	
Modules and Learning Outcome	Module title: LO1: LO2: LO3: Module title: LO1: LO2: LO3:

Number of Training Participants and Resuts

	Male	Female	Total
Registered traininig participants			
Successfully completed trainees			

Names of Trainers

	Name	EWTI/Guest
Module 1		
LO 1		
LO 2		
LO 3		
Module 2		
LO 1		
LO 2		
LO 3		
LO 4		

Names of Assistant Trainers

	Name	EWTI/Guest
Module 1		
LO 1		
LO 2		
LO 3		
Module 2		
LO 1		
LO 2		
LO 3		

<table>
<tr><td></td><td>
<table>
<tr><td>LO4</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Difficulties Encountered and Measures Taken</td><td>
<table>
<tr><th>Difficulties encountered</th><th>Measures taken</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Points of Successful Action</td><td>❒</td></tr>
<tr><td>Points of Failures</td><td>❒</td></tr>
<tr><td>Lesson Learned</td><td>❒</td></tr>
<tr><td>Attachment</td><td>❒ List of Participants ❒ Summary of Training Evaluation
❒ Progress Chart ❒ Summary of Pre/post-Training Quesionnaire</td></tr>
</table>

TRAINING COMPLETION REPORT

Course Title	*Preparation/Revision of TTLM*
Duration	*XX/YY/2021-ZZ/YY/2021*
Course Leader	*Ms.ZZZ*
Learning Outcome	**Module title:** *Teamwork, OHS and Kaizen* LO1: *Teamwork* LO2: *OHS* LO3: *Kaizen* **Module title:** *Preparation /Revision of TTLM* LO1: *Diagnosis of current TTLM* LO2: *Learning module and resource requirement* LO3: *PEG, Operation sheet and Lap Test* LO4: *Instruction Sheet, Self-check, Information Sheet, Reference and Answer for Self-check* LO5: *Session plan, Schedule, Pre test, post test, pre questionnaire, post questionnaire and answer for post test*

Number of Trainees and Result

	Male	Female	Total
Registered trainees	*8*	*2*	*10*
Successfully completed trainees	*10*	*0*	*10*

Name of Trainers

	Name	EWTI/Guest
LO 2	*Mr.H*	*EWTI*
LO 3	*Mr.Z*	*EWTI*
LO 4	*Mr.A*	*EWTI*
LO 5	*Mr.Z and Mr.S*	*EWTI*
LO6	*Mr.Z. and Mr.S*	*EWTI*

Name of Assistant Trainers

	Name	EWTI/Guest
LO 2	*Mr.A*	*EWTI*
LO 3	*Mr.H.*	*EWTI*
LO 4	*Mr.K*	*Guest*
LO 5	*Mr.E*	*Guest*
LO 6	*Ms.R*	*EWTI*

<table>
<tr><td>Difficulties Encountered and Measures Taken</td><td>
<table>
<tr><th>Difficulties encountered</th><th>Measures taken</th></tr>
<tr><td>TTLM for TTLM needs some revision (self-check questions need revision, formats of TTLM parts, Operation sheet need minor revision etc.)</td><td>■ Discussion and sharing the division of work
■ Notes taken for future discussion and revision</td></tr>
<tr><td>Using of zoom meeting and moodel system (for some trainees face some difficulty while using the technology)</td><td>1) technical advice given by the experts and facilitators,
2) giving guideance and instructions both in person and online and
3) timely technical support by facilitators.</td></tr>
<tr><td>Time alocation in session plan (the time allocated on the Session Plan made prior to the workshop were not accurate, as the facilitator have never experienced similar workshop, and for some participants, the subjects taught were new and unfamiliar. Both the facilitators and the participants need to have some time to internalise the issue.)</td><td>Re-scheduliing (the facilitator gave detailed explanation and let the participants to have enough time for internalising issues.)</td></tr>
</table>
</td></tr>
<tr><td>Points of Successful Action</td><td>❒ Most of our activity are done in the work shop based on our schedule and come to consensus on the preparation/revision of TTLM
❒ Practicing zoom meeting
❒ Practicing hybrid training by using moodel
❒ The procedure of the workshop was done according to the Guidelines for Training Operation and Management.
❒ Provision of good internet access to the participants
❒ Provision of a good environment to concentrate on work.</td></tr>
<tr><td>Points of Failures</td><td>❒ Some teams didn't complete tasks on time (due to shortage of time allocated)</td></tr>
<tr><td>Lesson Learned</td><td>❒ Participants of the trainee become familiar and understood the advantage of using zoom and moodel effectively for instructional purpose
❒ Enabling environment (internet access, quiet environment) can contribute a lot to the good outputs.
❒ Team work, effective communication, time management and application of Kaizen and covid protocols contributed for successful and safe delivery of training
❒ TTLM of EWTI modules need continuous revision and practice
❒ E-learning (Moodle) is very useful and has lots of potential for improvement of EWTI's training, therefore there is a need for further</td></tr>
</table>

	technical assistance on how to develop and utilize moodel to EWTI staffs
Attachment	❒ List of Participants ❒ Summary of Training Evaluation ❒ Progress Chart ❒ Summary of Pre/port-training Quesionnaire

ETHIOPIAN WATER TECHNOLOGY INSTITUTE

EWTI

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CERTIFICATE OF SUCCESSFUL COMPLETION

This certificate is awarded to

NAME OF RECIPIENT

In recognition of his /her successful accomplishment of -

_____ course

From _____to _____

Date issued: _____/_____/_____

_____

Registrar

_____

Director General

ETHIOPIAN WATER TECHNOLOGY INSTITUTE

EWTI

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CERTIFICATE OF TRAINING PARTICIPATION

This certificate is awarded to

NAME OF RECIPIENT

In recognition of his /her participation of -

_____ course

From _____to _____

Date issued: _____/_____/_____

_____ Registrar

_____ Director General

ANNEX 2
TTLM QUALITY REQUIREMENT TABLE

Table 5: TTLM Quality Requirements

No	Component	Minimum requirement for completion of each component	Quality check questions
1	Performance Evaluation Guide	▪ Uses the given format of the EWTI's Training O&M Guidelines. ▪ Contains detailed information for trainers to prepare evaluation environment, observe and assess learners' performance of practical skills, and ask oral questions to confirm their understanding of the performance. ▪ Includes general information about the LAP test, necessary materials and equipment, Rating Sheet for Demonstration, Oral Questions, recommended answers for oral questions. ▪ Is in alignment with LAP Test and Operation Sheet, dealing with the same job-related performance and there are no discrepancies among the 3 components.	**[OUTLINE]** ▪ Are all necessary columns filled in properly on the 1st page (course title, LG number and title, individual/group assessment, venue)? ▪ Is the assessment method appropriate? ▪ Is the assessment place/environment appropriate? ▪ Are preparation instructions concrete and understandable? ▪ Are all the required materials listed? Are they concrete and understandable with the specific item name and the quality? ▪ Are the listed materials realistic and usable/acceptable? **[RATING SHEET]** ▪ Are all necessary columns filled in properly on the Rating Sheet (course title, learner's name, trainer's name, LG No., individual/group assessment, venue)? ▪ Is the instruction for demonstrations concrete and understandable? ▪ Are the assessment items specific enough to understand what needs to be assessed? (e.g. "Prepare PEG" is too general and you cannot judge what is the acceptable status) **[ORAL QUESTIONS]** ▪ Do the questions avoid knowledge questions? (e.g. No definition questions and memory challenge) ▪ Are the questions related to the practical skills, written on the LM?
2	Training Schedule	▪ Uses the given format of the EWTI's Training O&M Guidelines.	▪ Is the appropriate format used? ▪ Are the activities appropriately categorized (Knowledge, Skill, and Others)?

No	Component	Minimum requirement for completion of each component	Quality check questions
		▪ The time spent for theoretical knowledge is in the range of 20% - 40 % of the total time of the training. ▪ The time spend for practical skill is in the range of 60% -80% of the total time of the training.	▪ Is the training schedule consistent with Learning Module and Session Plan? ▪ Is the lecture: practice proportion appropriate? ("Skill" session should be prioritized as much as possible in principle) ▪ Is the schedule well-adjusted to the learning outcomes and methodology? (Consider covering the same LO or activity in the same week rather than separating it to different weeks. Break time should be also effectively included.) ▪ Does the schedule contain all necessary activities (recap session, Kaizen, daily reflection, etc.)? ▪ Are the allocations of time for each activity appropriate? (It is better to secure some buffer time for flexibility.)
3	Training Session Plan	▪ Uses the given format of the EWTI's Training O&M Guidelines. ▪ Prepared for each LO, including Course title, Learning outcome, Session objectives, Trainers, Model time, Activities, Nominal duration, Training method, Trainer's role, and Training materials. ▪ Includes all the standard activities such as Daily recap session, Daily reflection, Common LO1 (KAIZEN) LAP Test.	▪ Does it appropriately describe the daily activities? ▪ Is the training method appropriate for the activities? ▪ Is the nominal duration appropriate for the activities? ▪ Is the role of trainers stated clearly? ▪ Are the essential training materials and LG mentioned?
4	Learning Guides	*Includes all the content listed below (a – f).*	

No	Component	Minimum requirement for completion of each component	Quality check questions
a	Instruction Sheet	▪ Gives enough information for learners on what to do with Learning Guide as a support for self-learning using EWTI format.	▪ Are the instructions listed sequential and clear? ▪ Does the explanation in Instruction Sheet cover the whole LG? ▪ Are the instructions written based on the format?
b	Self-check Sheet	▪ Deals with basic knowledge that is necessary to perform job-related skills. ▪ Covers key questions whose answers can be found in the corresponding Information Sheet. ▪ One or more Self-check Sheets are prepared for each Learning Guide.	▪ Are all the questions "must-to-know"? ▪ Do questions cover all key-knowledge / Information Sheet? ▪ Is it possible to find all the answers of the questions from the Information Sheet? ▪ Does Self-check questions imply the Operation Sheet?" ▪ Is the method of questions appropriate? (check the use of yes-no questions, rating, matching, true-false, fill-in the blank space, Do's & Don'ts etc.) <-point: not use descriptive questions ▪ Is the proportion of each type of question appropriate? (proper proportion and balance of different type of questions should be decided by the trainer.) ▪ Are the questions clear enough? ▪ Outline : Is the Self-check placed at the beginning of Learning Guide (immediately after Instruction Sheet)? ▪ Is the total number of questions appropriate? (It depends on the volume of “must-to-know” information, but in average 10-20, not too much, not too little) ▪ Does it contain appropriate number and form of answer column, according to the given questions?
c	Self-check sample answers	▪ Contains sample answers for all Self-check questions.	▪ Do all questions have sample answers? ▪ Are all answers correct? ▪ Are all answers presented in Information Sheet?

No	Component	Minimum requirement for completion of each component	Quality check questions
d	Information Sheet	▪ Follows the sample of LAP Test form in the common module (LO1). ▪ Is easy to read with concrete examples with pictures, graphs, and/or tables to help learners understand "Must-to-know" basic knowledge. The shorter, the better, exclusive of "nice to know" details.	▪ Is all information "must-to-know"? ▪ Is all information necessary for performing the intended skills? ▪ Is there enough information to perform the intended skills? ▪ Is the presentation of the information appropriate? (e.g. Enough figures and pictures? Amount of texts is enough/too much? Is it clear?)
e	Operation Sheet	▪ Follows the sample of operation sheet form in the common module (LO1). ▪ Contains step by step explanation of the target job related skills, so that trainers can demonstrate the skill by following the described and learners can do necessary exercise.	▪ Are all the tasks (contents) compatible with PEG? ▪ Are all steps of the tasks sequential and clear? ▪ Are the preparation notes and the instructions clear and understandable? ▪ Is the presentation of the Operation Sheet understandable and user-friendly, utilizing the diagram, photos, and any other visual items/instructions? (and these items are effectively used?) ▪ Are all the necessary materials listed? ▪ Are the given tasks/method appropriate and effective for learners to acquire necessary practical skills?
f	LAP Test	▪ Follows the sample of LAP Test form in the common module (LO1). ▪ Contains directions for learners what to do to show their capacity of performing the job-related skill which is the target of each Learning Guide.	▪ Is proper time duration for each assessment task specified at the top of the sheet? ▪ Are the tasks (contents) compatible with PEG and Operation Sheet? ▪ Are the preparation notes and the instructions clear and understandable?

No	Component	Minimum requirement for completion of each component	Quality check questions
g	Reference / Source	▪ Contains citation of all the related resources and reference materials that were used for the development of the TTLM, or any relevant resource recommended for the learners for their self-study.	▪ Are all the resources cited in the text and any relevant resource recommended for the learners for their self-study listed? ▪ Are all the resources in the text properly cited?
5	Pre/Post-tests	▪ Uses the given format of the EWTI's Training O&M Guidelines. ▪ Covers representative knowledge questions, taken from all self-checks in all LGs, consisting at least 25questions in easy to check format (T/F, Multiple choice, Matching).	▪ Is the total number of questions appropriate? ▪ Do the questions cover all the must-to-know knowledge? ▪ Do all questions come from self-checks? ▪ Do all questions have sample answers brought from self-check?
6	Pre/Post-tests sample answers	▪ Contains sample answers for all Pre/Post-test questions.	▪ Do all questions have sample answers? ▪ Are all answers correct?
7	Pre/Post-questionnaires	▪ Uses the given format of the EWTI's Training O&M Guidelines. ▪ Pre/Post-questionnaires format is identical. ▪ The instruction clearly explains that the questionnaires are not a part of evaluation. ▪ Covers all major job-related practical skills from all LGs.	▪ Are all questions filled based on the format? ▪ Do the questions reflect the leaning outcomes?

ANNEX 3
TRAINING PARTICIPANT'S DISCIPLINARY REGULATION

Annex 3

Ethiopian Water Technology Institute (EWTI)

Training Participant's Disciplinary Regulation

(First Edition)

April 2022

Annex 3

Training Participant's Discipline Regulation

During their stay in the institute, training participants are expected to properly attend there training, to have healthy relationship among them and with the institute, and also using properly the common and individual service that provided by the institute. If a training participant violates or commit in-disciplinary act, based on the type and repetitiveness of such in-disciplinary acts, the institute discipline committee will decide and take the following disciplinary action.

Article 1. Composition of the training participants discipline committee

a) The institute's education and training directorate director- chair person

b) The head of department where the accused e training participant is attending the training - secretary

c) The institute's legal advisor- member

d) Student service- member

e) Representative of training participants- member

Article 2. Training participant's in-disciplinary act that will result in recorded verbal warning

a) Intentionally shouting and disturbing the working environment, especially in the areas of common services (such as class rooms, workshops, library, meeting hall, around offices …)

b) Lack of willingness to show ID at entrance gate, library, examination rooms …

c) Not wearing the proper uniform at workshops and practical demonstrations areas

d) Refusing to respond to the announcement of the office (Lack of willingness to respond to call of the respected office)

e) Not keeping the line to have services/disturbing the line

f) Not using properly the property of the institute/ water pipe, toilets, electric curtain, chair tables etc.

g) In exam room, coping answers from someone, and being in possession of prohibited papers; and the exam result may be cancelled based on the decision of the committee

h) Jumping over the fences (to get in or out) of the compound

i) Other related violation of discipline;

Article 3. Violation of discipline that will result written warning

f) If a training participant already penalized by oral warning for committing one of

violation of discipline listed under Article 2 and if he/she repeats the same or similar violation again;

g) Writing and drawing offensives and immoral things in class room, library, other service giving rooms and on walls and also on chairs and tables;

h) Posting prohibited papers on notice board and in other areas of the institute.

i) Removing, tearing, scratching or destroying of notice that posted legally;

j) Entering to the compound with 'chat'/ eating 'chat';

k) Disturbing the calm environment being intoxicated by taking too much alcohol.

l) Gambling in the compound of the institute.

m) Smoking cigarette at prohibited areas of the compound.

n) Giving to someone else his/her ID card of the institute (or using the ID card of someone else); Disturbing events /exam day, registration day, graduation day etc./ in the compound;

o) Conducting unauthorized meeting in the compound;

p) Deliberately or carelessly damaging or destroying property of the institute/the training participants who come back after punishment before entering to the training they have to replace the property they damaged or destroyed in kind or payment.

q) Harassment/ scaring, troubling, over criticizing/ of female training participants by speech, writing and forcing;

r) Insulting, blacking names, terrifying by threatening the staffs of the institute/ trainer, workers, training participants / tearing/;

s) Removing pages from the books which are the institute's property and,

t) Other related violation of discipline.

Article 4. Major violations of discipline that will result in dismissal of training participant without any warning for one training time

a) If a training participant committed violation of discipline for second time instead of improving himself/herself with the first written warning for committed violation of discipline listed under Article 3.

b) Played a role to have a strike or attempted to have a strike;

c) Being found in possession of gun in the compound of the institute.

d) Creating disagreement and involving with fighting in team or individually, in the compound of the institute.

e) Being caught stealing or in robbery act in the compound of the institute.

f) Performing sexual intercourse in the compound of the institute, by force or mutual willingness.

g) Cheating by coping some body's signature or by using fabricated documents.

h) Other related violation of discipline.

Article 5. Major violation of discipline which will result in dismissal of a training participant without any warring for two training time

a) A training participant who was penalized for committed violation of discipline listed under Article 3 to Article 4; and instead of improving his/her behavior, he/she found committing violation of discipline for the second time;

b) Quarreled and involved infighting with the institute staffs or trainers, worker and training participant;

c) Hurting or attempting to hurt the institute staffs with gun or other weapon.

d) Having or using prohibited drugs in the institute compounds.

e) Other related violations of discipline.

Article 6. Major violation of discipline which will result in a permanent dismissal of a training participant without any precondition from the institute's education and training programs

a) The training participants those penalized for the violation of discipline listed under Article 5, and if they found repeating the same violation for the second time, they will be dismissed permanently from the institute's education and training program.

b) Providing to the institute fabricated or forged certificates, documents, etc.

c) Other related violation of discipline.

Article 7. The steps for taking disciplinary actions

a) When a training participant found committing violation of discipline, the trainer of the institute would bring him/her with evidence to head of the department that the training participant is attending.

b) The department head by investigating the severity of the violation of discipline will present the case to the discipline committee.

c) After receiving the case, the committee will examine and convey decision within three days.

The training participant who committed violation of discipline listed under Article 2 and Article 3, he/she follows the decision of committee while attending the training. However, in

case of the training participant who committed violation of discipline listed under Article 4 up to Article 6 he/she has to stay out of the institute and wait until the committee makes decision on the case.

Ethiopian Water Technology Institute (EWTI)

Guidelines for Training Operation and Management

Vol. II

Operating Procedures Manual for International Training

(Based on the cases funded by JICA)

March, 2024

The Project for Strengthening Capacity for Training Operation and Management for EWTI

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1 Introduction

The purpose of this manual is to provide a general procedure with detailed information on how to conduct international training at Ethiopian Water Technology Institute (EWTI) based on JICA funded international training experiences.

The manual also has a specific relevance to various departments within EWTI to conduct international training by providing sufficient information for future similar training. Above all, by bringing together detailed JICA based experiences, it is expected that much time-wasting can be avoided in preparation to deliver international training.

This manual was compiled with all the past experiences of JICA-funded international training courses conducted by EWTI. The contents range from screening the candidates for the international training; to each and every stage of implementation, to administrative procedures; and rules necessitated by federal laws and regulations. When it comes to administrative policies and procedures, as long as justifications are presented and accepted through the normal channels of the institute, there might be a room for approval and admission.

1.1 Preparation of General Information

General information (GI) about the training should be prepared by the Course Leader and should be approved by the EWTI management at least two months prior to the implementation of the training. Contents of GI includes introduction, a summary of the training course, training program schedule (even tentative), information on administrative arrangement and guidelines for filling application. Samples of GI attached (Annex 1) and application form are attached (Annex 2). The GI and Application form will be sent out with invitation cover letter. The detail of the cover letter is stated in 1.2.

1.2 Preparation of cover invitation letter from Ethiopian Water Technology Institute (EWTI)

Invitation letters for the international training applicants should be officially sent to the client organizations (water related sectors organization or institutes in different countries) under the name of the EWTI. The cover invitation letters should explain the General Information (GI) and application form such as the number of accepted candidates (the number of candidates may differ from an organization to another, according to the training design) and the submission deadline of application documents (the deadline is about one month prior to the beginning of the training). The letters should be signed by the Director General of EWTI. It is advisable to send the cover invitation letters to each country at least two months prior to the beginning of the training. In this case, JICA country offic of each country should also be addressed as CC. All the letters should be copied and/or scanned and kept at EWTI.

1.3 Dispatch of cover invitation letter and GI

The prepared cover invitation letter and GI with an application form should be sent to each country/ client organization by email or international courier service.

1.4 Report to each project partner office (in this case, JICA country office) in the invited countries (only if it is a project supported training course)

It is sometimes difficult to directly contact the client organization and/or candidate due to poor telephone and/or internet connections. Project partner offices in each client organization country may be able to follow-up on these initial contacts.

2 Application

2.1 Follow-up application status of international training client organization

Sometimes, the invitation letters and attached documents may not reach to the addressed candidate organizations or may get misplaced somewhere. It is important to contact client organizations to confirm that the documents have been properly delivered. Project partner offices (in this case, JICA country offices) should be asked to contact clients organizations in their countries that have failed to respond within about one month after sending the documents to inquire about their application.

2.2 Selection of International training candidates

Appropriate candidates for the course are selected by checking the educational background, work experience, age and so on in the submitted application forms according to the criteria described on GI. If the initial number of applicants shown by the respective organizations are less than the required number; it should be taken into consideration to fill the quota after the deadline of the application. However, if there are countries/ client organizations which do not have any candidate, the opportunity may be given to other countries/ organizations which submit the excess applications of the candidates with the required qualifications. The selection process should be finalized within one week after application deadline. For the selection, EWTI organized the screening committee, and the committee communicates the client organizations for clarification and further references for the candidates' educational and work experiences, when necessary. Some differences of the government structure and the demarcation of work in the sector should be considered, as the selection criteria made in the Ethiopian context may not be always applicable in other countries. The contact numbers and email addresses of expected participants should be kept and well managed with in the EWTI database. A sample of screening result is attached (Annex 3).

2.3 Acceptance letter for international training participants

Immediately after the selection is finalized, acceptance letters should be prepared (a sample attached, Annex 4). The letter is normally signed by the Director General of EWTI. The signed letters shall be sent to the trainees directly by email or international courier service. Together with the acceptance letter, separate "Instruction Sheet" is enclosed for both Ethiopians and foreign trainees which explains necessary procedures such as visa applications and necessary information before and during the training. A sample of instruction sheets is attached (Annex 5).

N:B; this international training manual is made with an assumption that the training is organized for

both local and international participants.

3 Acceptance

3.1 Flight booking

After the selection of trainees, appropriate flights are arranged for the international participants. The booking can be made immediately after all participants screening is finalized. Booking can be done directly or through flight agents.

N; B using flight agent will give more confident in securing seat reservation instead of direct booking.

Inform each participant about the flights

The detailed information about booked flights should be informed to each international trainee through email. Each trainee can check and confirm the contents of the ticket such as name spelling, date of arrival and departure, etc.

Flight ticket confirmation

E-tickets can be directly sent to the trainees from a travel agency (email address has to be provided to the travel agency) or EWTI can send it to the participants.

3.2 Applying for visas (information as of Feb, 2020)

Except Kenya and Djibouti all African countries require a visa to enter Ethiopia. There are two types of visa; one is **tourist** and the other one is **conference/training visa**. In this case the required visa is the latter one, conference visa. The conference/ training visa itself can be "**visa before arrival**" or "**visa upon arrival**". EWTI needs to request the Main Department for Immigration and Nationality Affairs of Ethiopia (MDINA) for the permit of entry conference visa for both before arrival and upon arrival visa. To request for conference visa, a photocopy of the candidate's passport required and it has to be sent by email to EWTI from each candidate. A sample of the request letter is attached (Annex 6). The permit from MDINA should be provided to EWTI staff who holds EWTI ID in a week time after the date of the request (a sample of the permit is attached, Annex 7). The scanned copy of permit should be sent to the trainees via email so that they can process their conference visa. Similarly, trainees who can access before arrival visa, should apply for their own visa in their country and they should cover all expenses necessary for the service. Then, they should inform EWTI via email that they have obtained a visa.

There are some countries where there is no Ethiopian embassy and trainees cannot obtain Ethiopian visa in their countries. In this case, they need a "visa upon arrival". trainees from the following countries require "visa upon arrival":

African countries which require "visa upon arrival" as of May 2021	Botswana, Cameroon, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zambia

N.B; Up-to-date information regarding visa application should be checked and confirmed at each time of training implementation because the entire visa issuance policy is subject to change periodically.

3.3 Hotel reservation

The hotel should be reserved at least two months before the training, preferably before sending invitations to each country. The reservation should be checked by EWTI for confirmation before arrival of international training trainees. Some hotels may require an advance payment.

N.B; prior to hotel booking information such as diet requirements, religion, gender and other sociocultural needs to be consulted with the hotel management.

3.4 Receiving international training trainees at the airport

Trainees should be picked up at the airport by an EWTI driver or hotel shuttle. The driver should hold a sign with EWTI or project partner organization (in this case, JICA country office) logo so that the trainees can find them easily. Sometimes it is difficult to pick them up all at once because of so many people coming out at the same time. Moreover, flights are often delayed. If there is someone who doesn't arrive at the airport or the hotel on time, check the arrival schedule to the travel agency or airline company. For any case, "Information Sheet", which includes contact address of the hotel, a contact number of persons in charge to pick them up from the airport, the information regarding their arrival date and the first day of the training, should be prepared (a sample of information sheet is attached, Annex 8) and sent to the international training trainees before their departure from their country.

3.5 Invitation to embassies in Ethiopia and media for opening and closing ceremony

Representatives from each embassy of the trainees' countries and Ministry of Water and Energy of Ethiopia (MoWE) are invited to the opening and closing ceremony held on the first and last day of the training. The invitation letter should be sent at least 10 days before the ceremony. Public media and public relations department of MoWE is also invited to the opening and closing ceremony. A sample of an invitation letter for the embassies and the ministry is attached (Annex 9).

Contact number of each embassy should be informed to the trainees beforehand because some trainees may want to visit their embassies to pay a courtesy call.

4 Preparation for training course

4.1 Arrangement of EWTI training room

Arrangement of the EWTI training room (tables, chairs, screen, microphone, PC and associated devices) should be completed at latest one day before the training. The training room can be set as per specific international training program requirement, if necessary. At least one full-time personnel should be assigned for emergency activities (Ex:-generator operation in case of power failure, LAN cable arrangement etc.) required during the training.

4.2 Arrangement of catering service

Catering service which provides standard meal service at EWTI compound should be communicated in advance to serve the international training trainees and trainers during the international training. The catering service provider should be consulted on issues such as dietary restriction based on their religion/culture, allergy or any related personal preference and the information should be notified to the trainees. The sample of catering service contract is attached (Annex 10).

4.3 Assignment of trainers

The assignment of trainers should be done according to the Guidelines for Training Operation and Management. Some specific needs for international training, such as language ability, cross cultural tolerance, international training mind set can be taken into consideration, when necessary. In case there is emergency situation where the main trainer can't make it, there should be a second trainer standby. When there is a need to invite guest trainers, the guest trainer should be communicated in advance and include his/her session in the training schedule.

4.4 Preparation of field practice

Preparation for field practice program should be arranged and included in training schedule. Safety cloths and safety shoes should be arranged for the trainees in advance if needed. Prior to field practice; field program schedule, assignment of trainers, arrangement of transportation from/to the field site, necessary logistic supply and catering service at the site should be checked in advance.

5 Course implementation

5.1 Opening ceremony

Arrangement of the conference room for the ceremony such as tables for guests and presenter should be completed one day before the opening day.

High officials from each trainee's country embassies, from MoWE or other organizations should be invited to the ceremony in advance. A sample of the opening ceremony is attached (Annex 11).

5.2 Implementation of training course

Training program is arranged and conducted by the assigned trainers. Administration side should be always in touch with trainers and shall prepare necessary things in advance. training officer should always stay in the training room to support the administrative matters because unexpected incident might occur during the training.

Daily transportation between Hotel to EWTI (training venue) should be arranged for the international trainees.

5.3 Closing ceremony

Arrangement of the conference room for the ceremony such as tables for guests and presenter should be completed one day before the closing day. Representatives from embassies of the trainees' countries

are also invited.

High officials from MoWE or other organizations should be invited to the ceremony in advance. A sample of the closing ceremony is attached (Annex 12).

5.4 Compiling administrative task before international trainees' departure

5.4.1 Returning any borrowed items

The participants need to return all the items they have borrowed by the institute at the start of the international training before they leave. These items may vary depending on what items trainees might borrow but usually such items are basic and necessary for trainees to successfully accomplish their training as well as their stay in the institution. Examples of items include SIM card (trainees from abroad will be provided with mobile SIM card on the first date of the training, see the section 6.1.2), any books borrowed from the library.

5.4.2 Currency exchange

The other issue to be remembered is that currency exchange (usually the local money into USD). It is believed that the amount of allowance given to the international trainees based on daily expenditure in Ethiopia; however, trainees may remain with some local currency at the end of their training and trainees will be in demand of currency exchange (USD). EWTI should strictly inform the international trainees about money related issues in advance. As a rule, EWTI encourages international trainees to use or spend any allowance money given before their last day and EWTI cannot promise or has no mandate to involve in any monetary activities. However, EWTI can do their best to assist the international trainees to have the service of currency exchange.

5.4.3 General feedback from the trainees

While daily/weekly reflection is officially conducted throughout the training period, according to the Guidelines for Training Operation and Management, the trainees are free to reflect whatever comments they have on daily basis; but it's good to take trainees' general comments either positive or negative as input for future improvements.

5.5 Departure of trainees for returning

Flight schedule and checkout time should be informed to the trainees at least one week before the completion of the training. Transportation from the hotel to the airport should be arranged beforehand. Transportation service of the hotel can also be used. It would be a good last impression for the trainees if a person from EWTI and project partner organization (in this case, JICA country office) rcan accompany them at the airport.

6 Others

6.1 Tasks of training officers

6.1.1 Life support activities

The life support treatments are important to the international trainees and need to be performed on daily basis. Sometimes the international trainees may have difficulties in adopting the Ethiopian culture

and life. The training officer should play a huge role on building the meaningful and necessary life support activities that will allow trainees to achieve the training objectives without any obstruction. Besides attending any issues related to life in Ethiopia need to be addressed through a training officer.

Therefore, a training officer should make the training more efficient and help everyone to achieve their goals and to be productive on the training through reducing stress and facilitating relaxation.

The most important task of EWTI training officer on the international training is to attend and provide daily life support treatment to the trainees during their stay, including their meals, communication, shopping, dealing with hotel services, etc. And the life support may include the cases of unexpected illness.

6.1.2 Mobile data service

The trainees should be notified on any mobile and internet related services A sample of information on mobile data service is attached (Annex 13).

6.1.3 Weekend program

A weekend program can be particularly designed for the international trainees to know the local culture and tastes. It is also important for the enjoyment of trainees from other countries because they do not have a chance to experience Ethiopia if they stay only at the hotel. Some examples of the past experience are shown below.

Place	Location
Entoto national park	Addis Ababa
Andnet park	Addis Ababa
National museum	Addis Ababa
Cultural restaurants	Addis Ababa
Entoto mountain to see whole view of Addis Ababa town	Addis Ababa
Merka Kunture (archeological site)	On the way to Butajira
Har Shetan crater lake	Butajira
Tiya (world heritage)	On the way to Butajira
Sodore hot spring	Sodre

6.1.4 Additional international training experience

This part shows samples of some good experiences format at the EWTI international training such as self-analysis and action plan made by trainees. The sample of self-analysis made by trainees is attached (Annex 14). EWTI has standard format for action plan attached to EWTI's Guidelines. The sample of standard format of action plan and the action plan made by trainees based on the standard format is attached (Annex 15).

6.2 Insurance

The insurance of foreign trainees should be covered by EWTI with the plan of "the Group Personal Accident (GPA) Plus Illness Extension". The GPA and medical illness insurance for foreign trainees could cost around 16,925ETB (as of January 2020). But costs related to pre-existing illness, pregnancy and dental treatment are not covered.

6.3 Cost

The expense for implementation of one international training is roughly calculated based on previous experience (Training on Operating and Maintaining Gen-set).

General information about the training is as follows.

Course title	International Training on Operating and Maintaining Gen-set
Date	from January 20 to February 8, 2020
Place	Ethiopian Water Technology Institute (EWTI), Addis Ababa, Ethiopia
Trainees	5 trainees from Nigeria and 5 from Malawi (Male: 9, Female: 1), 5 trainees from Ethiopia (Male: 5), Total 15 trainees
Daily allowance	550 ETB (equivalent to 17 USD) for foreign trainees 300 ETB (equivalent to 9 USD) for Ethiopian trainees

The international training on Operating and Maintaining Gen-set expense breakdown

Items	Birr	USD equivalent	Remarks
Communication	200	7	Mobile SIM cards for the trainees from Malawi and Nigeria
Transportation	317,901	10,000	Flights for foreign trainees
Accommodation	307,000	9,657	Hotel rooms (19 days) for foreign trainees and first evening dinner
Weekend program	10,000	315	Visited Andnet Park
Insurance	16,925	532	
Allowance	15,300	481	
Catering service	205,670	6,470	Lunch and tea break service for trainees and trainers for 14 working days
Stationary etc.	5,000	158	
Total	877,996	27,620	

1 USD = 31.7901Ethiopian Birr (as of 30 Dec 2019)

The expenses above do not include lecture fee, transportation for lecturers and accommodation fee for lecturers.

7 Summarized procedures of preparation schedule for the international training

The summarized procedure of preparation schedule for the international training shown below.

Summerized Procedure of Preparation Schedule for International Training Course (Operating and Maintaining a Gen-Set)

	Activities	Date	October	November	December	January	February
1	**Inviation**						
(1)	Preparation of General Information	-					
(2)	Dispatch of invitation and GI	Oct. 21					
2	**Application**						
(1)	Follow-up for selection of trainees through JICA office	-					
(2)	Deadline for application submission	Nov. 29					
(3)	Selection of trainees	-					
(4)	Notice of acceptance	Dec. 16					
3	**Acceptance**						
(1)	Booking for flights	-					
(2)	Information to participants for the flight	-					
(3)	Preparation for Visa	-					
(4)	Confirmation for air ticket	-					
(5)	Reservation of hotel	-					
(6)	Information to embassy and media	-					
(7)	Insurance	-					
4	**Preparation of training**						
(1)	TTLM preparation	-					
(2)	Assignment of trainers	-					
(3)	Rehearsal of LAP test	-					
5	**Training**						
(1)	Arrival of particiapnts	Jan. 19					
(2)	Opening celemony	Jan. 20					
(3)	Training	Jan. 20 - Feb.7					
(4)	Closing celemony	Feb. 7					
(5)	Departure of participants	Feb. 8					

Guidelines for Training Operation and Management

Annex 4: Operating Procedures Manual for International Training (EWTI)

Appendices

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

Third Country Training/ In-Country Training Program

GENERAL INFORMATION ON
Operating and Maintaining a Generator Set (Gen-set) *FY 2019*

Jan. 19 to Feb. 08, 2020

This information pertains to the aforementioned Third Country Training of the Japan International Cooperation Agency (JICA), which will be implemented as part of the Official Development Assistance of the Government of Japan based on bilateral agreement between the Government of Japan and the Government of Ethiopia.

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

I. Description

1. Title:
Operating and Maintaining a Generator set (Gen-set)

2. Course Period in Ethiopia
From Jan. 19 (arriving in Ethiopia) to Feb. 08 (leaving Ethiopia), 2020

3. Target Regions or Countries
- Ethiopia (Somali, Afar, Benishangul-Gumuz and Gambela Regions; Private company)
- Malawi
- Nigeria

4. Eligible / Target Organization
Regional Water bureaus, town water supply service, etc.

5. Course Capacity (Upper limit of Participants)

Number of trainees from participating countries / regions			
Nigeria	Malawi	Ethiopia	Total
5	5	5	15

6. Language to be used in this program: English

7. Course Objective:

Objectives	To provide applied skills and practical knowledge necessary for operating and maintaining a Gen-set
Learning Outcomes	At the end of training the leaners will be able to; • Explain the basics of teamwork, personal protection equipment (PPE) and Kaizen principle • Identify operation and supporting systems of Gen-set • Operate a Gen-set • Perform Gen-set maintenance • Explain the EWTI-style training principles

8. Training Contents:
Please see the attached Learning Module for the course.

9. Program Schedule:
The training consists of lectures, practice in the EWTI compound and some field visits.
The schedule is subject to change.

Date	Content	Place
Jan.19 (Sun)	Transfer from country of origin, Arrive in Addis Ababa	
Jan.20 (Mon)	Holiday (Ethiopian Epiphany)	
Jan.21 (Tue)	Opening program, Country report presentation, Pre-test	EWTI

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

Jan.22 (Wed)	LO1: -Teamwork, OHS and Kaizen (Self-check, Q&A) LO1: -Teamwork, OHS and Kaizen (Operation Sheet) LO1: -LAP test	EWTI
Jan.23 (Thu)	LO2: -Identify operation and supporting systems of Gen-set (Self-check, Q&A) LO2: - Identify operation and supporting systems of Gen-set (Demo. & practice) LO1: -LAP test	EWTI
Jan.24 (Fri)	LO2: -Identify operation and supporting systems of Gen-set (Demo. & practice) LO2: -LAP test LO1: -LAP test	EWTI
Jan.25 & 26	Weekend	
Jan.27 (Mon)	LO3: -Operate a Gen-set (Self-check, Q&A) LO3: -Operate a Gen-set (Demo. & practice) LO1: -LAP test	EWTI
Jan.28 (Tue)	LO3: -LAP test LO4: -Perform Gen-set maintenance (Self-check, Q&A) LO1: -LAP test	EWTI
Jan.29 (Wed)	LO4: Perform Gen-set maintenance (Demo. & practice) LO1: -LAP test	EWTI
Jan.30 (Thu)	LO4: Perform Gen-set maintenance (Demo. & practice) LO1: -LAP test	
Jan.31 (Fri)	Field practice	Outside EWTI
Feb.1 & 2	Weekend	
Feb.03 (Mon)	LO4: -LAP test LO1: -LAP test	
Feb.04 (Tue)	TOT Session 1 & 2 LO1: -LAP test	EWTI
Feb.05 (Wed)	TOT Session 3 & 4 LO1: -LAP test	EWTI
Feb.06 (Thu)	Action Plan preparation / Post test	EWTI
Feb.07 (Fri)	Action Plan Presentation Closing Ceremony	
Feb.8 (Sat)	Return to the country of origin	

10. Duties during training in Ethiopia:

All participants are requested to prepare and submit Action Plan and make presentation of this plan just before the closing ceremony.

11. Duties after training in Ethiopia

The participants are strongly recommended to implement the Action Plan they already prepared when they return to their respective country.

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

II. Conditions and Procedures for Application

1. Expectations from the Participating Organizations:

(1) This program is designed primarily for organizations that intend to address specific issues or problems identified in their operation. Participating organizations are expected to use the project for those specific purposes.

(2) In this connection, participating organizations are expected to nominate the most appropriate candidates to address the said issues or problems, carefully referring to the qualification requirements.

(3) Participating organizations are also expected to be prepared to make use of knowledge acquired by the nominees for the said purpose.

(4) The participating organization is responsible to support the participant for developing the Country Report, sharing the knowledge within the organization and seeking the possibility of implementation of the Action Plan developed by the participant during the program in Ethiopia.

2. Nominee Qualifications:

Applying Organizations are expected to select nominees who meet the following qualifications.

(1) **Essential Qualifications**

Applicants should:

- have a minimum of diploma/TVET graduate in Electricity/Electro-mechanics
- have practical experience of operating & maintaining Gen-set (both Engine & Alternator parts) at least two years
- preferably be in the leading position or to be in the leading position to train junior colleagues in operating & maintaining Gen-set
- be fluent in English enough to participate in discussion and understand presentation/explanation
- continue the carrier at the current organization more than two years after the training
- be in good health, both physically and mentally, to undergo the program in Ethiopia. Pregnant applicants are not recommended to apply due to potential risk of health and life issues of mother and fetus ➢ Must not be serving any form of military service

3. Required Documents for Application

(1) **Application Form**:

For international candidates: It is available at the JICA Country Office. An application form should be typed in English.

For domestic candidates: It is available at EWTI. An application form should be typed in English.

(2) **Photocopy of passport**: to be submitted with the application form, if you possess your passport which you will carry when entering Ethiopia for this program. If not, you are requested to submit its photocopy as soon as you obtain it.

*Photocopy should include the followings:

Name, Date of birth, Nationality, Sex, Passport number and Expire date

4. Procedures for Application and Selection : (1) Submission of the Application Documents:

All necessary documents for application should be submitted to JICA country office in the PDF form, **not later than November 29th, 2019.**

(2) Selection:

After receiving the documents through the proper channel from your government, the JICA office in the applicant's country will conduct screenings, and then forward the documents to EWTI in Ethiopia. Selection will be made by EWTI in consultation with EWTI/JICA Project office in Ethiopia. The participating organization with the best intention to utilize the opportunity of this program will be highly valued in the selection.

(3) Notice of Acceptance

Notification of results will be made by EWTI/JICA Project office through proper channels **not later than 16th December, 2019.**

5. Document(s) to be submitted by accepted candidates:

A country report should be prepared and submitted by each participant. The format is available at the JICA Country Office or sent to the participant directly by e-mail after the finalization of the selection.

6. Conditions for Attendance:

(1) not to utilize knowledge and skills acquired in the training for military purposes.

(2) to strictly adhere to the program schedule.

(3) not to change the program topics.

(4) not to extend the period of stay in Ethiopia.

(5) not to be accompanied by family members during the training.

(6) to return to home countries at the end of the training in accordance with the travel schedule.

(7) to refrain from engaging in any political activities, or any form of employment for profit or gain during the training.

(8) to observe Ethiopian laws and ordinances. If there is any violation of said laws and ordinances, participants may be required to return part or all of the training expenditure depending on the severity of said violation.

(9) to observe the rules and regulations of the accommodation and not to change the accommodation designated by EWTI/JICA project.

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

III. Administrative Arrangements

1. Organizer:

(1) **Name**: Ethiopian Water Technology Institute

(2) **Contact:** Kality, Addis Ababa
Tel:- XXXXXXXXXXX
P.O.Box:- XXXXXXXX
Email: XXXXXXX

2. Implementing Partner:

(1) **Name**: EWTI/JICA Project Office

(2) **Contact**: XXXXXXXXX

3. Travel to [name of the implementing country]:

(1) **Air Ticket**: The cost of a round trip ticket between international airports designated by JICA and EWTI/JICA project will be borne by EWTI/JICA Project. The e-tickets for international flight will be sent by EWTI/JICA project after the final decision on the acceptance. Any date change or stop over of flights is NOT strictly allowed by JICA. The participants will bear the fee in case the flights were changed.

(2) **Travel Insurance**: Coverage is from time of arrival to departure in Ethiopia. Thus, travelling time outside Ethiopia shall not be covered.

Note: Pre-existing illness, pregnancy and dental treatment are NOT covered.

4. Accommodation in Ethiopia:

EWTI/JICA Project office will arrange the following accommodations

For international participants: Hotel in Addis Ababa

For domestic participants: EWTI dormitory

5. Expenses:

The following expenses will be provided for the participants by EWTI/JICA Project office:

(1) Air ticket

(2) Travel insurance (from the date of arrival to the date of departure only)

(3) Accommodation (half board)

(4) Lunch (provided at EWTI)

(5) Daily allowance

(6) Transportation within the country

※Application Fee for VISA will NOT be covered by EWTI/JICA Project office.

6. Preparation for the training in Ethiopia:

Please apply VISA right after receiving our official acceptance letter which will be directly sent to Embassy and Consulate of Ethiopia and copied to you by JICA. JICA requests

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

the participating organization will bear domestic transportation, VISA application fees and any other costs related to this training within Ethiopia.

Appendix 1:
Sample of General Information (Operating and Maintaining Gen-set, 2020)

IV. Other Information

- A participant who has successfully completed the program will be awarded a successful training completion certificate by EWTI and EWTI/JICA project, in accordance with EWTI's Guidelines for Training Operation and Management.
- Allowances will be given to participants after their arrival in Ethiopia by EWTI/JICA project.

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

Guidelines of Application Form for the EWTI/JICA Training Program

The attached form is to be used to apply for the training programs of the Ethiopian Water Technology Institute (EWTI) in cooperation with Japan International Cooperation Agency (JICA), which are implemented as part of the 3rd pilot training program of the Project for Strengthening Capacity for Training Operation and Management for EWTI. Please complete the application form while referring to the following and consult with the respective country's JICA Office - or the Embassy of Japan if the former is not available - in your country for further information.

1) How many parts does the Application Form consist of?

The Application Form consists of three parts as follows;

Official Application
This part is to be confirmed and signed by the head of the relevant department/division of the organization which is applying.

Part A. Information on the Applying Organization
This part is to be confirmed by the head of the relevant department/division of the organization which is applying.

Part B. Information About the Nominee including Medical History and Examination
This part is to be completed by the person who is nominated by the organization applying.

Please refer to the General Information to find out which type the training program that your organization applies for belongs to.

2. How to complete the Application Form

In completing the application form, please be advised to:

(a) carefully read the General Information (GI) for which you intend to apply, and confirm if the objectives and contents are relevant to yours,
(b) be sure to write in the title name of the course/seminar/workshop/project accurately according to the GI, which you intend to apply,
(c) use a typewriter/personal computer in completing the form, or write in **block letters**,
(d) fill in the form in **English**,
(e) use ☑ or "x" to fill in the ( ) check boxes,
(f) attach a picture of the Nominee,
(g) attach additional page(s) if there is insufficient space on the form,
(h) prepare the necessary document(s) described in the General Information (GI), and attach it (them) to the form,
(i) confirm the application procedure stipulated by your government, and

(j) submit the original application form with the necessary document(s) to the responsible organization of your government according to the application procedure.

Any information that is acquired through the activities of the EWTI/JICA, such as the nominee's name, educational record, and medical history, shall be properly handled in view of the importance of safeguarding personal information.

3. Privacy Policy

1) Scope of Use

Any information used for identifying individuals that is acquired by EWTI/JICA will be stored, used, or analyzed only within the scope of EWTI/JICA activities. EWTI/JICA reserves the right to use such identifying information and other materials in accordance with the provisions of this privacy policy.

2) Limitations on Use and Provision

EWTI/JICA shall never intentionally provide information that can be used to identify individuals to any third party, with the following three exceptions:

(a) In cases of legally mandated disclosure requests;

(b) In cases in which the provider of information grants permission for its disclosure to a third party;

(c) In cases in which EWTI/JICA commissions a party to process the information collected; the information provided will be within the scope of the commissioned tasks.

3) Security Notice

EWTI/JICA takes measures required to prevent leakage, loss, or destruction of acquired information, and to otherwise properly manage such information.

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

Training Programs of EWTI/JICA

Application Form for EWTI/JICA Training Program

OFFICIAL APPLICATION

(to be confirmed and signed by the head of the relevant department / division of the applying organization)

1. Title: (Please write down as shown in the General Information)

2. Country Name:

3. Name of Applying Organization:

4. Name of the Nominee(s):

1)	3)
2)	4)

Our organization hereby applies for the training program of the EWTI/JICA and proposes to dispatch qualified nominees to participate in the programs.

Date:		Signature:		
Name:				
Designation / Position				Official Stamp
Department / Division				
Office Address and Contact Information	Address:			
	Telephone:	Fax:	E-mail:	

Confirmation by the organization in charge (if necessary)

I have examined the documents in this form and found them true. Accordingly I agree to nominate this person(s) on behalf of our government.

Date:		Signature:		
Name:				Official Stamp
Designation / Position				
Department / Division				

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

Part A: Information on the Applying Organization

(to be confirmed by the head of the department / division)

1. Profile of Organization

1) Name of Organization:

2) The mission of the Organization and the Department / Division:

2. Purpose of Application

1) Current Issues: Describe the reasons for your organization claiming the need to participate in the training program, with reference to issues or problems to be addressed.

2) Objective: Describe what your organization intends to achieve by participating in the training program.

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

3) Future Plan of Actions: Describe how your organization shall make use of the expected achievements, in addressing the said issues or problems.

4) Selection of the Nominee: Describe the reason(s) the nominee has been selected for the said purpose, referring to the following view points; 1) Course requirement, 2) Capacity /Position, 3) Plans for the candidate after the training and dialogue program, 4) Plan of organization and 5) Others.

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

Part B: Information about the Nominee

(to be completed by the Nominee)

1. Title: (Please write down as shown in the General Information) **(required)**

Attach the nominee's photograph (taken within the last three months) here
Size: 4x6
(Attach to the documents to be submitted.)

2. Information about the Nominee (nos. 1-9 are all required)

1) Name of Nominee (as in the passport)

Family Name

First Name

Middle Name

2) Nationality (as shown in the passport)			**5) Date of Birth (please write out the month in English as in "April")**			
3) Sex	( ) Male	( ) Female	**Date**	**Month**	**Year**	**Age**
4) Religion						

6) Present Position and Current Duties

Organization							
Department / Division							
Present Position							
Date of employment by the present organization	Date	Month	Year	Date of assignment to the present position	Date	Month	Year

7) Type of Organization

( ) National Governmental	( ) Local Governmental	( ) Public Enterprise
( ) Private (profit)	( ) NGO/Private (Non-profit)	( ) University
( ) Other ( )		

8) Outline of duties: Describe your current duties

9) Contact Information

Office	Address:	
	TEL:	Mobile (Cell Phone):
	FAX:	E-mail:
Home	Address:	
	TEL:	Mobile (Cell Phone):
	FAX:	E-mail:

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

Contact person in emergency	Name: Relationship to you:	
	Address:	
	TEL:	Mobile (Cell Phone):
	FAX:	E-mail:

10) Others (if necessary)

4. Career Record

1) Job Record (After graduation)

Organization	City/ Country	Period		Position or Title	Brief Job Description
		From Month/Year	To Month/Year		

2) Educational Record (Higher Education)(required)

Institution	City/ Country	Period		Degree obtained	Major
		From Month/Year	To Month/Year		

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

3) Training or Study in Foreign Countries

Institution	City/ Country	Period		Field of Study / Program Title
		From Month/Year	To Month/Year	

5. Language Proficiency (required)

1) Language to be used in the program (as in GI)				
Listening	( ) Excellent	( ) Good	( ) Fair	( ) Poor
Speaking	( ) Excellent	( ) Good	( ) Fair	( ) Poor
Reading	( ) Excellent	( ) Good	( ) Fair	( ) Poor
Writing	( ) Excellent	( ) Good	( ) Fair	( ) Poor
Certificate (Examples: TOEFL, TOEIC)				
2) Mother Tongue				
3)Other languages ( )	( ) Excellent	( ) Good	( ) Fair	( ) Poor

[1] Excellent: Refined fluency skills and topic-controlled discussions, debates & presentations. Formulates strategies to deal with various essay types, including narrative, comparison, cause-effect & argumentative essays.
[1] Good: Conversational accuracy & fluency in a wide range of situations: discussions, short presentations & interviews. Compound complex sentences. Extended essay formation.
[1] Fair: Broader range of language related to expressing opinions, giving advice, making suggestions. Limited compound and complex sentences & expanded paragraph formation.
[1] Poor: Simple conversation level, such as self-introduction, brief question & answer using the present and past tenses.

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

6. Expectation on the applied training program

1) Personal Goal: Describe what you intend to achieve in the applied training program in relation to the organizational purpose described in Part A-2.

2) Relevant Experience: Describe your previous vocational experiences which are highly relevant in the themes of the applied training program. (Required)

3) Area of Interest: Describe your subject of particular interest with reference to the contents of the applied training and dialogue program. (Required)

*7. Declaration (to be signed by the Nominee) (required)

I certify that the statements I made in this form are true and correct to the best of my knowledge.

If accepted for the program, I agree:

(a) not to bring or invite any member of my family (except for the program whose period is one year or more),
(b) to carry out such instructions and abide by such conditions as may be stipulated by the nominating government, Ethiopian Government and Japanese government regarding the program,
(c) to follow the program, and abide by the rules of the institution or establishment that implements the program,
(d) to refrain from engaging in political activity or any form of employment for profit or gain,
(e) to return to my home country at the end of the activities in Ethiopia on the designated flight schedule arranged by EWTI/JICA,
(f) to discontinue the program if EWTI/JICA and the applying organization agree on any reason for such discontinuation.
(g) to consent to waive exercise of my copyright holder's rights for documents or products that are produced during the course of the project, against duplication and/or translation by EWTI/JICA, as long as they are used for the purposes of the program.

Date:	Signature:
	Print Name:

Appendix 2:
Application Form (Operating and Maintaining Gen-set, 2020)

MEDICAL HISTORY AND EXAMINATION

1. Present Status

(a) Do you currently use any drugs for the treatment of a medical condition? (Give name & dosage.)

( ) No	( ) Yes >> Name of Medication ( ), Quantity ( )

(b) Are you pregnant?

( ) No	( ) Yes (months)

(c) Are you allergic to any medication or food?

( ) No	( ) Yes >>>	( ) Medication	( ) Food	( ) Other:

(d) Please indicate any needs arising from disabilities that might necessitate additional support or facilities.

( )
Note: Disability does not lead to exclusion of persons with disability from the program. However, upon the situation, you may be directly inquired by the EWTI/JICA official in charge for a more detailed account of your condition.

2. Medical History

(a) Have you had any significant or serious illness? (If hospitalized, give place & dates.)

Past:	( ) No	( ) Yes>>Name of illness ( ), Place & dates ( )
Present:	( ) No	( ) Yes>>Present Condition ( )

(b) Have you ever been a patient in a mental hospital or been treated by a psychiatrist?

Past:	( ) No	( ) Yes>>Name of illness ( ), Place & dates ( )
Present:	( ) No	( ) Yes>>Present Condition ( )

(c) High blood pressure

Past:	( ) No	( ) Yes
Present:	( ) No	( ) Yes>>Present Condition ( ) mm/Hg to ( ) mm/Hg

(d) Diabetes (sugar in the urine)

Past:	( ) No	( ) Yes		
Present:	( ) No	( ) Yes>>Present Condition ( )		
		Are you taking any medicine or insulin?	( ) No	( ) Yes

(e) Past History: What illness (es) have you had previously?

( ) Stomach and Intestinal Disorder	( ) Liver Disease	( ) Heart Disease	( ) Kidney Disease
( ) Tuberculosis	( ) Asthma	( ) Thyroid Problem	
( ) Infectious Disease >>> Specify name of illness ( )			
( ) Other >>> Specify ( )			

(e') Has this disease been cured?

( ) Yes	( ) No (Specify name of illness)
	Present Condition: ( )

3. Other: Any restrictions on food and behavior due to health or religious reasons?

I certify that I have read the above instructions and answered all questions truthfully and completely to the best of my knowledge.

I understand and accept that medical conditions resulting from an undisclosed pre-existing condition may not be financially compensated by EWTI/JICA and may result in termination of the program.

Date:	Signature:
	Print Name:

Appendix 3: Sample of Screening Results Format

Gen set operating Maintenance training

No	Name	Sex	Religion	Age	Type of Organization	Present Position	Degree Obtained	Job Record	Remark
Malawi Nominees Which can fit the requirement									
1	XXXX	M	Christian	38	National Governmental	Senior Plant Technician	Diploma (Electrical and Electronics)	2008-2019	
2	XXXX	M	Christian	47	Government Parastatal	Senior Motor vehicle technician	Advanced Diploma in motor Vehicle Engineering /Vehicle Diagnosis, Electrical and electronics, Service reception)	1999-2019	Use Drugs (Salbutamol tablets is used to treat wheezing and shortness of breath caused by breathing problems)
Malawi Nominees Which cannot fit the requirement									
1	XXXX	F	Christian	25	Parastatal	Graduate Maintenance Engineer/ Maintenance Engineer	BSC Mechanical Engineering (Honors)	April 2019	She has less than two years related Work experience; so not fit
2	XXXX	M	Anglican	41	Parastatal	Maintenance Supervisor	Diploma in Automobile Engineering, Degree in renewable Energy	2011-2019	His education back ground is not related; so not fit.
3	XXXX	M	Christian	37	Public Enterprise	Motor Vehicle maintenance Technician	Diploma in Motor Vehicle Engineering	2007-2019	His education back ground and work experience is not related; so not fit.

Appendix 4:
Sample of Acceptance Letter

To: Mr/Ms. XXXXXXX
Head of Department
Rural Water Supply and Sanitation Agency Ondo

Acceptance Letter for the Training Course on Operating and Maintaining a Generator set (Gen-set)

Dear Mr/Ms. XXXXXX

Ethiopian Water Technology Institute is pleased to inform that you are accepted for the training course on "Operating and Maintaining a Generator set (Gen-set)" which will be held in Addis Ababa, Ethiopia from January 20 to February 8, 2020.

We will communicate the details regarding the formalities of your trip to Ethiopia for the said training course according to the instruction attached herewith and the rest of information will be shared via email shortly.

It would be highly appreciated if you would undertake the necessary procedures for your departure to Ethiopia at your earliest convenience.

Thank you very much for your best cooperation.

Sincerely yours,

CC

- Director General of EWTI
- Deputy Director General (Mr. Tamiru Fekadu)
- Water Technology Education and Training Directorate
- JICA Project Office (EWTI)
- Registrar Office
  Ethiopian Water Technology Institute

Appendix 5:
Sample of Instruction Sheet for Participants

Instruction Sheet for the International Training (For Trainees from Nigeria and Malawi)
(Operating and Maintaining a Genset)

Please read the following information carefully and prepare for your departure.

1	Basic Information	Training period: January 20, 2020 ~ February 8, 2020 Training hour: 9:00～17:00 (subject to change) Training venue: EWTI, Addis Ababa
2	Visa Obtainment/ Arrival	【Visa for Malawian Trainees】 ➢ Please be informed that the visa obtainment and payment will be on arrival at the airport. ➢ Trainees must bring conference visa fee USD 30 (the cost to be covered by the trainees / the organization that the trainee belongs to). ➢ Trainees shall bring their valid passport (more than 6 months prior to expiration date), ➢ Conference Visa permission document from Main Department for Immigration and Nationality Affairs of Ethiopia ➢ Copy of Acceptance Letter from EWTI. ➢ Other necessary country rules to obtain on arrival visa should be considered. 【Yellow Card】 Every trainee has to bring his/her yellow fever vaccination certificate which is to be checked at the airport quarantine.
3	Land Transportation	➢ Transportation during the training including receiving and sending to airport will be arranged by the training organizers (EWTI). The fee for transportation in trainees' country should be covered by trainees.
4	Flight	➢ Reservation and sending of electronic ticket for the flight from the capital city of the trainees' country to Addis Ababa will be handled by training organizers (EWTI/JICA project).
5	Insurance	➢ Medical insurance for the trainees during the training in Addis Ababa will be covered by training organizers (EWTI/JICA project) from the date of arrival to the date of the departure from Ethiopia.
6	Daily Allowance	➢ Payment for 18 days of training period, ETB 550/day x 18 days = ETB 9, 900 (subject to change) will be covered by training organizers (EWTI/JICA project). ➢ The allowance should cover everyday dinner, lunch on the weekends and other expenses occur in Ethiopia. Lunch for working days (Monday to Friday) will be provided by the training organizers. ➢ Please note that the exchange of the local currency to USD is not allowed in many cases. You may not be able to exchange the remaining Ethiopian Birr. The organizer will provide the latest information on it.

Appendix 5:
Sample of Instruction Sheet for Participants

<table>
<tr><td>7</td><td>Hotel</td><td>➢ Hotel room reservation including everyday breakfast and depends on the flight time, lunch and dinner on the day of arrival will be arranged by training organizers (EWTI/JICA project).
➢ Laundry fee, mini bar, and room services are to be covered by the trainees.</td></tr>
<tr><td>8</td><td>Working Cloths and Safety Shoes</td><td>➢ Working cloths and safety shoes will be provided by the training organizers (EWIT/JICA project).
➢ Please let us know the size of your working cloth and safety shoes by Monday, December 30th, 2019 via email. Late submission may end up with no timely delivery of items (please pick your size from the below table).
<table>
<tr><th>No.</th><th>Items</th><th colspan="8">Working cloth and safety shoe sizes</th></tr>
<tr><td>1</td><td>Working cloth size/International cloth sizes</td><td>M</td><td>L</td><td>XL</td><td>2XL</td><td>3XL</td><td>4XL</td><td>5XL</td><td></td></tr>
<tr><td>2</td><td>Safety shoes size/EUR</td><td>38</td><td>39</td><td>40</td><td>41</td><td>42</td><td>43</td><td>44</td><td>45</td></tr>
</table></td></tr>
<tr><td>9</td><td>Communication</td><td>➢ A prepaid mobile sim-card will be prepared for each trainee. Please bring your own cellphone and inform us the size of your cellphone sim-card by Monday, December 30th, 2019 via email.
➢ SIM cards sizes:
• Standard SIM (15 x 25mm)
• Micro SIM (12 x 15mm)
• Nano SIM (8.8 x 12.3mm)</td></tr>
<tr><td>10</td><td>Airport pick up and sending off trainees at airport</td><td>➢ Picking up trainees from Addis Ababa International Airport and sending them off at Addis Ababa International Airport will be arranged by training organizers (EWIT).</td></tr>
<tr><td>11</td><td>Coordinator</td><td>➢ International training coordinators will be assigned by EWTI for each country group (Malawi and Nigeria). The trainees may communicate with the coordinator for any inquiries related to the training and living condition in Ethiopia.
➢ Personal contact details of the coordinator will be informed on the date of arrival.</td></tr>
</table>

Annexed documents:

1. Instruction of Country Report
2. Acceptance Letter
3. Tentative Training Schedule

For further information, please refer the following;

Mr/Ms. XXXXXXX
Deputy Chief Advisor
EWTI/JICA Project
Tel: XXXXXXXX
Email: XXXXXXX

Appendix 5:
Sample of Instruction Sheet for Participants

Mr/Ms. XXXXXXX
International Training Secretarial
EWTI/JICA Project
Tel: XXXXXXXX
Email: XXXXXXX

Mr/Ms. XXXXXXX
Training Material Development
EWTI/ JICA Project
Tel: XXXXXXXX
Email: XXXXXXX

Appendix 5:
Sample of Instruction Sheet for Participants

Instruction Sheet for the International Training (Ethiopian Trainees)
(Operating and Maintaining a Generator Set)

<table>
<tr><td>1</td><td>Basic Information</td><td>Training period: 20th January 2020 ~ 8th February 2020
Training hour: 9:00Am～17:00Pm (subject to change)
Training venue: EWTI, Addis Ababa</td></tr>
<tr><td>2</td><td>Depart and Arrival date</td><td>➢ Trainees should arrive at EWTI, Addis Ababa on 20th January 2020.</td></tr>
<tr><td>3</td><td>Daily Allowance</td><td>➢ Payment for 18 days of training period will be ETB 300/day x 18 days = ETB 5,400 (subject to change) will be covered by training organizers (EWTI/JICA project).
➢ Travel days allowance should be covered by your organization.</td></tr>
<tr><td>4</td><td>Transportation</td><td>➢ The transportation or travel cost from your region to EWTI, Addis Ababa should be covered by your organization.</td></tr>
<tr><td>5</td><td>Accommodation</td><td>➢ Dormitory from 20th January to 8th February 2020 will be arranged at EWTI by the training organizers (EWTI/JICA project).
*Please arrive at EWTI and check in between 8:30Am~17:30Pm on 20th January 2020.
Person in Charge: Mr/Ms. XXXXXX, Tel: XXXXX</td></tr>
<tr><td>6</td><td>Working cloths</td><td>➢ Working cloths and safety shoes will be provided by the training organizers (EWIT/JICA project).
➢ Each trainee is expected to submit the sizes of working cloth and shoes by Wednesday, 15th January 2020 via email or phone.
Mr/Ms. XXXXXX: XXXXXX@gmail.com / (+251XXXXXXX)

Late submission may end up with no timely delivery of items (please pick your size from the below table).
<table>
<tr><th>No.</th><th>Items</th><th colspan="8">Working cloth and safety shoe sizes</th></tr>
<tr><td>1</td><td>Working cloth size/International cloth sizes</td><td>M</td><td>L</td><td>XL</td><td>2XL</td><td>3XL</td><td>4XL</td><td>5XL</td><td></td></tr>
<tr><td>2</td><td>Safety shoes size/EUR</td><td>38</td><td>39</td><td>40</td><td>41</td><td>42</td><td>43</td><td>44</td><td>45</td></tr>
</table></td></tr>
<tr><td>7</td><td>Items to be provided</td><td>➢ Writing pen, notepad, water bottle, and daily allowance will be provided on 21st January 2020.</td></tr>
<tr><td>8</td><td>Protocol</td><td>➢ Some higher officials will be invited to the opening ceremony and closing ceremony of the training. Your consideration of dressing protocol on the opening day (21st January 2020) and closing day (7th February 2020) would be appreciated.</td></tr>
<tr><td>9</td><td>Coordinator</td><td>➢ The trainees may communicate with the coordinator for any enquiries related to the training and living condition in Ethiopia.
➢ Personal contact details of the Coordinator will be informed on the date of arrival.</td></tr>
</table>

Appendix 5:
Sample of Instruction Sheet for Participants

Annexed documents:

4. Acceptance Letter
5. Draft Training Program

For further information, please refer the following

Mr/Ms. XXXXXX
Registrar
EWTI
Tel: XXXXXXXX
Email: XXXXXXXX

Mr/Ms. XXXXXXXX
Deputy Chief Advisor
EWTI/JICA Project
Tel: XXXXXXXXXX
Email: XXXXXXXXX

Mr/Ms. XXXXXXXXXXX
International Training Secretarial
EWTI/JICA Project
Tel: XXXXXXX
Email: XXXXXXX

Mr/Ms. XXXXXXXXXX
Training Material Development
EWTI/ JICA Project
Tel: XXXXXXXXXXXX
Email: XXXXXXXXXX

Appendix 6:
Sample of Request Letter for Visa Issuance Permit
to the Main Department for Immigration and Nationality Affairs of Ethiopia (MDINA)

Main Department for Immigration and Nationality Affairs,
Federal Democratic Republic of Ethiopia

Request for Issuance of Entry Visa

Ethiopian Water Technology Institute a government capacity building organization established by council of Ministers regulation number 293/2015, one of its major mandate is provision of capacity building training in water and water related sector. Our vision is to be a center of Excellency in East Africa in 2025.

As part of exercise to achieve our vision we planned to conduct an international training for professionals from **Malawi** in Operating and Maintaining a Generator Set (Gen-set) from January 20 to 8 February 2020. Therefore, EWTI is pleased to notify that the persons on the list which is attached herewith are invited from Malawi for the training course on "Operating and Maintaining a Generator Set (Gen-set)" to be held in Addis Ababa.

The expenses during their stay, including accommodation, breakfast, lunch, dinner, insurance, etc., will be covered by EWTI in cooperation with Japan International Cooperation Agency.

The issuance of entry visa upon the arrival of participants attached herewith is requested and the coordination in advance for the necessary procedures for their entry would be highly appreciated.

Sincerely yours,

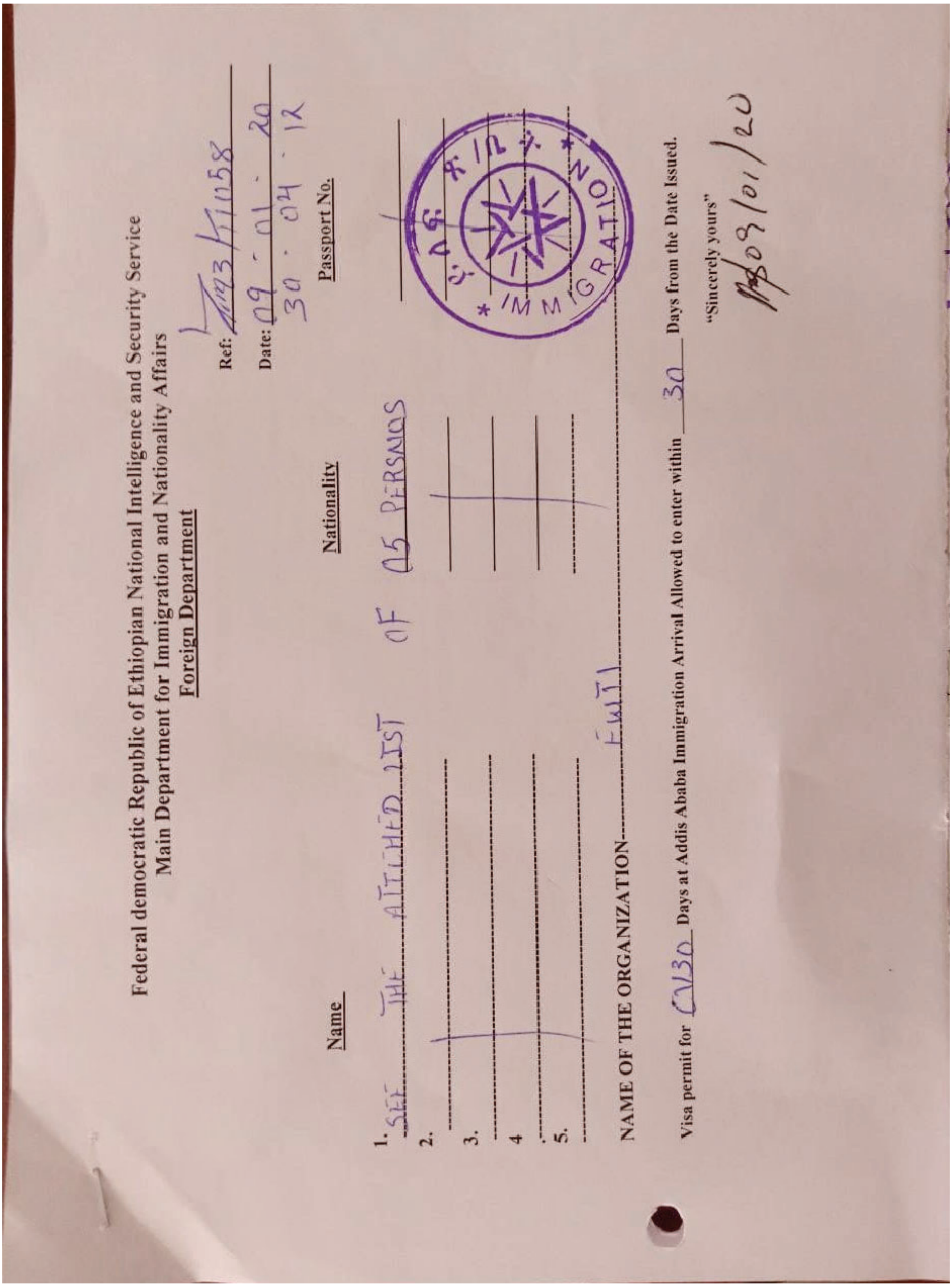
CC
To: Ministry of Water Irrigation and Energy (MoWIE)
Addis Ababa
To: Director General of EWTI
To: Deputy Director General (Mr. Tamiru Fekadu)
To: Water Technology Education and Training Directorate
To: Registrar Office
Ethiopian Water Technology Institute

Appendix 6:
Sample of Request Letter for Visa Issuance Permit
to the Main Department for Immigration and Nationality Affairs of Ethiopia (MDINA)

List of the Participants from Malawi for the EWTI Training Course

No.	Name	Nationality	Sex	Date of Birth	Passport No.	Position and Organization
1	XXXXXXX	Malawian	M	17 Sep 1981	XXXXXXX	Senior plant Technician Blantyre water Board
2	XXXXXXX	Malawian	M	6 Mar 1972	XXXXXXX	Senior Motor Vehicle Technician Central Region Water Board
3	XXXXXXX	Malawian	M	6 Jul 1978	XXXXXXX	Maintenance Supervisor Southern Region water Board
4	XXXXXXX	Malawian	M	5 Jun 1982	XXXXXXX	Motor Vehicle Maintenance Technician Northern Region Water Board
5	XXXXXXX	Malawian	F	2 Sep 1994	XXXXXXX	Graduate Maintenance Engineer Lilongwe Water Board

Appendix 7:
Sample of the Visa Issuance Permit from the Main Department for Immigration and Nationality Affairs of Ethiopia (MDINA)


Federal democratic Republic of Ethiopian National Intelligence and Security Service
Main Department for Immigration and Nationality Affairs
Foreign Department

Ref:
Date: 09 . 01 . 20
30 . 04 . 12

	Name	Nationality	Passport No.
1.	SEE THE ATTACHED LIST OF 05 PERSONS		
2.			
3.			
4.			
5.			

NAME OF THE ORGANIZATION

Visa permit for CV30 Days at Addis Ababa Immigration Arrival Allowed to enter within 30 Days from the Date Issued.

"Sincerely yours"

09/01/20

Appendix 8:
Sample of Orientation Sheet / Information Sheet

Information Sheet for
the International Training on Operating and Maintaining Genset

1. **Information Utilization Date:**
   - Arrival date (20 January 2020) and
   - First day of the training (21 January 2020)
2. **Foreign currency:**
   - The maximum foreign currency limit allowed to bring in is $ 3000. Any amount exceeding $3,000 must be declared upon arrival at the Addis Ababa International Airport.
3. **Currency Exchange:**
   - Please note that the exchange of the local currency (ETB) to USD is not allowed in many cases. You may not be able to exchange the remaining Ethiopian Birr. The organizer will provide the latest information on it.
   - Please be informed that Nigerian Naira or Malawi Kwacha cannot be exchanged here in Addis Ababa and please try to bring USD.
4. **Country Report:**
   - Please submit the final version of the country report on 21 January 2020, the first day of the training. Accordingly, please prepare your country report presentation for 21 January 2020.
   - 10 minutes will be given for each presenter.
5. **Registration:**
   - Registrations will also take place on 21 January 2020 morning at 9:00 am.
   - Application form of Ethiopian Water Technology Institute needs to be filled out on the first day's morning of the training, 21 January 2020.
6. **Daily Allowance:**
   - The total payment for 18 days of training period, ETB 550/day x 18 days = ETB 9, 900 will be handed over to you on 21 January 2020.
   - The allowance should cover everyday dinner, lunch on the weekends and other expenses occur in Ethiopia. Lunch for working days (Monday to Friday) will be provided by the training organizers.
7. **Hotel:**
   - Hotel room reservation including everyday breakfast and dinner on the day of arrival will be arranged by training organizers (EWTI/JICA project).

N.B.: The budget for on arrival day (20 January 2020) dinner should be less or equal to ETB 300, and alcohol shall be covered by trainees even if it is within the budget.

   - Smoking area: the Hotel rooms do not have smoking area but you can use 1st floor terrace and vacant parking areas at the back of the hotel for smoking.
   - Laundry: the trainees should cover the cost by themselves and you can check the detail from the Hotel reception.
   - In case, please note the hotel address and contact information below.
     - Location: Saris Abo, Addis Ababa, Ethiopia
     - Contact person: Mr/Ms. XXXXX
     - Contact phone number: +251XXXXXXX
     - Hotel phone number: +251XXXXXXX
8. **Hotel pick up:**
   - Vehicle will be arranged to pick you up from the hotel every morning at 8:30 am.

(Late comer should come to the training venue by him/herself)

9. **Airport pick up**
   - Persons to pick you up:
     - Mr/Ms. XXXXXXX, Senior Water Resource Management Expert
       Contact information: +251XXXXXXXX
   - Pick up time for Nigerian: 8:15 pm on 20 January 2020
   - Pick up time for Malawian: 8:55 pm on 20 January 2020

10. **Items to be provided:**
    - Writing pen, notepad, water bottle, mobile phone sim-card and daily allowance will be provided on 21 January 2020.

11. **Protocol:**
    - Some higher officials will be invited to the opening and closing ceremony of the international training and your consideration of dressing protocol would be appreciated on the opening and closing day (21 January 2020 and 7th February 2020).

12. **Coordinator:**
    - International Training Coordinators are assigned by EWTI for each country group (Malawi and Nigeria). The trainees may communicate with the coordinators for any enquiries related to the training and living conditions in Ethiopia.
    - Please note the below contact information.

Contact information for Nigerian Group
Mr/Ms. XXXXXXXXXXX
Training Officer
EWTI
Tel: XXXXXXXXXXX
Emai: XXXXXXXXXX

Contact information for Malawian Group
Mr/Ms. XXXXXXXX
Training Officer
EWTI
Tel: XXXXXXXXXX
Emai: XXXXXXXXX

Appendix 9:
Sample of Invitation Letter for Each Embassy for the Opening and Closing Ceremony

To: H.E. Ambassador XXXX XXXXX

Ambassador of Nigeria in Ethiopia

Addis Ababa, Ethiopia

Invitation Letter to the Opening Ceremony of the International Training

Dear Sir/Madam

It is a great honor to introduce Ethiopian Water Technology Institute, a governmental capacity building organization established by council of Ministers regulation number 293/2015. One of our major mandates is provision of capacity building trainings in water and water related sector with the vision to become a center of excellence in East Africa by 2025.

As a part of exercise to achieve our vision, we are planning to conduct an international training in collaboration with Japan International Cooperation Agency (JICA) for professionals from Nigeria and Malawi in "Operating and Maintaining Gen-set" from January 21,2020 to February 07,2020. Therefore, it is our distinct pleasure to invite you to attend the **Opening Ceremony** of the International Training to be held on **Tuesday, 21 January** at 10:00 A.M. at Ethiopian Water Technology Institute (EWTI), Addis Ababa.

Opening ceremony program, list of invited guests, list of professionals, details of the training program, and location map of the venue are attached hereto for your reference.

We would greatly appreciate your kind participation and provision of opening remark in the ceremony. For further information, please contact Mr/Ms. XXXXX via Tele: +251-XXXXX or E-mail: XXXXXXXX.

Sincerely yours,

Appendix 9:

Sample of Invitation Letter for Each Embassy for the Opening and Closing Ceremony

To: H.E. Ambassador XXXX XXXX

Ambassador of Nigeria in Ethiopia

Addis Ababa, Ethiopia

Invitation Letter to the Closing Ceremony of the International Training

Dear Sir/Madam

It is a great honor to introduce Ethiopian Water Technology Institute, a governmental capacity building organization established by council of Ministers regulation number 293/2015. One of our major mandates is provision of capacity building trainings in water and water related sector with the vision to become a center of excellence in East Africa by 2025.

As a part of exercise to achieve our vision, we are planning to conduct an international training in collaboration with Japan International Cooperation Agency (JICA) for professionals from Nigeria and Malawi in "Operating and Maintaining Gen-set" from January 21,2020 to February 07,2020. Therefore, it is our distinct pleasure to invite you to attend the **Closing Ceremony** of the International Training to be held on **Friday, 07 February 2021** at 2:00 pm. at Ethiopian Water Technology Institute (EWTI), Addis Ababa.

The agenda for closing ceremony and location map of the venue are attached hereto for your reference.

We would greatly appreciate your kind participation and provision of opening remark in the ceremony.

Sincerely yours,

Appendix 10:
Sample of Contract with Catering Service Provider

Contract for Supply of Catering Service for Training Program

This contract is made and entered on the day of January 13, 2020 in Addis Ababa, Ethiopia between **Project for Strengthening Capacity for Training Operation and Management for Ethiopian Water Technology Institute (EWTI)** hereinafter called "PURCHASER" on one part **xxxxxxxxx** of hereinafter called "SERVICE PROVIDER" of the other part**:**

WHEREAS the PURCHASER and the SERVICE PROVIDER have agreed on the terms and conditions (as stipulated in this contract) for the provision of Catering Services (as per details specified in the contract) at the premise of EWTI in Kality, Addis Ababa and Sululta Site in Oromia Special Zone.

Therefore, in consideration of the above premises and mutual covenants, the parties hereto agree as follows:

ARTICLE I

1.1 Price for the service to be provided at EWTI

Item No.	General description of service	Detail description of the service	Total # of people to be served per service	Service date	Fee (ETB)	
					Service fee / person / day	Sub-total price
1	Tea break/ Morning	**Snack:** English cake, Sambusa, Vegetable pizza, Potato Croquite (subject to change) **Drink:** Milk, Coffee, tea and small water	360	Jan 22, 23, 24, 27, 28, 29, 30, 31 and Feb 1,4,5,6,7, 2020 = 13 days	90	32,400

2	Lunch Dessert	**Cold dish:** Green salad, Nociase salad, Russian Salad with 3 different dressing **Hot Dish:** Vegetable briyane, Layonanoise potato, Pastalaforno, Assorted Vegitatble, Golden fried fish, Braised beef **Traditional Dish:** Zilzil Wot Key, Minchet Abish Alicha, Vegetable Wot (subjected to change) **Fruit Salad**	269	Jan 21, 22, 23, 24, 27, 28, 29, 30, 31 and Feb 1, 4, 5, 6, 7, 2020 = 14 days	390.00	104,910
3	Tea break/ Afternoon	Snack : muffin, spring roll, vegetable sandwich, swiss roll (subjected to change) Drink: milk, coffee, tea and small water	328	Jan 21, 22, 23, 24, 27, 28, 29, 30, 31 and Feb 1, 4, 5, 6, 2020 = 13 days	90.00	29,520
4	Special tea break/Afternoon	Fish Shish kebab, Meat shish kebab, chicken shish kebab Sambusa fasting and non-fasting Fish ball, Meet bal, Fruit kebab, Pizza fasting and not fasting, Muffin	60	Feb 7, 2020 =1day	250.00	15,000

1.2 Price for the service to be provided at Sululta Site in Oromia Special Zone

Item No	General Description of service	Detail description of the service	Total # of people to be served per service	Service date	Fee (ETB)	
					Service fee / person / day	Total price
1	Tea break/ Morning	**Snack:** English cake, Sambusa, Vegetable pizza, Potato Croquite (subjected to change) Drink: Milk, Coffee, tea and small water	35	Feb 3, 2020 = 1day	150	5,250

Appendix 10:
Sample of Contract with Catering Service Provider

2	Lunch Dessert	**Cold dish:** Green salad, Nociase salad, Russian Salad with 3 different dressing **Hot Dish:** Vegetable briyane, Layonanoise potato, Pastalaforno, Assorted Vegitatble, Golden fried fish, Braised beef **Traditional Dish:** Zilzil Wot Key, Minchet Abish Alicha, Vegetable Wot (subjected to change) **Fruit Salad**	31	Feb 3, 2020 = 1day	450	13,950
3	Tea break/ Afternoon	**Snack:** muffin, spring roll, vegetable sandwich, swiss roll (subjected to change) **Drink:** milk, coffee, tea and small water	31	Feb 3, 2020 = 1day	150	4,650
					Grand Total (ETB)	205,680

ARTICLE II

Obligations

2.1 Obligations of the PURCHASER

a. The PURCHASER shall settle the payment for the service provided by the CATERING SERVICE PROVIDER by the time the service providers fully provide the services stated in Article I.
b. The PURCHASER shall inform if there is a need to change the number of people to be served before 1 day.

2.2 Obligations of the Catering SERVICE PROVIDER

a. The SERVICE PROVIDER shall assign the necessary human force for the above service days as mentioned in article I.
b. The SERVICE PROVIDER shall provide each service including the delivery as per the schedule stated in article I
c. The SERVICE PROVIDER shall manage to provide the service for more number of people if necessary but the PURCHASER should manage to inform the SERVICE PROVIDER before 1day.
d. The SERVICE PROVIDER shall provide the service consistently, on time, and in good quality.

ARTICLE III

Terms of Payment

3.1 The PURCHASER shall pay the total amount of the contract ETB 205,680.00 (two hundred five thousand six hundred eighty birr) when completion of the service by The SERVICE PROVIDER or on 7th February 2020.

3.2 The SERVICE PROVIDER shall provide the PURCHASER an official receipt upon receipt of the payment

3.3 The SERVICE PROVIDER shall submit request for payment to the PURCHASER so that the PURCHASER can settle the payment subsequently.

3.4 The SERVICE PROVIDER shall address the receipt to ‘‘Earth and Human Corporation/Japan International Cooperation Agency’’ when the payment is settled.

Article IV

Effective Date

This agreement shall come into effect on…….

…… ……..

THE PURCHASER **THE SERVICE PROVIDER**

WITNESSES

Name **Signature**

…… ……

Appendix 11:
Sample of Opening Ceremony Agenda

Tentative Program of International Training Opening Ceremony

(January 21, 2020 at EWTI, Addis Ababa - Ethiopia)

PROGRAM TITLE: Electro-Mechanical Machinery Maintenance

MODULE TITLE: Operating and Maintaining Gen-set- International Training

Sr. No.	Activity	Duration	Time Schedule	Facilitator
1	Arrival of Invited Guests	10 min	09:45 ~ 09:55	EWTI Organizing Team
2	Introduction of the Ceremony Program	5 min	09:55 ~ 10:00	Mr. Wasihun Alemayehu, Corporate Communication Directorate Director, EWTI
3	Welcoming Speech by Deputy Director General	5 min	10:00 ~ 10:05	H.E. Mr. Tameru Fekadu, Deputy Director General, EWTI
4	Opening Remarks by Director General	10 min	10:05 ~ 10:15	H.E. Dr. Tamene Hailu, Director General, EWTI
14	Cultural Coffee Ceremony	30 min	10:15~10:45	EWTI Organizing Team
15	Visiting EWTI facility	30 min	10:45~11:15	EWTI Organizing Team
End of Closing Program 11:30				

Appendix 12:
Sample of Closing Ceremony Agenda

Tentative Program of International Training Closing Ceremony

(February 7, 2020 at EWTI, Addis Ababa - Ethiopia)

PROGRAM TITLE: Electro-Mechanical Machinery Maintenance

MODULE TITLE: Operating and Maintaining Gen-set- International Training

Sr. No.	Activity	Duration	Time Schedule	Facilitator
1	Arrival of Invited Guests	10 min	13:50 ~ 14:00	EWTI Organizing Team
2	Introduction of the Ceremony Program	5 min	14:00 ~ 14:05	Mr. XXX XXX, Corporate Communication Directorate Director, EWTI
3	Opening Remark	5 min	14:05 ~ 14:10	H.E. Mr. XXX XXX, Director General, EWTI
4	Brief Report of the Training Outcomes and Assessment by Trainer	5 min	14:10 ~ 14:15	Mr. XXX XXX, Electro-Mechanical Machinery Maintenance Technology Department, Course Leader, EWTI
5	Brief Report of the Training Achievements and Action Plan from the Trainees	5 min	14:15 ~ 14:20	Nigerian Trainees
		5 min	14:20 ~ 14:25	Malawian Trainees
		5 min	14:25 ~ 14:30	Ethiopian Trainees
6	Special Remark	5 min	14:30 – 14:35	H.E. Dr. Eng.XXX XXX, Minster, Min
7	Special Remark	5 min	14:35 – 14:40	H.E. Mr. XXX XXX, Deputy Chief of Mission, Embassy of Japan
10	Special Remark	5 min	14:40 ~ 14:45	Mr. XXX XXX Senior Representative, JICA Ethiopia Office
11	Certificate Handover	15 min	14:45 ~ 15:00	Rep of EoJ/Rep of JICA/Rep of MoWIE
12	Gift Handover	15 min	15:00 ~ 15:15	Mr. XXX XXX, Water Technology Education and Training Directorate Director, EWTI
13	Closing Remark	5 min	15:15 ~ 15:20	Mr. XXX XXX, Deputy Director General, EWTI
14	Photo Session	10 min	15:20~15:30	EWTI Organizing Team
15	Cultural Coffee Ceremony	30 min	15:30~16:00	EWTI Organizing Team
End of Closing Program 16:00				

Appendix 13:
Sample of Information on Mobile Data Service

Ethiopian Prepared Phone Service Information

Domestic call

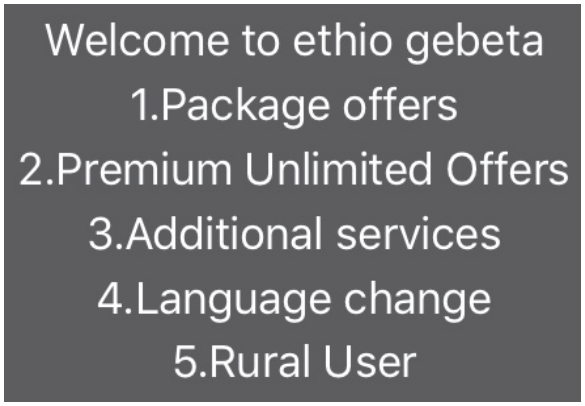
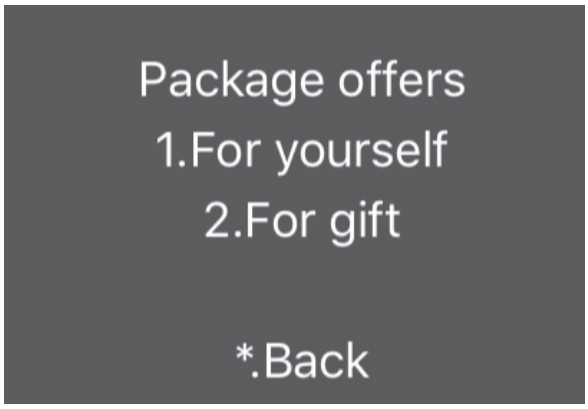
1. To check your remaining balance:
   - Please dial *804# and you should be able to see your remaining balance and remaining balance expiration date.

2. To recharge your balance:
   - Please write *805*, voucher hidden number and # all together and then dial.

3. Regular phone call tariff:
   - From 7am-10pm: 50cents/minute
   - From 10pm-7am, weekends, official holidays: 35cents/minute

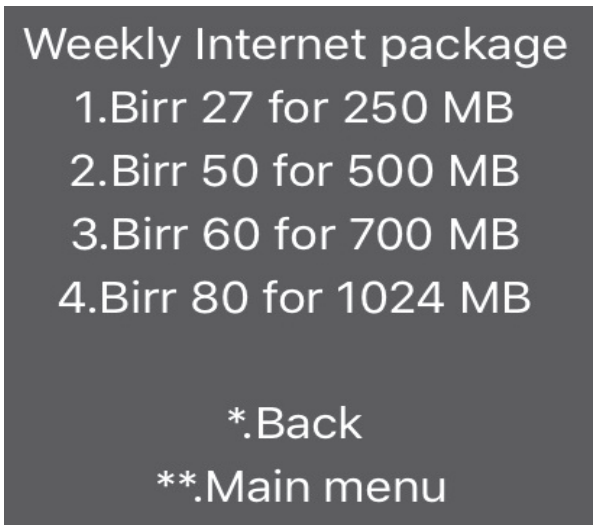
4. Regular Internet tariff:
   - Any time: 20cents/megabyte

5. Other Internet, phone call and message package service:
   - Dial *999# to check package alternatives
   - As an example, please follow the steps below (screen shot), to choose packages alternative.

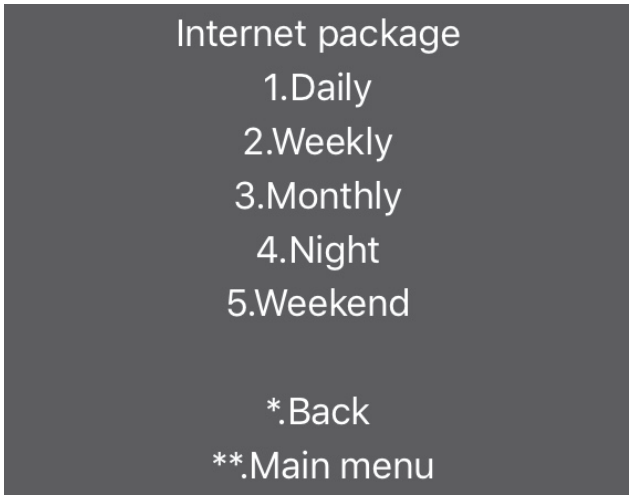
Step 1	Step 2
	

Appendix 13:
Sample of Information on Mobile Data Service

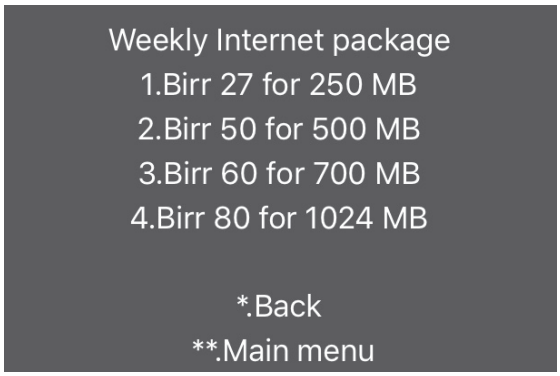
Step 3



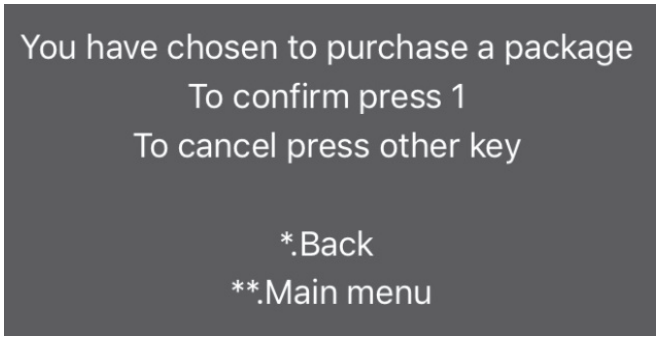
Step 4



Step 5



Step 6



International phone call:

- To call to Malawi or Nigeria: 8.95 cents/ minute

Appendix 14:

Sample of Experience at EWTI International Training: "Self-analysis" Made by Trainees

Sample of Self Analysis

Course Title: Operating and Maintaining Gen -set
Name: xxxxxxxxxxxxxxx
Date: Feb 5th ,2020
Duration: January 21 – February 7, 2020
1. What were your best three learning from the technical perspective?
- Stability to diagnose an engine faultier or fault. - Ability to use new tools both the electrical and mechanical extensively - Can do few repairs now when the problem occurs
2. What were your best three learning from the instructional / pedagogical perspective?
- Patience to re-explain and answer question no matter how silly. - Interaction and relationship with us as friends, which boosted our communication with them. - Self-check discussion and interaction, give us a pre knowledge of the course.
3. What are the things you can utilize / adopt when you go back to your workplace? (list at least three things)
- Kaizen - Informing safety measures especially in the area of PPE. - Maintenance plan and log sheet of every equipment in my country.
4. Free comments (related to EWTI's training management)
- My coming here has been blessing, been to understand the basic concept and the operation of both mechanical and the electrical parts of Generator. - I will also like to say thanks the EWTI and JICA management has done a great job with this beautiful training scheme and will improve them to keep it up. - In addition have learned to repair more engines here to boost my confidence and learn new things.

TRAINEE'S ACTION PLAN PREPARATION FORMAT

Name of Trainee: _____

Name of organization: _____

No.	List of activities	Schedule of action	Responsible person	Required resource

Additional Remark:

_____

_____

_____

_____

_____

_____

_____

_____

Prepared by: _____ Signature:

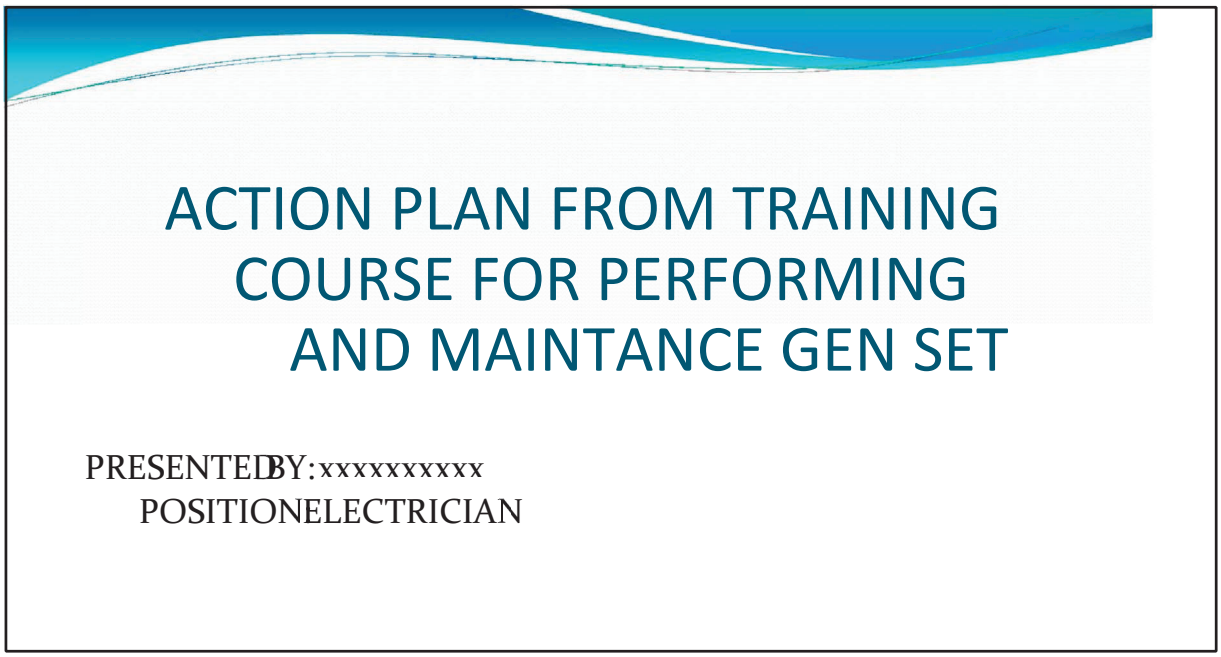
_____

Assisted by: _____ Signature:

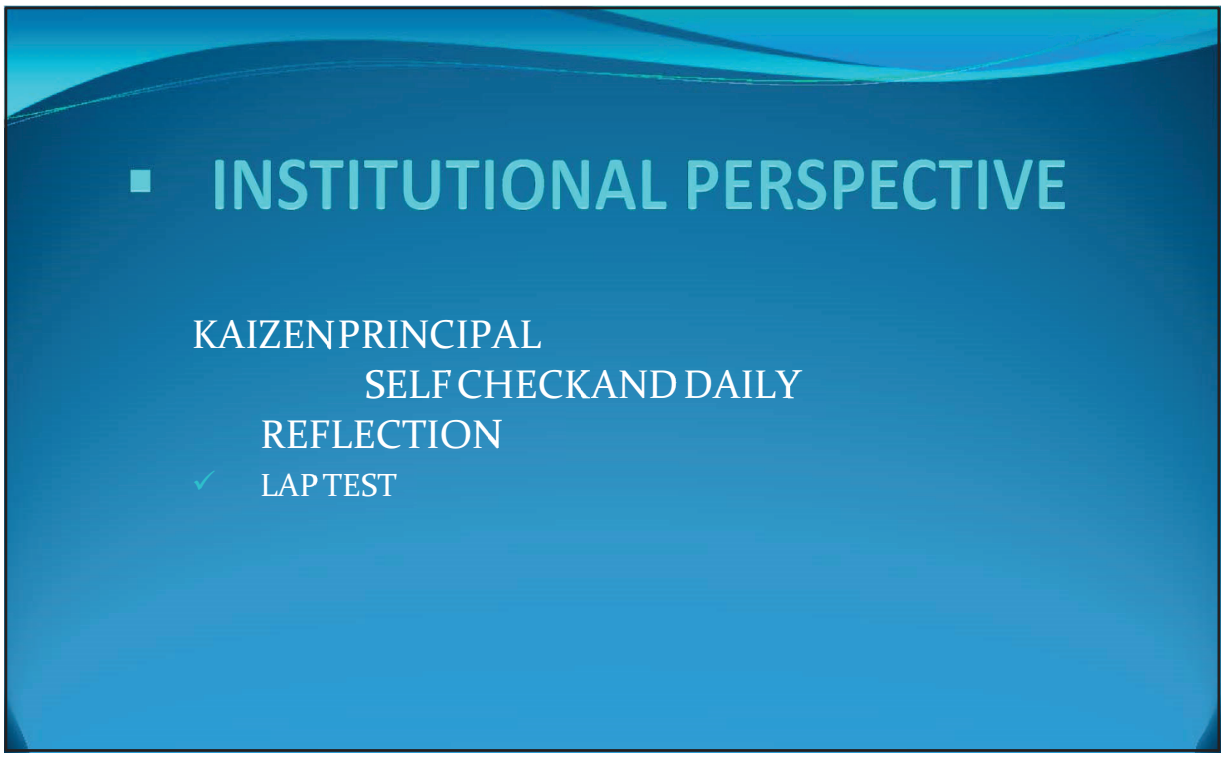
_____

Appendix 15:
Sample of Experience at EWTI International Training:
"Action Plan" Format and Action Plan Made by Trainees

Sample of Action Plan Presentation

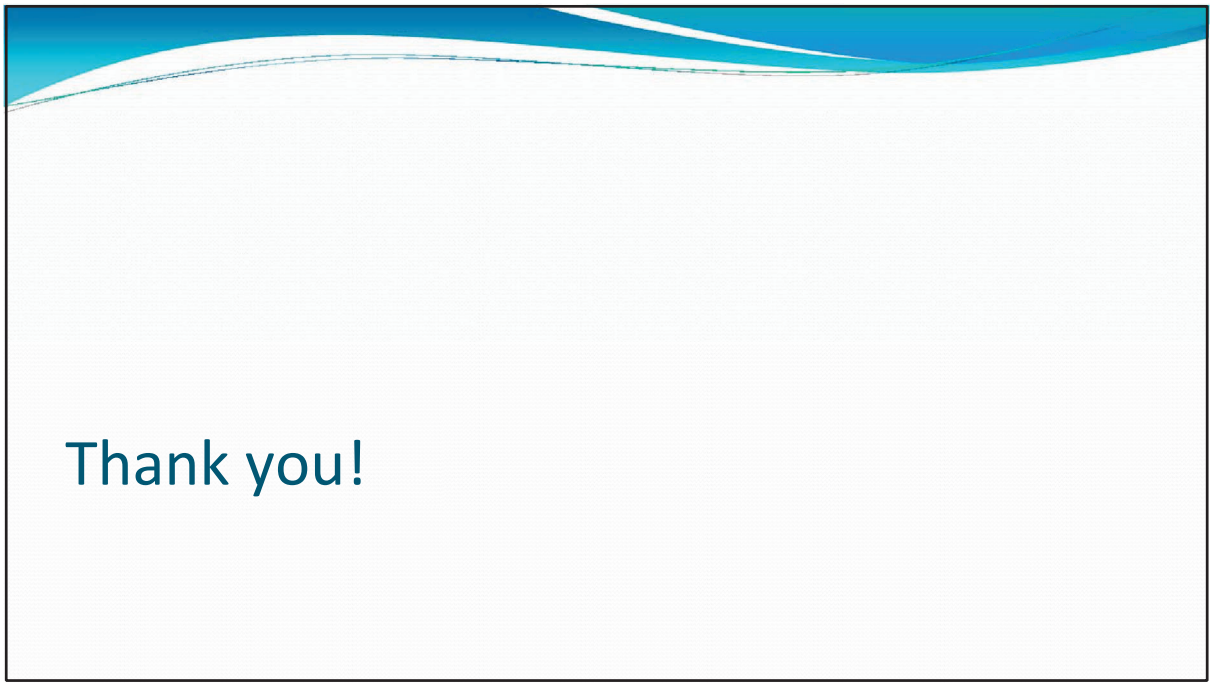


Appendix 15:
Sample of Experience at EWTI International Training:
"Action Plan" Format and Action Plan Made by Trainees



NO	LIST OF ACTIVITIES	SCHEDULE OF ACTION 3 MONTH		RESPONSIBLE PERSON	REQUITED RESOURCE
		FROM	TO		
1	KAIZEN PRINCIPLE	Feb 10/20	April 10/20	xxxxxxxxx.	Cleaning materials, equipment
2	Give Training for operator	Feb 20/20	FER 30/20		Training materials, budget for trainees.
3	Generator operation log sheet	Feb. 20/20	Feb. 25/20	Operator	Materials preparation
4	List out purchasing materials. Tools for maintenance	April 05/20	April 10/20	Purchaser	Maintenance and testing tools.
5	Maintenance of gen set	April, 10/20	March, 30/20		Oil, work shop preparation, support of staffs
6	Daily inspection and record	Feb, 10/20	March, 30/20	Operator	Measuring instrument.

Appendix 15:
Sample of Experience at EWTI International Training:
"Action Plan" Format and Action Plan Made by Trainees



Ethiopian Water Technology Institute (EWTI)

TTLM for Utilizing Drilling Fluids for Mud Engineering (For Trainer)

June, 2024

The Project for Strengthening Capacity for Training Operation and Management for EWTI

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Abbreviation List

Abbreviation	Full term
WRDT	Water resource development and drilling technology
DFE	drilling fluid engineering
FV	Funnel viscosity
LM	Learnig module
LG	Learnig Guide
LAP	learning activity performance
LCM	Lost circulation material
SG	specific gravity (SG).
KCl	potacium cloride
PHPA	Partially hydrolyzed polyacrylamide polymer
PAC	Polia anolic cellulose
PH	potential hydrogen
API	american petrolium institute
PFD	Posphate free dispersant
ROP	rate of penetration

LEARNING MODULE

MODULE TITLE: Utilizing drilling fluids for mud drilling

MODULE CODE: WRDT / DFE / LM01 / 0422v3

NOMINAL DURATION: 6-days class and 2-days field work

MODULE DESCRIPTION:

The module aims to provide the trainees with the knowledge, skills and right attitudes to identify mud drilling equipment, measuring and maintaining mud drilling fluid to adjust the required desirable property of mud.

LEARNING OUTCOME:

At the end of the module, the learner will be able to acquire the following

LO1: Preparing and operating mud drilling equipment and mud pits

LO2: Measuring and maintaining mud drilling fluids

MODULE CONTENTS:

LO1. Preparing and operating mud drilling equipment and mud pits

- 1.1 Identifying mud drilling equipment
  - 1.1.1 Understanding types and functions of mud drilling equipment
  - 1.1.2 Assembling and disassembling filter press
- 1.2 Preparing mud pits
  - 1.2.1 Calculating mud pits volume
  - 1.2.2 Creating a dimension sketch of mud pits

LO2. Measuring and maintaining mud drilling fluids

- 2.1 Identifying types and functions of mud drilling fluids
- 2.2 Identifying major properties, and measuring and maintaining drilling fluids
- 2.3 Identifying types and functions of drilling fluid additives
- 2.4 Identifying contamination prevention and treatment of mud drilling fluids

LEARNING METHODS: *(Learning methods may use one or more among the list)*

- ☒ Lecture
- ☒ Self-check
- ☒ Question and answer
- ☒ Demonstration
- ☒ Case Studies
- ☒ Project work
- ☒ Practical exercise
- ☒ Group work
- ☒ Presentation
- ☒ Self-study
- ☒ Assessment and feedback

ASSESSMENT METHODS:

(Assessment methods may use one or more among the list)

☒ Written Test

☒ Practical exam

☒ Oral questions

☒ Attendance

ASSESSMENT CRITERIA:

(Assessment Criteria derived from Contents covered under specific LO)

LO1. Preparing and operating mud drilling equipment and mud pits

- Identifying mud drilling equipment
- Preparing mud pits

LO2. Measuring and maintaining mud drilling fluids

- Identifying types and functions of mud drilling fluids
- Identifying major properties, and measuring and maintaining drilling fluids
- Identifying types and functions of drilling fluid additives
- Identifying contamination prevention and treatment measures of mud drilling fluids

RESOURCE REQUIREMENTS FOR LEARNING MODULE

Module Title	Utilizing drilling fluids for mud drilling
Module Code	WRDT / DFE / LM01 / 0422v3

Item No.	Category / Item	Description/ Specification	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1	TTLM			1:1
2	Reference Book	See last pages of LG 1 & LG 2		1:1
B	**Learning Facilities and Infrastructure**			
1	Store room		1	1:15
2	Workshop room	For tools demonstration	1	1:15
C	**Consumable Materials**			
1	Foam	Liter	50	50:15
2	Bentonite	Kg	20	20:15
D	**Tools and Equipment**			
1	Drilling tools (Mud drilling & DTH)		1	1:15
2	Drilling machine (Rig)		1	1:15
3	Drilling tools		1	1:15
4	Mud rotary bits		1	1:15
5	DTH bits		1	1:15
6	Drilling pipe		10	10:15
7	Drilling collar		1	1:15
8	Surface casing 6m		1	1:15
9	PVC casing 45m		15	15:15
10	Product casing 15m		5	5:15
11	Mud mixer		1	1:15
12	Welding machine		1	1:15

13	Generator		1	1:15
14	Dewatering pump		1	1:15
15	Water tanker		1	1:15
16	Break out tools		1	1:15
17	Pipe wrench		3	3:15
18	Chain tong		1	1:15
19	Tool box		1	1:15
20	Mud balance		1	1:15
21	Marsh funnel		1	1:15
22	Sand content kit		1	1:15
23	Rheometer/ filter press		1	1:15
24	pH		1	1:15
25	hardness measurement kit		3	3:15
26	Make-up water from 3 different sources in containers		3	3:15
27	Mud samples from 3 different sites		3	3:15
28	Stick to stir the mud samples		3	3:15
29	Buckets (for washing tools)		3	3:15
30	Water for washing in Jerry cans		3	3:15
31	Wiping cloths		0.5	0.5:15
32	Tables for 4 booths		3	3:15
33	Stopwatch		3	3:15
34	Plastic sheet for tables		3	3:15
35	Bowls (for catching the spilled mud samples during the operation)		3	3:15

Training Schedule

Module Title	Utilizing drilling fluids for mud drilling
Duration	From _____ to _____

Day No.	Date	Time	Training Content	Trainer	Assistant Trainer	Knowledge	Skill	Others	Total Hrs.	Remarks
Day1	M/D	9:00-11:00	Registration	Mr/Ms. XX	Mr/Ms. XX			2:00		
		11:00-11:30	Pre-Test/Pre-Questionnaire					0:30		
		11:30-12:00	LGs Distribution					0:30		
		12:00-14:00	Lunch break							
		14:00-15:30	Registration					1:30		
		15:30-16:00	Pre-Test/Pre-Questionnaire					0:30		
		16:00-17:00	LGs Distribution					1:00	6:00	
Day2	M/D	9:00-9:30	General Orientation	Mr/Ms. XX	Mr/Ms. XX			0:30		
		9:30-10:00	Course Guidance	Mr/Ms. XX	Mr/Ms. XX			0:30		
		10:00-10:30	Common Module : Self-check1, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:30				
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	Common Module : Self-check1, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-15:10	Common Module: Self-check2&3, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:10				
		15:10-15:30	Common Module: Operation Sheet				0:20			
		15:30-16:00	Tea break	-	-					
		16:00-16:40	Common Module: Operation Sheet	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10			5:00	
Day3	M/D	9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30	LG1: Self-check 1, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:20				
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	LG1: Self-check 2, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-14:30	LG1: Self-check 2, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:30				
		14:30-15:30	LG1: Operation Sheet (Demonstration & Self-exercise on Task 1)	Mr/Ms. XX	Mr/Ms. XX		1:00			
		15:30-16:00	Tea break	-	-					
		16:00-16:40	LG1: Operation Sheet (Demonstration & Self-exercise on Task 1)	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10			5:00	
Day4	M/D	9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-9:40	LG1: Operation Sheet (Demonstration on Task 2)	Mr/Ms. XX	Mr/Ms. XX		0:30			
		9:40-10:30	LG1: Operation Sheet (Self-exercise on Task 2)	Mr/Ms. XX	Mr/Ms. XX		0:50			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	LG1: LAP Test	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-	-					
		14:00-15:00	LG1: LAP Test	Mr/Ms. XX	Mr/Ms. XX		1:00			
		15:00-15:30	LG2: Self-check 1, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:30				
		15:30-16:00	Tea break	-	-					
		16:00-16:40	LG2: Self-check 1, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:40				
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10			5:00	
Day5	M/D	9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30	LG2: Self-check 2, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:20				
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	LG2: Self-check 3, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-	-					
		14:00-14:30	LG2: Self-check 3, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:30				
		14:30-15:30	LG2: Self-check 4, Q&A	Mr/Ms. XX	Mr/Ms. XX	1:00				
		15:30-16:00	Tea break	-	-					
		16:00-16:40	LG2: Self-check 4, Q&A	Mr/Ms. XX	Mr/Ms. XX	0:40				
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10			5:00	
Day6	M/D	9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30	LG2: Operation Sheet (Demonstration on Task 1)	Mr/Ms. XX	Mr/Ms. XX		1:20			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	LG2: Operation Sheet (Demonstration on Task 1)	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-	-					
		14:00-15:30	LG2: Operation Sheet (Self-exercise on Task 1)	Mr/Ms. XX	Mr/Ms. XX		1:30			

Day No.	Date	Time	Training Content	Trainer	Assistant Trainer	Knowledge	Skill	Others	Total Hrs.	Remarks
		15:30-16:00	Tea break	-	-					
		16:00-16:40	LG2: Operation Sheet (Self-exercise on Task 1)	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10			5:00	
Day7	M/D	-9:00	Mobilization of all trainers,traines and equipment to site							
		9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX		0:10				
		9:10-10:30	LG1: Field exercise on site	Mr/Ms. XX			1:20			
		10:30-11:00	Tea break							
		11:00-12:00	LG1: Field exercise on site	Mr/Ms. XX			1:00			
		12:00-14:00	Lunch break							
		14:00-15:30	LG1: Field exercise on site	Mr/Ms. XX			1:30			
		15:30-16:00	Tea break							
		16:00-16:40	LG1: Field exercise on site	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		17:00-	Demobilisation	Mr/Ms. XX					5:00	
Day8	M/D	-9:00	Mobilization of all trainers,traines and equipment to site							
		9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX		0:10				
		9:10-10:30	LG2: Field exercise on site	Mr/Ms. XX			1:20			
		10:30-11:00	Tea break							
		11:00-12:00	LG2: Field exercise on site	Mr/Ms. XX			1:00			
		12:00-14:00	Lunch break							
		14:00-15:30	LG2: Field exercise on site	Mr/Ms. XX			1:30			
		15:30-16:00	Tea break							
		16:00-16:40	LG2: Field exercise on site	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		17:00-	Demobilisation	Mr/Ms. XX					5:00	
Day9	M/D	9:00-9:10	Recap Session & Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30	LG2: LAP Test	Mr/Ms. XX	Mr/Ms. XX		1:20			
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	LG2: LAP Test	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-	-					
		14:00-15:30	LG2: LAP Test	Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-	-					
		16:00-16:40	LG2: LAP Test	Mr/Ms. XX	Mr/Ms. XX		0:40			
		16:40-16:50	Common Module: LAP test (KAIZEN)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:50-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX	0:10			5:00	
Day10	M/D	9:00-9:10	Recap Session & daily reflection	Mr/Ms. XX	Mr/Ms. XX	0:10				
		9:10-10:30	Preparation for Post-test (This time can be utilised for additional practical training)	Mr/Ms. XX	Mr/Ms. XX			1:20		
		10:30-11:00	Tea Break	-	-					
		11:00-12:00	Preparation for Post-test (This time can be utilised for additional practical training)	Mr/Ms. XX	Mr/Ms. XX			1:00		
		12:00-14:00	Lunch break	-	-					
		14:00-15:00	Post-Test/Post-Questionnaire	Mr/Ms. XX	Mr/Ms. XX			1:00		
		15:00-15:30	Action Plan Session	Mr/Ms. XX	Mr/Ms. XX		0:30			
		15:30-16:00	Tea break	-	-					Certificaiton preparation
		16:00-17:00	KAIZEN Reflection session	Mr/Ms. XX	Mr/Ms. XX		1:00		5:00	
Day11	M/D	9:00-10:30	Presentation of Action Plan	Mr/Ms. XX	Mr/Ms. XX		1:30			Certificaiton preparation
		10:30-11:00	Tea Break	-	-					Certificaiton preparation
		11:00-11:30	Presentation of Action Plan				0:30			Certificaiton preparation
		11:30-12:00	Course Evaluation Sheet	Mr/Ms. XX	Mr/Ms. XX			0:30		Need extra support to the Registrar
		12:00-14:00	Lunch break	-	-					
		14:00-15:00	Course Reflection Session	Mr/Ms. XX	Mr/Ms. XX			1:00		
		15:00-15:30	Tea break	-	-					
		15:30-17:00	Course Closing Ceremony	Mr/Ms. XX	Mr/Ms. XX			1:30	5:00	
				Total Hours		13:50	28:50	13:20	56:00	
				Percentage		25%	51%	24%	100%	

Performance Evaluation Guide Ver.3

This is guide for Individual or Group Performance Evaluation. Based on given design of the performance evaluation, trainers must be prepare necessary equipment's, materials and consumables and its setting. During the actual performance evaluation, the trainer must fill-in in the consecutive Rating Sheet.

If trainees fail and do not get the passing scores at the 1st trial, trainers can give the trainees the chance for the 2nd trial and its results will be filled-in using "Trainees' Assessment Data Sheet" (Template TM-8 and TM-9 of the O&M Guidelines).

Module Title	Utilizing drilling fluids for mud drilling
Learning Guide number and title	**LO1. Preparing and operating mud drilling equipment and mud pits**
Assessment	Individual ■ Group □
Date of Trial	
Venue of assessment	Classroom■ Workshop□ Machine site■ Field Practice in the field□ Others……..□

Preparation and setting for the performance assessment

In order to do the assessment ready for the

- **drilling mud from the site**
- **make up water**
- **litmus paper**
- **calcium hardness strip chemicals like**
- **Bentonite**
- **polymers**
- **special chemicals**
- **additives etc**

Necessary material and equipment needed for the test

No	Material, consumables and equipment	Quantity
1	Drilling rig with mud pump	1set / each
2	Filter press	1pc
3	Mud suction and delivery hose	1pc
4	Shale shaker	1pc
5	Mud balance	1pc
6	Marsh funnel	1pc
7	Sand content test kit	1pc

Rating Sheet for Demonstration Ver.3

This is the sheet for recording the rating of the performance evaluation of the trainees.

Course Title	Utilizing drilling fluids for mud drilling
Trainee's name/ Group number	
Trainer's name	
Learning Guide number and title	**LO1. Preparing and operating mud drilling equipment and mud pits**
Assessment	Individual■ Group□
Date of Trial	
Venue of Assessment	Classroom□ Workshop■ Machine site■ Practice Field□ Others…□

Instruction for LAP test

- **Read the instruction written in the LAP test**
- **Test will be conducted by individual trainees by turn**
  - Identify and explain drilling fluid measurement equipment's mud pits
  - Use basic equations and find out settling and suction pits volume
  - Preparing mud pits design

No	During the demonstration of skills, did the trainee (circle Y for Yes and N for No)	1st trial	2nd trial
1	Wear the required safety devices or clothes	Y/N	Y/N
2	Check if the suction line is full of fluid	Y/N	Y/N
3	Identify tools used for mud drilling fluid measurement (Filter press, marsh funnel, mud balance, and sand content test kit) *All four measurement tools are required to answer	Y/N	Y/N
4	Assemble anddisassemble filter press equipment	Y/N	Y/N

No	During the demonstration of skills, did the trainee (circle Y for Yes and N for No)	1st trial	2nd trial
5	Create sketch including the dimension of mud pit using rectangular shape as per the volume of borehole. Total volume of borehole= 2.35m^3 <Suction Pit> • Correct volume: 4.7m^3 • Correct dimensions: Length 2.4m, Width 1.5m, Depth 1.3m <Settling Pit> • Correct volume: 2.35m3 • Correct dimensions: Length 1.5m, Width 1.5m, Depth 1.1m	Y/N	Y/N
The trainee's demonstration was:		□Satisfactory □No	□Satisfactory □No

Oral Questions Ver.3

Q	The trainee should answer the following questions	Satisfactory response	
		1st Trial	2nd Trial
1	What will happen if we do not measure always drilling fluid property		
2	Why are we designing the mud pits?		
3	What will happen if we do not use filter press membrane paper?		
The trainee's knowledge was		□Satisfactory □No	□Satisfactory □No
Feedback to trainee			

The trainee's overall performance was:	1st Trial	2nd Trial
	□Satisfactory □No	□Satisfactory □No
Trainee's signature:	Date:	
Trainer's signature:	Date:	

Recommended answers for oral questions

Q	Recommended Answer
1	The drilling fluid will be contaminated and the drilling activity face problem.
2	To be economical and managedrilling fluid waste by getting correct volume of the mud pits to make the drilling process easier.
3	The filter cake will not beformed, and the thickness of the mudcannot be measured.

TG-03

PERFORMANCE EVALUATION GUIDE

This is a guide for individual or group performance evaluation. Based on given design of the performance evaluation, trainers must prepare necessary equipment, materials and consumables and its setting. During the actual performance evaluation, the trainers must fill-in in the consecutive Rating Sheet.

The results of the 1st trial, if participants failure, the trainers can give a chance for the 2nd trial and its results will be filled-in using “Training Participants’ Assessment Data Sheet” (TM-08 of the Guidelines for Training Operation and Management).

Module Title	Utilizing drilling fluids for mud drilling
Learning Guide number and title	LG2: Measuring and maintaining mud drilling fluids
Venue of assessment	☐Classroom ☒Workshop ☐Machine site ☐Practice Field ☐Others

Preparation and setting for the performance assessment

- ■ Prepare or avail the below equipment and materials related to the components of the assessment
- ■ Ensure if there is a suitable area/ space for the assessment
- ■ Avail the rating sheet for demonstration per each trainee
- ■ Avail necessary PPE such as overall cloth, hand gloves, helmet, and plastic boots

Necessary material and equipment

No	Material, consumables, and equipment	Quantity
1	LAP test handouts including recording sheet (distributed to each trainee)	Number of trainees / group
2	Mud balance	1 pc
3	Marsh funnel	1 pc
4	Filter press	1 pc
5	pH and calcium hardness measuring kit	1 set
6	Sand content kit	1 pc
7	Litmus Paper	1 packet
8	Make-up water from 3 different sources in containers	1 set
9	Mud samples from 3 different sites	1 set
10	Stick to stir the mud samples	3 pcs
11	Buckets (for washing tools)	2 pcs
12	Water for washing in Jerry cans	2 sets

13	Wiping cloths	5 pcs
14	Tables for 4 booths	8 pcs
15	Stopwatch	2 pcs
16	Trash can	1 pc
17	Bowls (for catching the spilled mud samples during the operation)	6 pcs
18	Plastic sheet for tables	3 pcs

Table to be filled by trainers at the workshop

***In order to check the performance of the trainees' activity, trainer has to fill the below table before starting LAP Test**

No	Drilling fluid properties measure	Desirable Property	Assessment method	Measured by trainers		
				Sample 1	Sample 2	Sample 3
1	Viscosity of mud	27-32 sec	Group			
2	Filtration volume	15 mm	Group			
3	Mud cake	0.79 mm	Group			
4	Sand content	Below 1 %	Group			
5	Density	1.05~1.10gm/cm3	Individual			
6	pH	8.5-9.5	Individual			
7	Calcium hardness	Below 100 mg/lit	Individual			

TG-03

RATING SHEET FOR DEMONSTRATION

This is a guide for the rating of the performance evaluation of the learners. The results of the evaluation shall be recorded on the Training Participants' Assessment Data Sheet (TM-08).

Assessment	☒Individual ☒Group
Date of 1st Trial	
Date of 2nd Trial	

Instruction for demonstration

Instruction to be given to the trainees in order to conduct the following instructed tasks in a workshop.

- ■ Read the instruction on the LAP test and listen to the trainer's explanation carefully.
- ■ Form/ confirm the group of 3 to 4 persons to take the test with for group work.
- ■ Check the kits, equipment, and other accessories necessary for measuring viscosity, density, pH, filter cake and filtration volume, sand content at the test site.
- ■ Conduct measuring drilling fluid property.
- ■ Perform KAIZEN while taking the LAP test.
- ■ Respond to the trainers for the oral questions provided on this sheet.
- ■ Follow the time schedule for each task of the LAP test. Overtime is not accepted.

During the demonstration of skills, did the trainee (Circle Y for Yes and N for No)			1st trial	2nd trial
*Make-up water sample number used for the test				
*Mud sample number used for the test				
1.1	Calcium hardness	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement / data	Y/N	Y/N
		3.Correct interpretation of data / analysis of necessary actions to be taken	Y/N	Y/N
1.2	pH	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement / data	Y/N	Y/N

		3. Correct interpretation of data / analysis of necessary actions to be taken	Y/N	Y/N
1.3	Density	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement/ data	Y/N	Y/N
		3. Correct interpretation of data/ analysis of necessary actions to be taken	Y/N	Y/N
1.4	Viscosity	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement / data	Y/N	Y/N
		3. Correct interpretation of data / analysis of necessary actions to be taken	Y/N	Y/N
1.5	Sand content	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement / data	Y/N	Y/N
		3. Correct interpretation of data / analysis of necessary actions to be taken	Y/N	Y/N
1.6	Filtration volume	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement / data	Y/N	Y/N
		3. Correct interpretation of data / analysis of necessary actions to be taken	Y/N	Y/N
1.7	Mud Cake	1. Proper handling of the measuring device	Y/N	Y/N
		2. Accuracy of measurement / data	Y/N	Y/N
		3. Correct interpretation of data / analysis of necessary actions to be taken	Y/N	Y/N
The trainee's demonstration was:			☐Satisfactory ☐No	☐Satisfactory ☐No

TG-03

ORAL QUESTIONS

This is a guide for the rating of the oral questions to be asked during the LAP test. The results of the evaluation shall be recorded on the Training Participants' Assessment Data Sheet (TM-08).

Q	The trainee should answer the following questions	Satisfactory response	
		1st Trial	2nd Trial
1	What is the effect of high concentration of pH in the make-up water?		
2	What would happen if the density of mud is above the standard?		
3	What would happen if mud cake and filtration volume is larger than the standard?		
4	What are the causes / reasons for the different or wrong measurement results even from the same drilling fluid sample in following tests?		
	(A) Marsh funnel		
	(B) Sand content		
	(C) Filter press		
The trainee's knowledge was		☐Satisfactory ☐No	☐Satisfactory ☐No
Feedback to trainee *To be filled on the Training Participants' Assessment Data Sheet (TM-08)*			

The trainee's overall performance was:	1st Trial	2nd Trial
	☐Satisfactory ☐Not Satisfactory	☐Satisfactory ☐Not Satisfactory

Recommended answers for oral questions

Q	Recommended Answer
1	It contaminates the drilling fluid.
2	It causes the loss of circulation and borehole collapse.
3	■ It reduces BH diameter as the mud cake is thick. ■ The loss of circulation will occur as much fluid goes to the wall.
4	(A) Measurement error of fluid outflow time and/or of fluid volume, etc
	(B) Measurement error of fluid volume in sand content tube
	(C) Assembly error of filter press, measurement error of fistulation time or pressure, etc.

Training Session Plan

Module Title	Utilizing drilling fluids for mud drilling
Learning Outcome	Preparing and operating mud drilling equipment and mud pits
Session Objectives	At end of the session, the trainee will be able to: 1. Understand types and functions of mud drilling equipment 2. Assemble and disassemble filter press 3. Calculate mud pits volume 4. Create a dimension sketch of mud pits
Trainers	XXX

Day 1

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-11:00	Registration	120min	-	Coordinate and facilitate the session	Template/format
11:00-11:30	Pre-Test/Pre-Questionnaire	30min	Assessment & Feedback	Coordinate and facilitate the session	Template/format
11:30-12:00	LGs Distribution	30min	-	Coordinate and facilitate the session	Module
12:00-14:00	Lunch break	120min			
14:00-15:30	Registration	90min		Coordinate and facilitate the session	Template/format
15:30-16:00	Pre-Test/Pre-Questionnaire	30min		Coordinate and facilitate the session	Template/format
16:00-17:00	LGs Distribution	60min		Coordinate and facilitate the session	Module

Day 2

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:30	General Orientation	30min	Presentation	Coordinate and facilitate the session	Template/format
9:30-10:00	Course Guidance	30min	Presentation	Coordinate and facilitate the session	Template/format
10:00-10:30	Common Module : Self-check1, Q&A	30min	Self-check/ Question and answer	Instruct how to do self check and conduct self learning. Ask whether learners answered self check correctly and which question was most chalenging and explaining them about the correct answer.	Common Module: Self-check and Information Sheet
10:30-11:00	Tea Break	30min			
11:00-12:00	Common Module : Self-check1, Q&A	60min	Self-check/ Question and answer	Ditto	Common Module: Self-check and Information Sheet
12:00-14:00	Lunch break	120min			
14:00-15:10	Common Module: Self-check2&3, Q&A	70min	Self-check/ Question and answer	Ditto	Common Module: Self-check and Information Sheet
15:10-15:30	Common Module: Operation Sheet	20min	Demonstration/ Practical exercise	Demonstrate how to fill in KAIZEN Daily Check Sheet and conduct Weekly Review and Reflection. / Let learners practice by themselves with necessary support and advice.	Common Module: Operation Sheet
15:30-16:00	Tea break	30min			
16:00-16:40	Common Module: Operation Sheet	40min	Demonstration/ Practical exercise	Demonstrate how to fill in KAIZEN Daily Check Sheet and conduct Weekly Review and Reflection. / Let learners practice by themselves with necessary support and advice.	Common Module: Operation Sheet
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet

Day 3

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	LG1: Self-check 1, Q&A	20min	Self-check/ Question and answer	Instruct how to do self check and conduct self learning. Ask whether learners answered self check correctly and which question was most chalenging and explaining them about the correct answer.	LG1: Self-check and Information Sheet
10:30-11:00	Tea Break	30min			
11:00-12:00	LG1: Self-check 2, Q&A	60min	Self-check/ Question and answer	Ditto	LG1: Self-check and Information Sheet
12:00-14:00	Lunch break	120min			
14:00-14:30	LG1: Self-check 2, Q&A	30min	Self-check/ Question and answer	Ditto	LG1: Self-check and Information Sheet
14:30-15:30	LG1: Operation Sheet (Demonstration & Self-exercise on Task 1)	60min	Demonstration/ Practical exercise	Demonstrate how to identify Mud drilling equipments and assemble and disassemble the filter press. / Let learners practice by themselves with necessary support and advice.	LG1: Operation Sheet and necessary mud drilling equipment
15:30-16:00	Tea break	30min			
16:00-16:40	LG1: Operation Sheet (Demonstration & Self-exercise on Task 1)	40min	Demonstration/ Practical exercise	Ditto	LG1: Operation Sheet and necessary mud drilling equipment
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet

Training Session Plan

Module Title	Utilizing drilling fluids for mud drilling
Learning Outcome	Measuring and maintaining mud drilling fluids
Session Objectives	At end of the session, the trainee will be able to: 1. Explain the types and functions of mud 2. Apply drilling mud testing with proper equipment 3. Identify drilling fluid additives 4. Identify fluid contamination and maintenance 5. Use tools and mixings/additives to measure/adjust mud drilling properties
Trainers	XXX

Day 4

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-9:40	LG1: Operation Sheet (Demonstration on Task 2)	30min	Demonstration/ Practical exercise	Demonstrate how to design mud pits	LG1: Operation Sheet and necessary mud drilling equipment
9:40-10:30	LG1: Operation Sheet (Self-exercise on Task 2)	50min	Demonstration/ Practical exercise	Let learners design mud pits with necessary support and advice	LG1: Operation Sheet and necessary mud drilling equipment
10:30-11:00	Tea Break	30min			
11:00-12:00	LG1: LAP Test	60min	Assessment & Feedback	Give instruction to trainees how to take the test, Fill rating sheet, ask oral question and give feedback according to the test results	LG1: LAP Test, PEG, Necessary mud drilling equipment
12:00-14:00	Lunch break	120min			
14:00-15:00	LG1: LAP Test	60min	Assessment & Feedback	Ditto	LG1: LAP Test, PEG, Necessary mud drilling equipment
15:00-15:30	LG2: Self-check 1, Q&A	30min	Self-check/ Question and answer	Instruct how to do self check and conduct self learning. Ask whether learners answered self check correctly and which question was most chalenging and explaining them about the correct answer.	LG2: Self-check and Information Sheet
15:30-16:00	Tea break	30min			
16:00-16:40	LG2: Self-check 1, Q&A	40min	Self-check/ Question and answer	Ditto	LG2: Self-check and Information Sheet
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet

Day 5

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	LG2: Self-check 2, Q&A	80min	Self-check/ Question and answer	Instruct how to do self check and conduct self learning. Ask whether learners answered self check correctly and which question was most chalenging and explaining them about the correct answer.	LG2: Self-check and Information Sheet
10:30-11:00	Tea Break	30min			
11:00-12:00	LG2: Self-check 3, Q&A	60min	Self-check/ Question and answer	Ditto	LG2: Self-check and Information Sheet
12:00-14:00	Lunch break	120min			
14:00-14:30	LG2: Self-check 3, Q&A	30min	Self-check/ Question and answer	Ditto	LG2: Self-check and Information Sheet
14:30-15:30	LG2: Self-check 4, Q&A	60min	Self-check/ Question and answer	Ditto	LG2: Self-check and Information Sheet
15:30-16:00	Tea break	30min			
16:00-16:40	LG2: Self-check 4, Q&A	40min	Self-check/ Question and answer	Ditto	LG2: Self-check and Information Sheet
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet

Day 6					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	LG2: Operation Sheet (Demonstration on Task 1)	80min	Demonstration/ Practical exercise	Demonstrate how to use tools and mixings/additives to measure/adjust mud drilling properties	LG2: Operation Sheet and necessary mud drilling equipment, materials and consumables
10:30-11:00	Tea Break	30min			
11:00-12:00	LG2: Operation Sheet (Demonstration on Task 1)	60min	Demonstration/ Practical exercise	Ditto	LG2: Operation Sheet and necessary mud drilling equipment, materials and consumables
12:00-14:00	Lunch break	120min			
14:00-15:30	LG2: Operation Sheet (Self-exercise on Task 1)	90min	Demonstration/ Practical exercise	Let learners practice by themselves for measurement and maintenace of drilling properties with tools. Give necessary support and advice.	LG2: Operation Sheet and necessary mud drilling equipment, materials and consumables
15:30-16:00	Tea break	30min			
16:00-16:40	LG2: Operation Sheet (Self-exercise on Task 1)	40min	Demonstration/ Practical exercise	Ditto	LG2: Operation Sheet and necessary mud drilling equipment, materials and consumables
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet
Day 7					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
-9:00	Mobilization of all trainers,traines and equipment to site	-	-	-	-
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	LG1: Field exercise on site	80min	Field work	Let learners observe the site, give supplemental explanation to what is learned at class, arrange opportunity for more practices (usage of drilling equipment and demonstration of mud pit design)	TTLM LG1 Necessary mud drilling equipment
10:30-11:00	Tea break	30min			
11:00-12:00	LG1: Field exercise on site	60min	Practical exercise	Ditto	Ditto
12:00-14:00	Lunch break	120min			
14:00-15:30	LG1: Field exercise on site	90min	Practical exercise	Ditto	Ditto
15:30-16:00	Tea break	30min			
16:00-16:40	LG1: Field exercise on site	40min	Practical exercise	Ditto	Ditto
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet
17:00-	Demobilisation	-	-	-	-
Day 8					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
-9:00	Mobilization of all trainers,traines and equipment to site	-	-	-	-
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	LG2: Field exercise on site	80min		Let learners observe the site, give supplemental explanation to what is learned at class, arrange opportunity for more practices (Demonstration of measuring and mainting drilling fluid)	TTLM LG2 Necessary mud drilling equipment, materials and consumables
10:30-11:00	Tea break	30min			
11:00-12:00	LG2: Field exercise on site	60min	Practical exercise	Ditto	Ditto
12:00-14:00	Lunch break	120min			
14:00-15:30	LG2: Field exercise on site	90min	Practical exercise	Ditto	Ditto
15:30-16:00	Tea break	30min			
16:00-16:40	LG2: Field exercise on site	40min	Practical exercise	Ditto	Ditto
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet
17:00-	Demobilisation	-	-	-	-

Day 9					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap Session & Daily Reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	LG2: LAP Test	90min	Assessment & Feedback	Give instruction to trainees how to take the test, Fill rating sheet, ask oral question and give feedback according to the test results	LG2: LAP Test, PEG, Necessary mud drilling equipment, materials and consumables
10:30-11:00	Tea Break	30min			
11:00-12:00	LG2: LAP Test	60min	Assessment & Feedback	Ditto	Ditto
12:00-14:00	Lunch break	120min			
14:00-15:30	LG2: LAP Test	90min	Assessment & Feedback	Ditto	Ditto
15:30-16:00	Tea break	30min			
16:00-16:40	LG2: LAP Test	40min	Assessment & Feedback	Ditto	Ditto
16:40-16:50	Common Module: LAP test (KAIZEN)	10min	Assessment & Feedback	Instruct how to fill KAIZEN check sheet	KAIZEN Check sheet
16:50-17:00	Daily Reflection	10min	Assessment & Feedback	Instruct how to fill Daily Reflection Sheet	Daily Reflection Sheet
Day 10					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap Session & daily reflection	10min	Assessment & Feedback	Coordinate and facilitate the session	Projector, presentation materials
9:10-10:30	Preparation for Post-test (This time can be utilised for additional practical training)	80min	demonstration	Answer questions from learners if necessary	LG1, LG2
10:30-11:00	Tea Break	30min			
11:00-12:00	Preparation for Post-test (This time can be utilised for additional practical training)	60min	Group work	Answer questions from learners if necessary	LG1, LG2
12:00-14:00	Lunch break	120min			
14:00-15:00	Post-Test/Post-Questionnaire	60min	Assessment & Feedback	Instruct how to conduct Post-test/ Post-questionnaire	Post-test/ Post-questionnaire
15:00-15:30	Action Plan Session	30min	Project work	Instruct how to prepare Action Plan with major objectives and detail procedures	Projector, presentation materials
15:30-16:00	Tea break	30min			
16:00-17:00	KAIZEN Reflection session	60min	Assessment & Feedback	Coordinate and facilitate the session	KAIZEN Reflection Sheet
Day 11					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-10:30	Presentation of Action Plan	90min	Presentation	Coordinate and facilitate the session	Projector, presentation materials
10:30-11:00	Tea Break	30min			
11:00-11:30	Presentation of Action Plan	30min	Presentation	Coordinate and facilitate the session	Projector, presentation materials
11:30-12:00	Course Evaluation Sheet	30min	Assessment & Feedback	Coordinate and facilitate the session	Course Evaluation Sheet
12:00-14:00	Lunch break	120min			
14:00-15:00	Course Reflection Session	60min	Assessment & Feedback	Coordinate and facilitate the session	
15:00-15:30	Tea break	30min			
15:30-17:00	Course Closing Ceremony	90min	-	-	-

Answers Box self-check LG 1

Self-check 1-1	Identifying mud drilling equipment

Answer Sheet

1-1: T/F

1	2	3	4	5	6	7	8	9
F	F	T	T	F	F	F	T	No Answer

1-2: Fill-in-the-blank

1) Viscosity

2) Content of sands

3) Dip indicator strip

Self-check 1-2	Preparing mud pits

Answer Sheet

2-1: T/F

1	2	3	4	5
T	F	F	T	T

2-2: Short answers & Fill-in-the-blank

1) No Answer
2) Suction pit / Settling pit
3) Suction pit
4) Settling pit
5) 1.5 to 3
6) Flow line

Date: April 2022

Answers Box self-check LG 2

Self-check 2-1	Identifying types and functions of mud drilling fluids

Answer Sheet

1-1: Multiple choice

1)	2)	3)	4)	5)
d	d	a	a	d

1-2: T/F

1)	2)	3)	4)	5)
F	F	F	F	T

Self-check 2-2	Identifying major properties, and measuring and maintaining drilling fluids

Answer Sheet

2-1: Multiple choice

1)	2)	3)	4)	5)
d	d	a	a	b

2-2: T/F

1)	2)	3)	4)	5)	6)
T	T	T	F	F	T

Date: April 2022

Self-check 2-3	Identifying types and functions of drilling fluid additives

Answer Sheet

3-1: T/F

1)	2)	3)	4)	5)	6)	7)
F	T	F	T	T	F	T

PRE-TEST QUESTION SHEET (Written test)

Name: _____ Date: _____

Time started: _____ Time fished: _____

***Use the Answer Sheet at the end of this sheet to fill out your answers.**

Directions-1: Answer all the questions listed below:

Choose the appropriate answers for the given questions.

1. Which order of mixing fluid is correct?
   - A. Water, polymer, special chemical bentonite
   - B. Water, bentonite, polymer, special chemical
   - C. Water, polymer, bentonite, special chemical
   - D. Water, special chemical, polymer, bentonite

2. What is the major contamination source in drilling fluid?
   - A. Chemical
   - B. Bentonite
   - C. Drilling cuttings
   - D. EZ-mud

3. The chemical used for increasing the weight of drilling fluid is
   - A. Polymer
   - B. Calcium
   - C. Barite
   - D. EZ-mud

4. Which one is NOT the major function of polymer?
   - A. Increase viscosity and solid suspension
   - B. Filtration control
   - C. Lubrication
   - D. Reduce fluid loss

5. Filter presses is used to measure _____
   - A. Fluid viscosity
   - B. Filtration control and filter cake
   - C. Solid control

D. Calcium hardness and acidity of makeup water

6._____ is a device used to remove drilled solids.

A. Mud mixer

B. Mud balance

C. Sand content test kit

D. Shale shaker

7._____ is used to store adequate volume of drilling fluid.

A. Suction pit

B. Settling pit

C. Mud pit

D. Flow line

8. _____is simply an inclined, flow path to direct mud coming out from the bore hole to the mud pit.

A. Suction line

B. Flow line

C. Collapsible tank

D. Excavated pit

9. What needs to be considered during selection of drilling fluid?

A. Soil and ground formation of the area

B. Drilling machine

C. Mixing equipment

D. Drilling tools

10. Which one of the following is not a function of drilling fluid?

A. Stabilizing borehole

B. Making filter cake

C. Collapsing borehole

D. Cooling the drilling tools

11. In order to stop the lost circulation, one must _____

A. Add more bentonite

B. Dilute the drilling fluid with water

C. Add cement in the drilling fluid

D. Add polymers

12. Generally speaking, which one of the following could change the conditions of drilling fluid property from desirable to undesirable?

A. Addition of bentonite accumulation

B. Addition of polymers

C. Addition of drilling cuttings

D. Addition of water

13. What is the device used to measure mud cake?

A. Drip hardness strip

B. Mud balance

C. Filter press

D. Funnel viscosity meter

14. An average filtration loss value is

A. 20 mm

B. 15 mm

C. 25mm

D. 2mm

PRE-TEST ANSWER SHEET

Answer Sheet for Direction 1

1	2	3	4	5	6	7	8	9
B	C	C	B	B	D	C	B	A
10	11	12	13	14				
C	C	C	C	B				

NOTE : Only used for progress chart

Score: _____

Rating: _____

POST-TEST QUESTION SHEET (Written test)

Name: _____ Date: _____

Time started: _____ Time fished: _____

***Use the Answer Sheet at the end of this sheet to fill out your answers.**

Directions-1: Answer all the questions listed below:

Choose the appropriate answers for the given questions.

1. Which order of mixing fluid is correct?
   - A. Water, polymer, special chemical bentonite
   - B. Water, bentonite, polymer, special chemical
   - C. Water, polymer, bentonite, special chemical
   - D. Water, special chemical, polymer, bentonite

2. Filter presses is used to measure _____
   - A. Fluid viscosity
   - B. Filtration control and filter cake
   - C. Solid control
   - D. Calcium hardness and acidity of makeup water

3. What is the major contamination sourse in drilling fluid?
   - A. Chemical
   - B. Bentonite
   - C. Drilling cuttings
   - D. EZ-mud

4. The chemical used for increasing the weight of drilling fluid is
   - A. Polymer
   - B. Calcium
   - C. Barite
   - D. EZ-mud

5._____ is used to store adequate volume of drilling fluid.

A. Suction pit

B. Settling pit

C. Mud pit

D. Flow line

6. Which one is NOT the major function of polymer?

A. Increase viscosity and solid suspension

B. Filtration control

C. Lubrication

D. Reduce fluid loss

7. Generally speaking, which one of the following could change the conditions of drilling fluid property from desirable to undesirable?

A. Addition of bentonite accumulation

B. Addition of polymers

C. Addition of drilling cuttings

D. Addition of water

8._____ is a device used to remove drilledsolids.

A. Mud mixer

B. Mud balance

C. Sand content test kit

D. Shale shaker

9._____is simply an inclined, flow path to direct mud coming out from the bore hole to the mud pit.

A. Suction line

B. Flow line

C. Collapsible tank

D. Excavated pit

10. An average filtration loss value is

A. 20 mm

B. 15 mm

C. 25mm

D. 2mm

11. Which one of the following is not a function of drilling fluid?
    A. Stabilizing borehole
    B. Making filter cake
    C. Collapsing borehole
    D. Cooling the drilling tools

12. In order to stop the lost circulation, one must _____
    A. Add more bentonite
    B. Dilute the drilling fluid with water
    C. Add cement in the drilling fluid
    D. Add polymers

13. What is the device used to measure mud cake?
    A. Drip hardness strip
    B. Mud balance
    C. Filter press
    D. Funnel viscosity meter

14. What needs to be considered during selection of drilling fluid?
    A. Soil and ground formation of the area
    B. Drilling machine
    C. Mixing equipment
    D. Drilling tools

POST-TEST ANSWER SHEET

Answer Sheet for Direction 1

1	2	3	4	5	6	7	8	9
B	B	C	C	C	B	C	D	B
10	11	12	13	14				
B	C	C	C	A				

NOTE: Only used for progress chart

Score: _____

Rating: _____

Pre-training Questionnaire

Training Module Title	Utilizing drilling fluids for mud drilling
Duration	*YYYY/MM/DD - YYYY/MM/DD*
Name of Training Participant	
Date	*YYYY/MM/DD*

Please thick (✓) the appropriate colums.

LO1: Preparing and operating mud drilling equipment and mud pits

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior person	performed by myself without help	supervised someone performing
No.	**Tasks**	1	2	3	4	5
1	Identify mud drilling equipment (its types and functions)					
2	Prepare mud pits					
Q2: Overall, I think I am …% confident to do this job (LO1) now.		<50%	>50%	>70%	>80%	>90%

LO2: Measuring and maintaining mud drilling fluids

Q1: During my job experiences so far, I have…		had no related experiences	worked with someone performing as an assistant	performed it by myself with some support of senior person	performed by myself without help	supervised someone performing
No.	**Tasks**	1	2	3	4	5
1	Identify types and functions of mud drilling fluids					
2	Identify major properties, and measure and maintain drilling fluids					
3	Identify types and functions of drilling fluid additives					
4	Identify contamination prevention and treatment measures of mud drilling fluids					
Q2: Overall, I think I am …% confident to do this job (LO2) now.		<50%	>50%	>70%	>80%	>90%

Post-training Questionnaire

Training Module Title	Utilizing drilling fluids for mud drilling
Duration	*YYYY/MM/DD - YYYY/MM/DD*
Name of Training Participant	
Date	*YYYY/MM/DD*

Please thick (✓) the appropriate colums.

LO1: Preparing and operating mud drilling equipment and mud pits

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	**Tasks**	1	2	3	4	5
1	Identify mud drilling equipment (its types and functions)					
2	Prepare mud pits					
Q2: Overall, I think I am …% confident to do this job (LO1) now.		<50%	>50%	>70%	>80%	>90%

LO2: Measuring and maintaining mud drilling fluids

Q1: After the completion of the training, I can…		not perform it at all	work with someone performing as an assistant	perform it by myself with some support of senior	perform by myself without help	supervise someone performing
No.	**Tasks**	1	2	3	4	5
1	Identify types and functions of mud drilling fluids					
2	Identify major properties, and measure and maintain drilling fluids					
3	Identify types and functions of drilling fluid additives					
4	Identify contamination prevention and treatment measures of mud drilling fluids					
Q2: Overall, I think I am …% confident to do this job (LO2) now.		<50%	>50%	>70%	>80%	>90%

250

Ethiopian Water Technology Institute (EWTI)

Learning Guide #1

(For Learners)

Module Title: Utilizing drilling fluids for mud drilling

Module Code: WRDT/DFE/LM01/0422v3

LG Code: WRDT/DFE/LM01/LG1/0422v3

LG1: Preparing and operating mud drilling equipment and mud pits

Date: April 2022

Instruction Sheet 1	Learning Guide #1	Preparing and operating mud drilling equipment and mud pits

This Learning Guide is developed to provide you with the necessary information regarding the following content coverage and topics:

LO1. Preparing and operating mud drilling equipment and mud pits

1.1 Identifying mud drilling equipment

1.2 Preparing mud pits

This Guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to

- Understand types and functions of mud drilling equipment
- Assemble and disassemble filter press
- Calculate mud pits volume
- Create a dimension sketch of mud pits

Learning Instructions:

1. There is a set of basic knowledge and skills that underpin performance related to the job in this Learning Guide. You are expected to go through all the parts to prepare yourself for operation and LAP test at the end of the Learning Guide.
2. Try to answer to "Self-check 1" to confirm your current knowledge. Leave any items blank that you cannot answer now, which is for you to learn in this Guide.
3. Read the information written in the "Information Sheets 1". Try to understand what is being discussed, and answer all items in "Self-check 1," including the items you could not answer when you tried for the first time. You may be tested using "Self-check 1" to confirm your understanding of the basics, before you are allowed to proceed to the training of job-related operations.
4. Repeat 2 and 3 above for the rest of the Guide until just before "Operation Sheet," to complete preparation of the basics.
5. Demonstrate "Operation Sheet," and conduct the LAP Test to complete the Learning Guide.

Date: April 2022

Self-check 1-1	Identifying mud drilling equipment

Name: _____ Date: _____

Time started: _____ Time finished: _____

Directions: Answer all the questions listed below. Use the answer sheet provided in the next page.

1-1. Write "T" if the statement is true or "F" if the statement is false.

1) Marsh funnel and Viscosity cup are used to measure resistance of fluid flow.
2) Mud balance is used to know the density of drilling fluids and solid.
3) Sand content test kit is measured as a percent of total fluid volume of particles retained on a 200-mesh sieve.
4) Filter presses is used to measure filtrate control and filter cake.
5) pH control indicates only acidity of a mud drilling make up water.
6) Sand content kit consists of special developed sieve with mesh size 0.08 mm (200-mesh).
7) Shale shakers are the most important and complex-to-use.
8) The primary purpose of a shale shaker is to remove as many drilled solids as possible with removing excessive amounts of drilling fluid.
9) The marsh funnel viscometer is a simple device used for quick measurements of fluid viscosity.

1-2. Fill in the blank space below.

1) Marsh funnel is used to measure _____
2) Sand content kit is used for_____
3) _____ is used to know hardness of calcium levels in the make-up water.

Answer Sheet

1-1: T/F

1	2	3	4	5	6	7	8	9

1-2: Fill-in-the-blank

1)

2)

3)

Information Sheet 1-1	Identifying mud drilling equipment

1.1 Mud Drilling fluid and Equipment

The general principle of mud rotary drilling is the same as that of air rotary drilling. The basic difference is that mud (the primary fluid) is substituted for air as a circulating medium.

The drilling rig is the same for both methods. In mud drilling, mud pump is attached to the drilling rig whereas air compressor is used in air drilling. However, in reverse circulation drilling, both mud pump and air compressors are used.

1.2 Mud Drilling Equipment and Tools

As in air drilling, drilling rig for mud drilling can be either table rotary (Kelly type) or top-head drive. For Kelly or rotary table rigs, the drill string is rotated from the rotary table. For top-head drive rigs, the drill string is rotated from the hydraulically operated top drive motor. The components of the rotary drilling machines are designed to serve two main functions simultaneously as below;

- Rotation of the bit
- Continuous circulation of the drilling fluid

The bit is attached to the lower end of the drill pipe, which resembles a long tubular shaft.

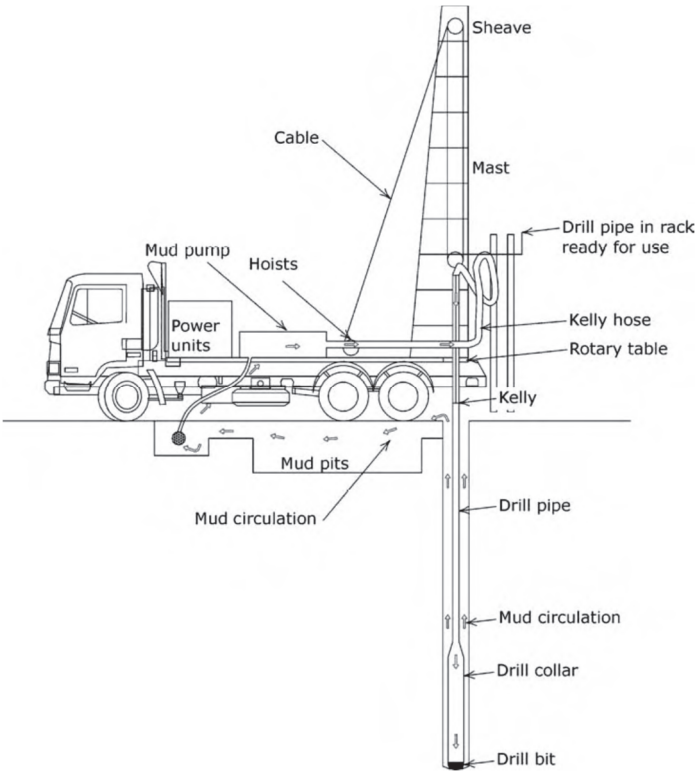


Figure 1: Arrangement of Mud drilling rig site

1.3 Testing Kit for Drilling Fluid

1.3.1 Marsh funnel

The marsh funnel is made of break-resistant plastic and has a fixed orifice with a specified diameter. A fixed mesh near the top across half the cone avoids the orifice getting blocked

by greater particles. The high-impact plastic measuring cup is designed specifically for use with marsh funnel.

Viscometer has scales in cubic centimeter and fluid ounces. The marsh funnel viscosity respectively has the funnel flow time scales based on the ratio of the speed of the sample fluid as it passes through the orifice to the amount of force that is causing the fluid to flow. The marsh funnel viscosity is reported as the number of seconds required for 500 cm^3 of sample fluid to flow out of a full marsh funnel.

Viscosity : The Marsh funnel viscosity is used for routine field measurement.

Figure 2: Marsh Funnel with Viscosity Cup

Viscosity is defined as the internal resistance of fluid flow. It is significant in affecting the lifting power of mud. Viscosity depends upon the concentration, quality, and dispersal of the suspended solids. In the field, Viscosity is measured as a timed rate of flow using a Marsh funnel. A certain volume of drilling fluid is allowed to drain from special funnel into cup. The flow time is recorded and calibrated against the time required for an equal volume of water to drain from the funnel which is about 19 seconds at 21.1°C.

Funnel viscosity (FV) is the ratio of the speed of the slurry as it passes through the outlet tube (shear rate) to the force (weight of the slurry) causing the slurry to flow (shear stress). Funnel viscosity is reported as the seconds required for one quart of slurry to flow out a full funnel.

Equipment used for measuring FV

- Marsh Funnel
- Measuring Cup (graduated)

Figure 3: FV testing kit

- Stopwatch
- Thermometer

Figure 4: Stopwatch

1.3.2 Mud balance

Density or Mud Weight - Mud balance is used to know the density of drilling fluids.

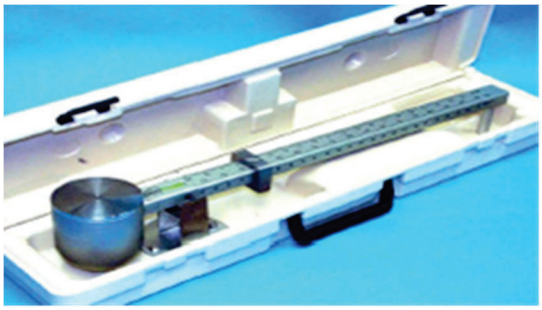


Figure 5: Mud balance

Density is weight per unit volume of mud and has a buoyant effect upon the particles. Increasing mud density increases its carrying capacity both by buoyancy and particles due to additional solids in interference.

Read the density of the drilling fluid at the edge of the sliding weight.

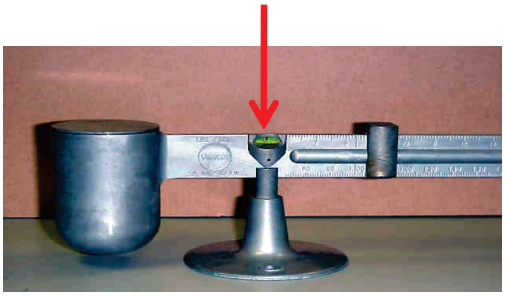


Figure 6: Mud balance with stand

1.3.3 Sand content text kit

The ***sand content*** of the drilling fluid defines sand-sized particles larger than 74 µm in size. The volume of sand, including that of void spaces between grains, is usually measured and expressed as volume percent. Sieve analysis is the preferred method for sand content

determination because of the reliability of the test and simplicity of equipment. Excessive sand may result in the deposition of a thick filter cake on the wall of the hole or may make the drilling tools stuck in the hole when circulation is stopped, thus, interfering with successful operation of drilling tools or setting of casings. High sand content also may cause excessive abrasion of pump parts and pipe connections.

Sand content kit consists of special developed sieve with mesh size 0.08 mm (200-mesh), a proper plastic funnel and a special modeled measuring tube. A mark at the measuring tube indicates the amount of the filled in drilling fluid. The percentage of sand may read off directly from the measuring tube graduated from 0 to 20%.

Sand content test kit is used to know the content of sands in the drilling fluids. It reports as percent by volume. Sand content is measured as a percent of total fluid volume of particles retained on a 200-mesh sieve.

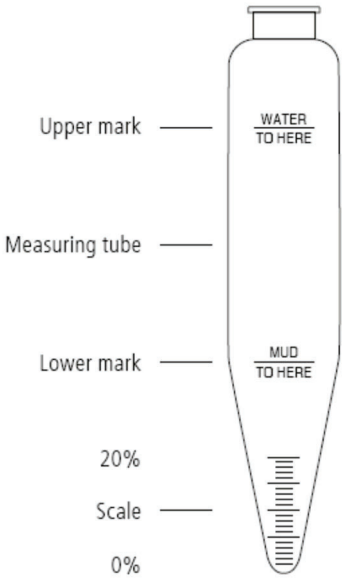


Figure 7: Measuring tube

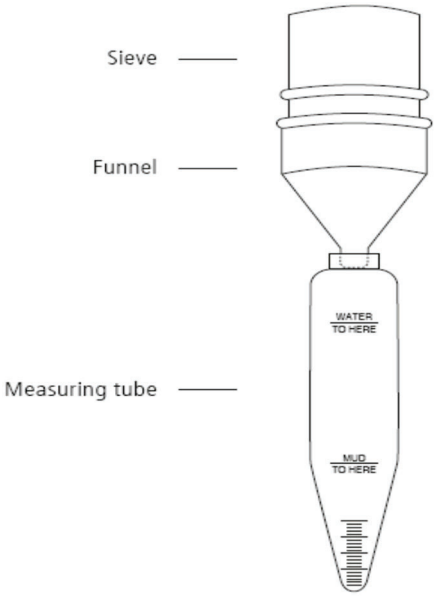


Figure 8: Arrangement of sand content test kit

Figure 9: Sand content kit

Figure 10: Gauge on measuring tube

1.3.4 Filter press

Filter press is used to measure filtrate control and filter cake. This fluid loss is to be measured in cc of filtrated volume of fluid after thirty minutes. The cake thickness is to be measured and recorded in mm.

Figure 11: Filter press kit

Figure 12: Hardened filter paper

1.3.5 pH

pH control indicates acidity or alkalinity of a fluid it measures with p-Hydroid paper or pH meter.

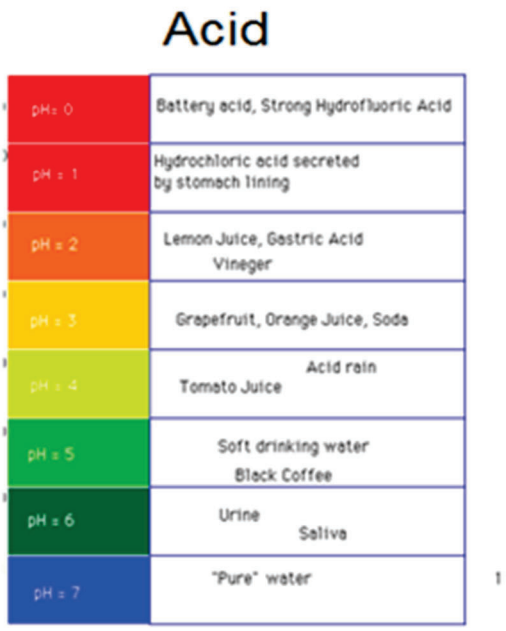


Figure 13: Color for acidity value

Figure 14: Color for alkalinity value

1.3.6 Dip hardness indicator strip

Dip hardness indicator strip is used to know hardness of calcium levels in the make-up water.

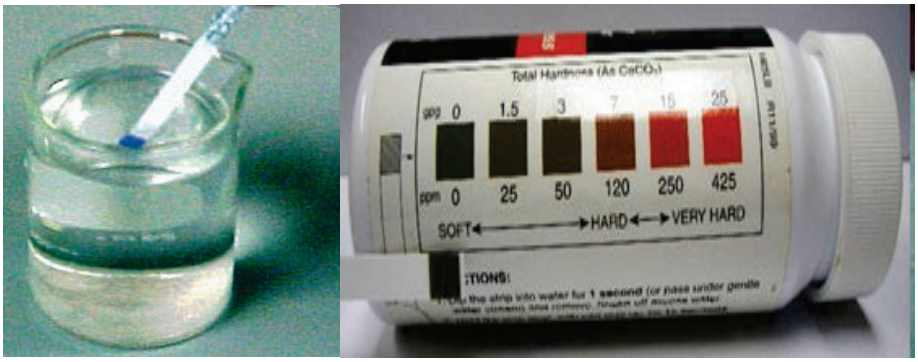


Figure 15: Dip hardness indicator strip

1.3.7 Mud shale shaker

Drilling shale shaker is the third generation of linear motion shaker. Mud shale shaker is using the horizontal excitation of vibration motor as vibration source. The material on the sieve was up forward for linear motion, referred to as Linear shaker. Drilling shale shaker is the most widely used mud shale shaker. All shaker screens can be fit on shakers by wedge blocks or hooks. Shale shakers are the most important and easiest-to-use solids-removal equipment.

How a shale shaker screens fluid?

The primary purpose of a shale shaker is to remove as many drilled solids as possible without removing excessive amounts of drilling fluid. These dual objectives require that cuttings (or drilled solids) convey off the screen while simultaneously most of the drilling fluid is separated and removed from the cuttings. Frequently, the only stated objective of a shale shaker is to remove the maximum quantity of drilled solids. Stopping a shale shaker is the simplest way to remove the largest quantity of drilled solids while this will also remove most of the drilling fluid. The size of drilled cuttings greatly influences the quantity of drilling fluid that tends to cling to the solids. If as much drilling fluid as possible is conserved, it can reduce the drilling costs.

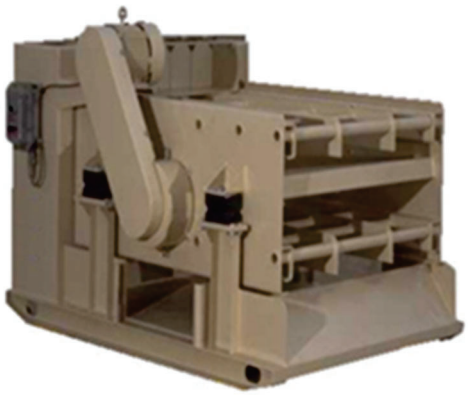


Figure 16: Elliptical motion type shell shaker

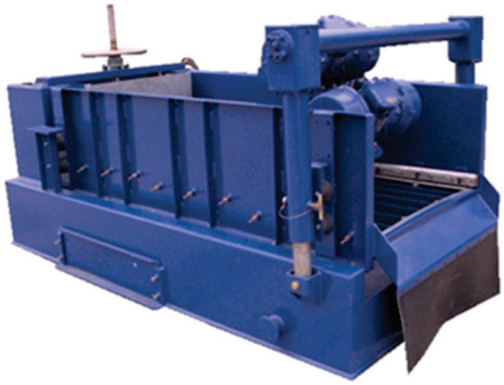


Figure 17: Linear motion type shell shaker

When the screen moves on the downward stroke, the large solids are suspended above the screen and encounter the screen at a farther point toward the discharge end of the shaker. This is the reason that the elliptical, circular, and linear motion screens transport solids.

Self-check 1-2	Preparing mud pits

Name: _____ Date: _____

Time started: _____ Time finished: _____

Directions: Answer all the questions listed below. Use the answer sheet provided in the next page:

2-1. Write "T" if the statement is true or "F" if the statement is false.

1) The mud pit location depends on the direction of mud pump inlet direction and the length of the suction hose of the mud pump.
2) Suction pits is to store adequate volume of drilling fluid and to act as effective settling basin for suspended cuttings.
3) Mud pit should have at least two pits; one settling pit and the other is suction pit.
4) Settling pit is excavated for the purpose of receiving mud returned from the well and allowing the solids in the mud to settle out.
5) The size of the mud pits is dictated by the volume of drilling fluid contained in the finished borehole.

2-2. Write short answers or fill in the blank space below.

1) What is the major importance of correct mud pit design?
2) _____ and _____ are the pits that are required to drill a borehole.
3) _____ is a mud tank or pit dug in the earth which mud is picked up by the suction of the mud pumps.
4) _____ is a pit that is dug in the earth for the purpose of receiving mud returned from the well and allowing the solids in the mud.
5) The volume of pit is _____to_____ times the volume of the finished borehole.
6) _____ is simply an inclined, gravity-flow conduit to direct mud coming out the top of the well bore to the mud surface-treating equipment.

Answer Sheet

2-1: T / F

1	2	3	4	5

2-2: Short answers & Fill-in-the-blank

1)

2)

3)

4)

5)

6)

Date: April 2022

Information Sheet 1-2	Preparing mud pits

2.1 Mud pits and settling tanks

In mud drilling, mud pit is used in some cases, and portable settling tanks are used in the place of mud pits. However, the most common mud pit is the dug mud pits at the drilling sites. Two or three pits are dug in the ground. One or two pits are used as settling pits for the drill cuttings removed from the hole by the circulating mud. Most drill cuttings are settled down in these pits. The second or third pit is used as the main pit, from which the mud pump sucks the mud to the drill line.

The mud pit location depends on the direction of mud pump inlet direction and the length of the suction hose of the mud pump. There should be appropriate space between the mud pit and the rig. Mud pit which is very close to the rig may result in the collapse of the rig as a result of the collapse of the mud pit. Thus, depending on the suction hose length and suction capacity of the mud pump, placing the mud pits as far away from the rig is appropriate.

Figure 18: Mud pit

Figure 19: Mud tank

Bentonite is mixed with water using a mixing funnel in the mud pit. From the mud pit, it is sucked through the suction line of the mud pump and delivered in the mud line connected to the swivel head of the drilling rig.

2.2 Design of mud pits

Drilling fluids, also referred to as drilling mud, are added to the well bore to facilitate the drilling process by suspending cuttings, controlling pressure, stabilizing exposed rock, providing buoyancy, and cooling the drill bit.

Flow line is simply an inclined, gravity-flow conduit to direct mud coming out the top of the well bore to the mud surface-treating equipment. When drilling certain highly reactive clays, the flow line may become plugged and require considerable effort by the rig crew to keep it open and flowing.

2.2.1 Correct mud pit design

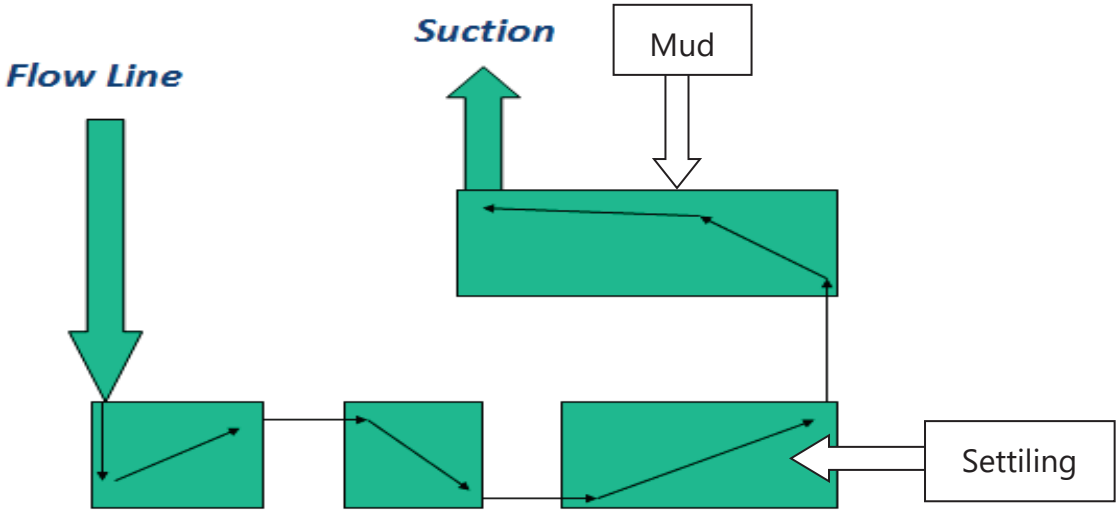


Figure 20: Correct mud pit design

Prior to the actual design of mud pit, some preparation work must be done. This preparation work includes pit volume calculation and drawing as per the recommended depth, excavation of the pit and facilitation of settling of solids.

- Excavate the pit as per the estimated depth
- Check the pit dimension
- Approve correct pit design

Drilling fluid is usually mixed adjacent to the drilling rig, in either portable or excavated mud pits. The principal objective of mud pits is to store adequate volume of drilling fluid and to act as effective settling basin for suspended cuttings.

2.2.2 Incorrect mud pit design

If the settling pit and suction pit are not separated, cuttings are not settled in the bottom of the pit, and they enter the bore hole again and regrind. As a result, it reduces the rate of penetration, loses circulation, and increases solid contained in the mud. Though this type of mud pit design could be found as traditional design in some places, it is not recommended and not adopted in the drilling industry.

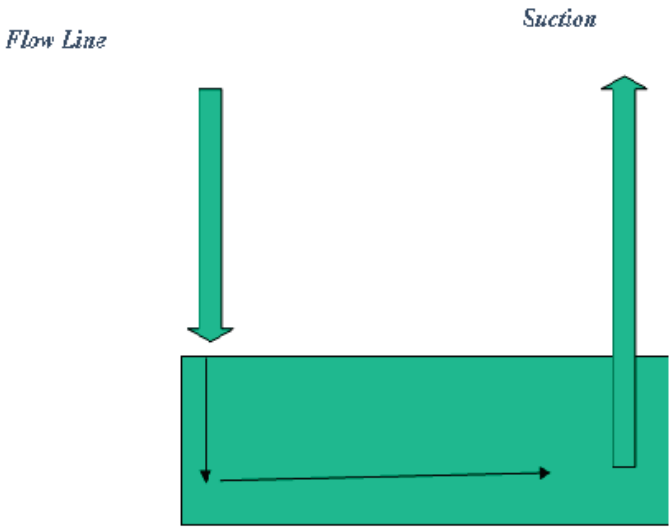


Figure 21: Incorrect mud pit design

2.2.3 Type and size of mud pit

(1) Type of mud pit

Suction pit :

A mud tank or pit dug in the earth where mud is picked up by the suction of the mud pumps. It is also called a suction pit.

Settling pit :

A pit that is dug in the earth for the purpose of receiving mud returned from the well and allowing the solids in the mud to settle out. Steel mud tanks are more often used today, along with various auxiliary equipment for controlling solids quickly and efficiently.

(2) Size of mud pit

The size of the mud pits is dictated by the volume of drilling fluid contained in the finished borehole and the need for a reserve volume which varies according to the rotary drilling system used. Usually, the volume of pit is 1.5 to 3 times the volume of the finished borehole. For mud rotary drilling, however, total pits volume should be preferably three times the volume of finished borehole in order to avoid the risk of fluid losses.

Each mud pit should have at least two pits; one is for settling and the second is for suction. The mud pit can be rectangular or trapezoidal in shape. Size of each mud pit should cover two times of the volume of the finished borehole for suction pit and one time for setting pit. In case the drilling depth is more than 300m, two setting pits and one suction pit should be considered for economical and realistic drilling site design.

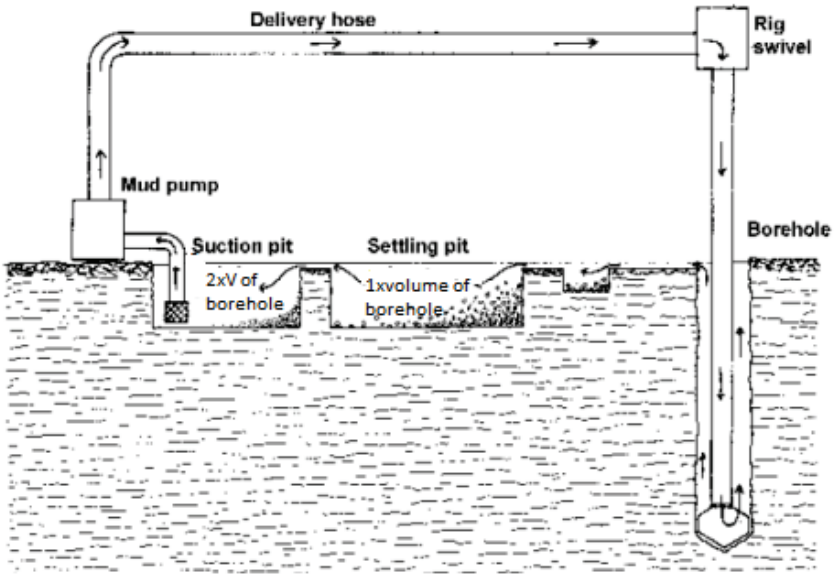


Figure 22: Arrangement of mud pits

Calculation of mud pit volume

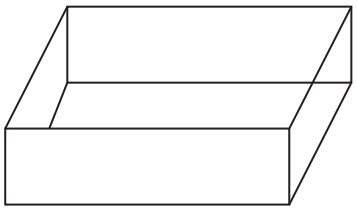
Borehole Volume $= \pi r^2 H$

Suction Pit Volume = 2 times of the Borehole Volume

Settling Pit Volume = 1 time of the Borehole Volume

For rectangular mud pit, the volume is calculated using the following equation.

Volume = Length * Width * Depth (H)



For efficient removal of suspended cuttings, the pit should be constructed in two sections; the settling pit and the suction pit.

Operation Sheet 1	Learning Guide #1	Preparing and operating mud drilling equipment and mud pits

Summary

This operation sheet includes the execution procedure of the identification and operation of mud drilling equipment as well as preparation of mud pit.

Task-1: Identification and operation of mud drilling equipment

Preparation:

- The learner(s) need to wear the required safety devices or clothes.
- Trainer prepares necessary equipment for the exercise.
- Though video can substitute an actual visit to the working machinery, the trainees will be exposed to as realistic situation as possible.

Instruction:

1-1 Trainer shows learners the following equipment and tools and explain the functions. After the explanation, identify each equipment and explain the functions by yourself.

- Marsh funnel
- Mud balance
- Shale shaker
- Filter press
- Sand content kit
- Other equipment and tools for mud rotary drilling

1-2 Trainers demonstrate how to disassemble filter press following the below steps. After the demonstration, disassemble filter press by yourself.

Step 1: Remove pressure regulator with T-screw
Step 2: Remove barrel in stand
Step 3: Tight out gasket from filter paper
Step 4: Tight out filter paper
Step 5: Tight out backing screen from base
Step 6: Tight out gasket in base

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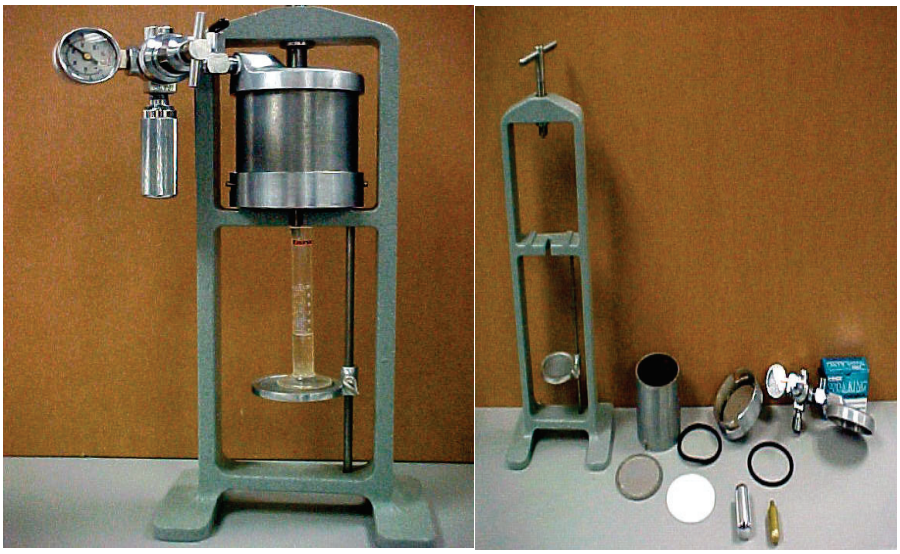


Figure 23: Disassembly of filter press

1-3 Trainers demonstrate how to assemble filter press following the below steps. After the demonstration, assemble filter press by yourself.

Step 1: Add 1st gasket in base  Figure 24	Step 2: Place backing screen in base  Figure 25
Step 3: Add filter paper  Figure 26	Step 4: Add the 2nd gasket above filter paper  Figure 27

Date: April 2022

Step 5: Add barrel

Figure 28

Step 6: Place barrel in stand

Figure 29

Step 7: Add pressure regulator assembly and tighten with T-screw

Figure 30

Once all above steps are completed, the filter press is ready to use for measuring filter control and filter cake by adding fluid.

Task-2: Preparation of mud pits

Preparation:

- The trainer shall distribute answer sheets to the learners before the exercise.

Instruction:

2-1 A well is going to be drilled in soft formation. The well is to be drilled for a depth of 100m and diameter of 10 inches. You are given the following instruction by trainer with necessary explanation and demonstration. Use the table below.

Source of table: Drilling technology textbook

Recommended Suction and Settling Pit Dimensions and Bore Hole Volume

BH diameter and Depth	Volume of Hole	Approximate Volume of Hole	Required Volume of Pit	Suction Pit Recommended Dimeter in Meter			Settling Pit Recommended Diameter in Meter		
MM(Inches) × Meters	M²	Liters	Liters	Length	Width	Depth	Length	Width	Depth
100(4")×25M	0.20	200	600	0.8	0.6	0.8	0.6	0.6	0.6
100(4")×50M	0.39	400	1,200	1.2	0.8	0.8	0.8	0.8	0.6
100(4")×75M	0.59	600	1,800	1.6	0.9	0.9	0.9	0.9	0.7
100(4")×100M	0.79	800	2,400	1.6	1.0	1.0	1.0	1.0	0.8
150(6")×25M	0.44	450	1,350	1.2	0.9	0.8	0.9	0.9	0.6
150(6")×50M	0.88	900	2,700	1.6	1.1	0.9	1.1	1.1	0.7
150(6")×75M	1.33	1,300	3,900	2.0	1.3	1.0	1.3	1.3	0.8
150(6")×100M	1.77	1,800	5,400	2.2	1.4	1.1	1.4	1.4	0.9
200(8")×25M	0.79	800	2,400	1.6	1.0	1.0	1.0	1.0	0.6
200(8")×50M	1.57	1,500	4,500	2.1	1.3	1.1	1.3	1.3	0.9
200(8")×75M	2.36	2,350	7,050	2.4	1.5	1.3	1.5	1.5	1.1
200(8")×100M	3.14	3,150	9,450	2.8	1.6	1.4	1.6	1.6	1.2
250(10")×25M	1.23	1,200	3,600	1.9	1.1	1.2	1.1	1.1	1.0
250(10")×50M	2.45	2,500	7,500	2.6	1.4	1.4	1.4	1.4	1.2
250(10")×75M	3.68	3,700	11,100	2.8	1.7	1.5	1.7	1.7	1.3
250(10")×100M	4.91	4,900	14,700	3.2	1.8	1.7	1.8	1.8	1.5

1) Calculate the volume of the required mud pit.

   For rectangular mud pit the volume is calculated using the following equation.
   *Volume = Length(L) * Width(W) * depth (H)*

   - **Suction Pit**
     Suction Pit Volume = 2 times of the Borehole Volume = 4.91m^3*2=<u>9.82 m^3</u>
   - **Settling Pit**
     Setting Pit Volume = 1 time of the Borehole Volume =4.91m^3*1=<u>4.91m^3</u>
   - **Borehole Volume** $= \pi r^2 H = \pi * 0.015625m^2*100m$=<u>4.91$m^3$</u>

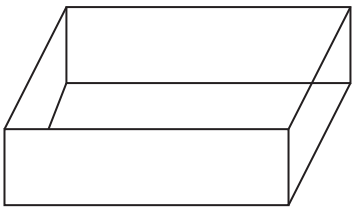
2) Create a sketch including the dimension of the mud pit using rectangular shape.

   - **Suction Pit**

   Length =3.2m

   Width =1.8

   Depth =1.7m



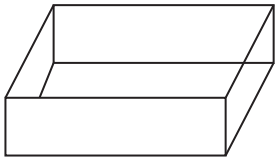
Date: April 2022

－ Settling Pit

Length = 1.8m

Width = 1.8m

Depth = 1.5m



2-2 A well is going to be drilled in soft and medium formation. The well is to be drilled for a depth of 50m and diameter of 6 inches. You are given the following instruction by trainer with necessary explanation and demonstration. Use the table on the previous page.

1) Calculate the volume of the required mud pit.

2) Create a sketch including the dimension of the mud pit using rectangular shape.

LAP Test 1	Learning Guide #1	Preparing and operating mud drilling equipment and mud pits

Task-1: Identification and operation of mud drilling equipment

Preparation:

- This task will be done individually by turn.
- The learner(s) need to wear the required safety devices or clothes.
- This LAP Test can be conducted either in a workshop with real equipment and tools, or in a machine site.

Instruction:

You will be displayed with drilling rig, auxiliary equipment, drilling tools and safety equipment. Follow the below instructions.

1-1 Demonstrate that you can identify each equipment's function by pointing where the followings are located.

- Shale shaker
- Filter press
- Mud balance
- Marsh funnel
- Sand content kit
- Other equipment and tools for mud rotary drilling

1-2 Disassemble and assemble filter press.

Task-2: Preparation of mud pits

Preparation:

- This task will be done individually by turn.
- The trainer shall distribute answer sheets to the learners before the exercise.

Instruction:

2-1 A well is going to be drilled in soft formation. The well is to be drilled for a depth of 75m and diameter of 8 inches. You are given the following instruction by the drilling trainer. Use the table below.

Source of table: Drilling technology textbook

Recommended Suction and Settling Pit Dimensions and Bore Hole Volume

BH diameter and Depth	Volume of Hole	Approximate Volume of Hole	Required Volume of Pit	Suction Pit Recommended Dimeter in Meter			Settling Pit Recommended Diameter in Meter		
MM(Inches) × Meters	M^2	Liters	Liters	Length	Width	Depth	Length	Width	Depth
100(4")×25M	0.20	200	600	0.8	0.6	0.8	0.6	0.6	0.6
100(4")×50M	0.39	400	1,200	1.2	0.8	0.8	0.8	0.8	0.6
100(4")×75M	0.59	600	1,800	1.6	0.9	0.9	0.9	0.9	0.7
100(4")×100M	0.79	800	2,400	1.6	1.0	1.0	1.0	1.0	0.8
150(6")×25M	0.44	450	1,350	1.2	0.9	0.8	0.9	0.9	0.6
150(6")×50M	0.88	900	2,700	1.6	1.1	0.9	1.1	1.1	0.7
150(6")×75M	1.33	1,300	3,900	2.0	1.3	1.0	1.3	1.3	0.8
150(6")×100M	1.77	1,800	5,400	2.2	1.4	1.1	1.4	1.4	0.9
200(8")×25M	0.79	800	2,400	1.6	1.0	1.0	1.0	1.0	0.6
200(8")×50M	1.57	1,500	4,500	2.1	1.3	1.1	1.3	1.3	0.9
200(8")×75M	2.36	2,350	7,050	2.4	1.5	1.3	1.5	1.5	1.1
200(8")×100M	3.14	3,150	9,450	2.8	1.6	1.4	1.6	1.6	1.2
250(10")×25M	1.23	1,200	3,600	1.9	1.1	1.2	1.1	1.1	1.0
250(10")×50M	2.45	2,500	7,500	2.6	1.4	1.4	1.4	1.4	1.2
250(10")×75M	3.68	3,700	11,100	2.8	1.7	1.5	1.7	1.7	1.3
250(10")×100M	4.91	4,900	14,700	3.2	1.8	1.7	1.8	1.8	1.5

1) Calculate the volume of the required mud pit.

2) Create a sketch including the dimension of the mud pit using rectangular shape.

Date: April 2022

List of Reference Materials

1. Driscoll, F. G, 1986. Groundwater and wells. Second edition, Johnson division, St. Paul, Minnesota 55112.
2. Peter Ball, 2001. Drilled wells. First edition: 2001. SKAT, Swiss Centre for Development Cooperation, in Technology and Management.
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4. Compressed air and Gas institute, 2002. Air Compressor Selection and Application 5th Edition.
5. SCHRAMM, Drill rig safety.
6. OHS Academy Course 902 Study Guide, 2013. Well site preparation and drilling safety. 2000 - 2014 Geigle Safety Group, Inc.
7. Anti-Entropics, Inc. Revision 1 – 09/2008. Environmental Remediation Drilling Safety Guideline. A summary of industry practices and techniques to help drillers enhance safety performance, environmental performance.

Date: April 2022

Ethiopian Water Technology Institute (EWTI)

Learning Guide #2

(For Learners)

Module Title: Utilizing drilling fluids for mud drilling

Module Code: WRDT/DFE/LM01/0422v3

LG Code: WRDT/DFE/LM01/LG2/0422v3

LG2: Measuring and maintaining mud drilling fluids

Date: April 2022

Instruction Sheet 2	Learning Guide #2	Measuring and maintaining mud drilling fluids

This Learning Guide is developed to provide you with the necessary information regarding the following content coverage and topics:

LO2. Measuring and maintaining mud drilling fluids

2.1 Identifying types and functions of mud drilling fluids
2.2 Identifying major properties, and measuring and maintaining drilling fluids
2.3 Identifying types and functions of drilling fluid additives
2.4 Identifying contamination prevention and treatment of mud drilling fluids

This Guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to

- Explain the types and functions of mud
- Apply drilling mud testing with proper equipment
- Identify drilling fluid additives
- Identify fluid contamination and maintenance
- Use tools and mixings/additives to measure/adjust mud drilling properties

Learning Instructions:

1. There is a set of basic knowledge and skills that underpin performance related to the job in this Learning Guide. You are expected to go through all the parts to prepare yourself for operation and LAP test at the end of the Learning Guide.
2. Try to answer to "Self-check 1" to confirm your current knowledge. Leave any items blank that you cannot answer now, which is for you to learn in this Guide.
3. Read the information written in the "Information Sheets 1". Try to understand what is being discussed, and answer all items in "Self-check 1," including the items you could not answer when you tried for the first time. You may be tested using "Self-check 1" to confirm your understanding of the basics, before you are allowed to proceed to the training of job-related operations.
4. Repeat 2 and 3 above for the rest of the Guide until just before "Operation Sheet," to complete preparation of the basics.
5. Demonstrate "Operation Sheet," and conduct the LAP Test to complete the Learning Guide.

Date: April 2022

Self-check 2-1	Identifying types and functions of mud drilling fluids

Name: _____ Date: _____

Time started: _____ Time finished: _____

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page.

1-1 Choose the best answer to the below questions.

1) What are the major functions of drilling fluid?
   a. Removing cuttings from the face of the drill bit
   b. Transporting cuttings away from the bit face and out of the hole
   c. Lubricating and cooling drilling tools
   d. All
2) What are the major types of drilling fluid?
   a. Water-based drilling fluid
   b. Oil-based drilling fluid
   c. Air-based drilling fluid
   d. All
3) What needs to be considered during the selection of drilling fluid?
   a. Geological formation; clay shell, sand, etc.
   b. Depth
   c. Drilling cost
   d. Diameter of borehole
4) What is the mixing order of drilling fluid?
   a. Water + Bentonite + Polymer + special chemicals if necessary
   b. Water + Polymer + Bentonite + special chemicals if necessary
   c. Bentonite + Water + Polymer + special chemicals if necessary
   d. Water + Bentonite + Polymer + special chemicals if necessary
   e. Special chemicals + Bentonite + Polymer + Water
5) What effects or situations could be expected during drilling in clay formation?
   a. Clay swells
   b. Diameter of the well gets smaller
   c. Difficult to insert productive casing
   d. All

1-2 Write “T” if the statement is true or “F” if the statement is false.

1) Any make-up water can be used for preparing drilling fluid.
2) Geological formation is not important factor for selection of drilling fluid.
3) It is possible to use both water-based and oil-based mud fluid for water well drilling.
4) Polymer can be used to increase viscosity and accelerate fluid loss to permeable formation.
5) The drilling fluid should deposit a thin, impermeable filter cake on the borehole.

Answer Sheet

1-1: Multiple choice

1)	2)	3)	4)	5)

1-2: T / F

1)	2)	3)	4)	5)

Date: April 2022

Information Sheet 2-1	Identifying types and functions of mud drilling fluids

General Overview

Drilling fluid is a critical component of many drilling jobs and can make the difference between successful completion of a drilling job and a failure or abandonment of wells. Using the right drilling fluid can reduce drilling time and costs. The most important characteristics of drilling fluids for a specific geology and drilling equipment are explained in this section.

Selection of Drilling Fluids

Several factors influence the selection of a drilling fluid for a particular job, including the geology to be encountered, quality of the water used to make the drilling fluid, as well as the type of drilling equipment, mixing equipment, and solids control equipment available.

1.2.1 Geology

The type of fluid system used for a specific drilling job ultimately depends on the type of geology to be encountered. This information is provided by a geologist based on the results of core samples taken in the area to be drilled. In many cases, a range of soil types are present, and the basic drilling fluid needs different additives to cope with changing soil conditions during the various phases of drilling.

Clay and Shale:

Clay has very low permeability (not much water can pass through it), but it can swell significantly when it is in contact with water. Swelling clay can reduce the diameter of hole, leading to higher pipe torque and drag, and stuck pipe. Clay does not need to swell in contact with water to cause problems; the presence of water wetting of non-swelling clay in the formation may cause them to slough (shed), which can lead to the collapse of hole.

Sand:

Sand is much more permeable than clay, and unconsolidated (loose) sand will flow when wet, leading to hole collapse. Filter cake formation by bentonite and filtration control agents stabilize the hole in the presence of sand. Sandstone, which is consolidated sand (sand cemented together to form rock), does not collapse like sand but can still be very permeable.

Gravel:

Gravel needs a drilling fluid with good suspension properties to transport the larger sized cuttings. It also tends to be very permeable, so additives to control the lost circulation may be necessary. The volume of drilling fluid required per meter of hole drilled also depends on the soil type. Clay requires around 3-5 times the volume of drilling fluid compared with sand (which requires around 1:1 ratio), because clay sucks up water which makes the slurry thick and hard to pump so that increased amounts of fluid are needed to maintain good slurry flow.

1.2.2 Water Quality

Clays and polymers used in drilling fluids are adversely affected by contaminants in water and will not work properly in poor quality water e.g., hard or salty water. The type of contamination and how to treat it is discussed in the section on drilling fluid components.

Drilling Fluid Components

Drilling fluid can be either water or oil based. The industrial drilling fluids sector uses only water-based fluids, so oil-based fluids (used in the oil and gas sector) will not be discussed here. In addition to water, a typical water-based drilling fluid contains clay, polymers, and specialty additives e.g., surfactants. In some cases, a weighting agent such as barium sulfate (barite) may be added to increase the density of the fluid. Lost circulation material (LCM) may also be added to plug fractures in the formation that drilling fluid can escape through, leading to the fluid disappearing from the hole and appearing elsewhere ('fracture out'). LCM can be fibers, swelling polymers, or material such as shredded paper.

Each of the chemicals that make up drilling fluid has specific requirements in term of pH, calcium hardness, length of time to fully hydrate etc. If chemicals are added in the wrong order, they will not work properly, and may require excess quantities to obtain desirable properties for drilling. The various components of drilling fluid are discussed in the following sections to help explain how the chemicals work in drilling fluid and why the order of addition is so important.

Clay (BENTONITE) :

The term clay is used to describe a varied group of fine-grained crystalline minerals e.g., montmorillonite and kaolinite. Clay consists of tiny plate-like crystals, with sizes ranging

from less than 0.5 micron up to 2 microns in diameter (micron = one millionth of a meter). Clay particles fall into a size category known as colloids, and the specific behavior of clay colloids in water is the reason for their widespread use in drilling fluid. Colloidal solutions are controlled by electrostatic surface charges that result in attractive or repulsive forces between the particles. Colloidal particles are often negatively charged so they repel one another in solution. The tiny size and charged surface of colloidal particles means that liquid suspensions of colloids are very stable over time and settle out very slowly unless de-stabilized by chemical treatment.

Water :

The water used to make a drilling fluid can have a huge impact on its final properties. Some drilling fluid chemicals, such as bentonite and certain polymers, work best in water with specific properties. If mud with poor quality water, 1) the mud may not perform the way it should, leading to problems with hole stability and cuttings transport, and/or 2) higher quantities of chemicals will be needed to produce a mud with the desired properties, which increases costs.

Polymers :

A polymer is a long chain molecule made up of many smaller molecules (monomers) linked together in various ways. There are a huge variety of polymers with a wide range of properties. They can be natural in origin, modified versions of natural polymers, or completely synthetic. Natural polymers are often obtained from plants e.g. starch, cellulose, and guar gum, and are used in food manufacturing to thicken many products e.g. yogurt. The term biopolymer is used to describe polymers made by organisms such as bacteria, rather than plants. Man-made polymers e.g. polyacrylamide, poly acrylate, polypropylene, and polycarbonate are used in a wide range of applications and can be used to make materials as diverse as pipes, clothing, water bottles, and contact lenses.

Mixing Order :

The order in which the various components of a drilling fluid are added is critical. The order of addition is as follows:

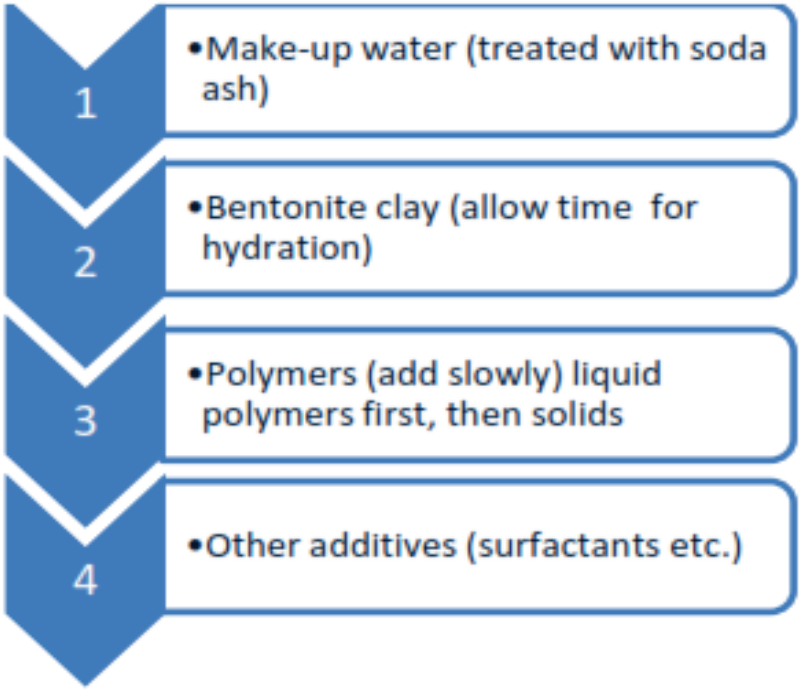

Figure 1: Mixing order of drilling fluid

Functions of Drilling Fluids

1.4.1 Major Functions of Drilling Fluid

The major functions of a drilling fluid are listed in the table below.

Table 1: Major functions of a drilling fluid

S/N	Functions	Purposes
1	**Transport cuttings away from the bit face and out of the hole**	Cuttings accumulating at the bit will slow the rate of penetration, increasing drilling time and costs. If cuttings are not transported efficiently from the hole, they accumulate around the drill pipe and it can become stuck (packing off), leading to costly delays and even loss of the hole.
2	**Suspend solids**	The fluid must keep solids in suspension while they are being transported and when the fluid is at rest (pump switched off), otherwise cuttings will drop out and accumulate in the hole.
3	**Control subsurface pressure**	The column of drilling fluid exerts a pressure on the formation, preventing fluid in the formation from entering the borehole and causing caving and collapse.

4	**Stabilize the borehole**	The drilling fluid should deposit a thin, impermeable filter cake on the borehole wall to reduce infiltration of water from the drilling fluid into the surrounding formation. Water entering the formation causes it to soften or swell, which can result in caving and sloughing which can lead to stuck pipe and borehole collapse.
5	**Cool the bit and lubricate the drill string**	Bits can be damaged by the high temperatures generated during drilling. Friction of the drill pipe against the wall of the bore increases the torque required to turn the bit and increases drag when the drill pipe is raised and lowered.
6	**Transmit hydraulic energy to down hole tools**	In some situations, down hole motors are used to rotate the bit; pressure from the drilling fluid powers the motor.
7	**Maximize information from sampling**	A suitable drilling fluid will help keep cores and cuttings in good condition, increasing sample recovery.

1.4.2 Functions of Polymers in Drilling Fluid

Drilling fluids use a narrow range of polymers that have specific functions useful for a drilling fluid. A polymer is selected to take advantage of a primary function e.g. filtration control, but polymers often have secondary functions that are not always beneficial. It is important to know what these secondary functions are so that their effects can be considered. For example, the addition of a polymer to reduce filtration loss may increase viscosity to undesirable levels, so the amounts of other polymers in the system may need to be reduced to keep viscosity at manageable levels. On the other hand, secondary functions are useful because we can often get a polymer to perform double duty e.g. clay stabilization (primary function) as well as filtration control (secondary function).

Major functions of polymer are described as below.

- Increase viscosity and solids suspension
- Reduce fluid loss to permeable formations (filtration control)
- Prevent clay or shale from swelling (shale stabilization)
- Lubrication (reduce friction)
- Gel strength
- Hole stabilization

Self-check 2-2	Identifying major properties, and measuring and maintaining drilling fluids

Name: _____ Date: _____

Time started: _____ Time fished: _____

Directions: Answer all the questions listed below. Use the answer sheet provided in the next page:

2-1 Choose the best answers to the below questions.

1) Why do we measure drilling fluid viscosity?
   a. To know the drilling fluid flow resistant
   b. To adjust the property of the drilling fluid to the desirable
   c. To know the fluid density
   d. a. and b.
2) What would happen if the density of drilling fluid is heavier than the standard?
   a. Lose circulation.
   b. Stuck drilling tools
   c. Form good mud cake on the borehole
   d. a. and b.
3) What material is required to weight the density to control sub-surface pressure?
   a. Barite /Barite sulphate
   b. Magnesium
   c. Sodium
   d. Calcium
4) What measures should be taken when the drilling fluid becomes flocculants?
   a. Add deflocculant
   b. Add waiter
   c. Add barite
   d. All
5) What material is required to stop filtration?
   a. Chemical
   b. Polymers
   c. Bentonite
   d. Water

2-2 Write “T” if the statement is true or “F” if the statement is false.

1) Solid control is one of the methods for desirable drilling fluid properties.
2) pH is not an important property for making drilling fluids.
3) Calcium bentonite is preferable than Sodium bentonite.
4) Standard viscosity of water is 19sec/1500 ml.
5) If the sand content is below 1%, it is the sign for wall collapse.
6) When drilling work stops due to a problem or to change the drilling tools, the fluid will not be settled in the well if the fluid has high gel strength.

Answer Sheet

2-1: Multiple choice

1)	2)	3)	4)	5)

2-2: T/F

1)	2)	3)	4)	5)	6)

Date: April 2022

Information Sheet 2-2	Identifying major properties and measuring and maintaining drilling fluids

2.1 Major Properties of Drilling Fluids

Drilling fluid has several properties that are important to its performance. These include density, filtration control, solids content, pH, and the levels of chemical contaminants. A drilling fluid is designed by a mud engineer to have a set of properties suited to an application.

The properties of the drilling fluid change during the drilling process because drilled solids and other contaminants build up in the mud. Drilling fluid additives like polymers are also removed from the system on drilled cuttings and need to be replenished. It is important that drilling mud properties are monitored so that adjustments can be made to the fluid as required. If this isn't done, the fluid can lose its effectiveness, resulting in problems such as slow rate of penetration, failure to clean the hole, and loss of hole stability.

2.1.1 Density

The density of a material is defined as the mass of a specific volume of that material. Density is expressed in a range of different units, including pounds per gallon (ppg), kg/m3, and specific gravity (SG).

The most common unit used for measuring density in drilling fluid is SG. The SG is defined as the density of a substance relative to water, which has an SG of 1 at 4°C.

Table 2: SG of common materials

Vegetable Oil	0.9-0.92	Barite	4.2
Water	1	Titanium	4.5
Alcohol (ethanol)	0.79	Iron	7.85

Density = Mass ÷ Volume

The density of a drilling fluid gives an indication of its solids content. The build-up of solids in drilling fluid is undesirable, causing several problems such as reduced rate of penetration, and wear and tear on equipment. Rate of penetration is affected more by density than any other drilling fluid property: higher density means slower rate of penetration, which means the hole takes longer to drill.

Rate of penetration is affected by differences between the hydrostatic pressure exerted by the mud column and the formation pressure. Increased mud density creates higher mud

hydrostatic pressure. As the mud pressure increases over the formation pressure, the freshly drilled cuttings are held in place (chip hold down pressure) rather than transported away by the flow of drilling fluid. This causes cuttings to be reground under the bit, reducing the penetration rate.

2.1.2 Viscosity

Viscosity is defined as the resistance of a fluid to flow. It originates because of internal friction within a fluid, which is caused by interactions between molecules that make up the fluid. We can easily see differences in viscosity by comparing the ease of pouring water (thin or low viscosity) and honey (thick or high viscosity).

Viscosity can be increased by adding viscos fires e.g. bentonite and polymers, and reduced by adding thinning agents e.g. water and thinners.

2.1.3 Gel Strength

The drilling fluid gel strength indicates how well the fluid will suspend drilled cuttings when stationary i.e. when the pump is switched off and circulation ceases. If the drilling fluid has too low a gel strength, the cuttings will drop out in the hole, which we don't want. On the other hand, high gel strengths are not desirable because they impede effective mud cleaning and require high pump pressures to get the fluid moving again.

2.1.4 Filtration

The hydrostatic pressure exerted by the column of drilling fluid on the formation usually prevents fluids in the formation from entering the hole, but the drilling fluid filtrate, which is the drilling mud minus the solids, can enter the formation and cause problems such as hole instability, caving, and collapse. For example, when clay is present in the formation, invasion of drilling fluid filtrate may cause significant swelling, leading to tight hole, higher pipe torque and drag, and differential sticking. For this reason, it is vital to deposit an effective filter cake on the wall of the hole to prevent/reduce filtrate from entering the formation.

A good drilling fluid will deposit a thin, tough, low permeability filter cake that stabilizes the hole and prevents or minimizes fluid loss to the formation; sodium bentonite clay particles will form this type of filter cake. The filter cake that forms should be thin because a thick filter cake decreases the hole diameter, which increases the contact area between the drill pipe and the formation as shown below. This is undesirable because it can cause tight hole, higher pipe torque and drag, and differential sticking. The factors affecting fluid loss include:

- Formation porosity, which is determined by geology e.g. sandstone is quite porous.

- Exerted pressure on the formation which depends on mud density and depth.
- Type of solids present, and their concentration, size, and shape: small, thin bentonite clay platelets form an effective filter cake, whereas drilled solids such as sand and silt particles disrupt filter cake formation, leading to higher permeability filter cakes and higher filtrate losses to the formation.
- Viscosity of the filtrate: the more viscous the filtrate, the slower it will penetrate the formation.
- Temperature: higher temperatures will reduce filtrate viscosity.

2.1.5 Properties of Makeup Water in Drilling Fluids

The water used to make a drilling fluid can have a huge impact on its final properties. Some drilling fluid chemicals, such as bentonite and certain polymers, work best in water with specific properties. If made with poor quality water, 1) the mud may not perform the way it should, leading to problems with hole stability and cuttings transport, and/or 2) higher quantities of chemicals will be needed to produce a mud with the desired properties, which increases costs. The most important properties of water with respect to drilling fluids are pH, hardness, and salinity.

2.2 Bentonite

2.2.1 Properties of Bentonite

The clay used in drilling fluids is sodium montmorillonite, commonly known as sodium bentonite, or just bentonite. Sodium bentonite has the properties shown in the table below. Most natural bentonite is in the form of calcium bentonite, which doesn't have the same desirable properties as sodium bentonite. The largest sodium bentonite deposits are found in Wyoming and other states in the USA and are of the highest quality.

Table 3: Properties of sodium bentonite

Properties of Sodium bentonite	Function in drilling fluid
Swells considerably in fresh water (hydrates), producing a viscous suspension that is shear thinning.	Viscosity; filtration control
Slurry capable of suspending solids (gel structure).	Increase cuttings carrying capacity of moving fluid and suspension capacity of stationary fluid
Excellent sealing ability (low permeability).	Bore hole stabilisation; filtration control
High specific surface area	Small amounts needed to produce desirable properties

Bentonite clay platelets are flexible and very thin, only a few nanometers (nano = one billionth of a meter) thick. They have a 3-layer structure as shown in the figure below. Their crystal structure means they have permanent negative charges on their top and bottom surfaces and either positively or negatively charged edges, depending on the pH of the clay suspension.

2.2.2 Hydration and Swelling

The negative charge on the face of bentonite clay platelets attracts positive ions to the clay surfaces e.g. predominantly sodium ions (Na+) in the case of sodium bentonite, and calcium ions (Ca+2) for calcium bentonite. The reason calcium bentonite doesn't swell to the same extent as sodium bentonite is due to the +2 charge on the calcium ion.

When clay is dry, it is in the form of aggregates of clay platelets stacked together like packs of cards as shown in the figure above. When the clay is placed in water, the stacks of platelets begin to hydrate and swell to varying degrees, because water is attracted to both the negative clay surface and the positively charged ions in between the layers. Because the calcium ion has a +2 charge, it strongly attracts two different negative platelet surfaces (see figure on the next page), holding them together and limiting the amount of water that can enter, which reduces the amount of swelling that can take place.

Sodium ion, with just one positive charge, can only interact with one platelet at a time, so it doesn't interfere with swelling, and sodium bentonite can swell to the extent that the individual platelets become completely separated (dispersed). This greatly increases its surface area and colloidal activity, which has a large effect on viscosity and other properties.

Bentonite is often referred to in terms of its yield value, which is the number of barrels of clay slurry of a specific viscosity (15 cp) yielded when one ton of clay is added to freshwater.

The large difference between sodium and calcium bentonite yields is due to the difference in the degree of swelling as discussed above. Often sodium bentonite is treated with polymer to increase its yield, so that less product is needed to achieve the same viscosity compared with pure sodium bentonite.

The grind size of the bentonite also affects the yield, with finer grind sizes hydrating more quickly to produce the maximum yield. Very high yield bentonites are often used as 'one sack' systems, but if other polymer additives are required e.g. to stabilize clay, the viscosity may become too high. A lower yield bentonite may therefore be more suitable as a base to build on in such cases.

Bentonite needs adequate mixing and time to swell/hydrate to its full potential which will produce the viscosity and filtration control properties we are looking for in a mud. Usually, about 20 minutes is required after adding the bentonite to the mixing system, although this depends on the type of bentonite and its grind size.

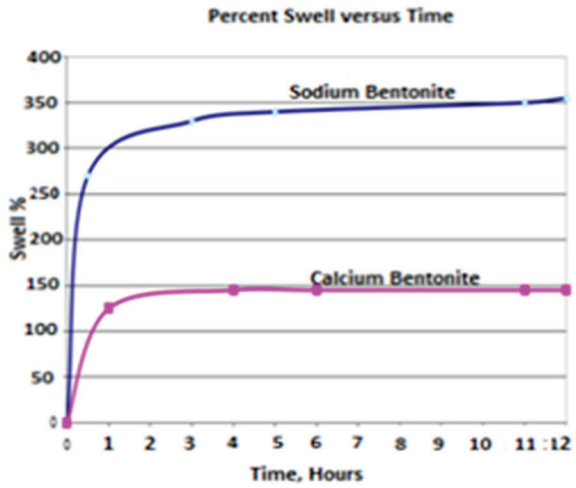

Figure 2: Percent swell versus time

As shown in the graph on the left, most of the swelling takes place within the first hour. Note the large difference between sodium and calcium bentonite. Sodium bentonite continues to swell at a slower rate over the next 8 hours or so before leveling off. Bentonite needs to be well mixed to obtain efficient hydration, because this helps mechanically separate the aggregates of platelets, speeding up the process of hydration. If the bentonite isn't mixed properly initially, the rate of hydration will be slower, and the drilling fluid will develop its properties over a longer period. This may lead to excess bentonite being added by operators to obtain a desired viscosity quickly, which can result in a large increase in viscosity occurring once the bentonite fully hydrates, especially if it is left to sit overnight. The mud may then require dilution or treatment with thinners to reduce viscosity to manageable levels.

2.2.3 Filtration and Lubrication

The thin flexible bentonite platelets with their coating of water provide excellent lubrication on the walls of the borehole, reducing friction between the wall and drill pipe. Because they are so thin, the platelets lie flat and overlap to produce a thin filter cake with very low permeability that limits fluid loss to the formation. Calcium bentonite does not disperse into separate platelets as sodium bentonite does but remains aggregated in thicker packets of platelets. The aggregated platelets do not form the thin, low permeability filter cake that sodium bentonite does, so fluid loss is higher for the same concentration of clay.

2.2.4 Flocculation

The forces acting between clay particles in solution are either attractive or repulsive. The balance between these forces determines which will dominate, which in turn depends on the nature of the chemicals present. For bentonite in fresh water and at alkaline pH, the forces

between clay platelets are mostly repulsive, so the clay suspension is dispersed. At more acidic pH, there are more positive charges on the clay platelet edges and there is more edge-face association (see figure opposite), but the overall attraction is still repulsive, and the clay suspensions do not settle.

Flocculation occurs when the strong repulsive forces keeping particles dispersed are neutralized to some degree so that the particles can move closer together. This can happen in a number of ways. For example, if we add a chemical that ionizes in water i.e. forms positively and negatively charged particles, e.g. sodium chloride (in salt water), these ions can screen some of the negative charges on the clay particles so they feel less repulsion and can move closer together. As the clay particles move closer together, attractive forces begin to dominate and the clay particles flocculate (come together). The flocculated particles adversely affect the properties of bentonite-based mud. These structures can include loose associations of clay particles (flocs) big enough to drop out of suspension. In relatively concentrated clay suspensions, as in drilling fluid, flocculation tends to produce a continuous gel-like structure rather than flocs.

The formation of this continuous gel structure has a large effect on funnel viscosity, yield point, and gel strengths, causing them to increase to undesirable levels. Increased fluid loss to the formation occurs because the clay particles can form large numbers of face-edge associations (house of cards structure) that prevent the platelets lying flat and forming a thin impermeable filter cake. Instead, the cake becomes thick and highly permeable. Thick cakes can cause stuck pipe because of the reduction in hole diameter, and the increased filtrate loss to the formation can destabilize the hole. The production of larger 'flocs' that settle out of suspension usually occurs when specific flocculants are added to drilling fluids e.g. certain polymers (these will be discussed in the next section).

There are degrees of flocculation, with the severity depending on the nature and concentration of the contaminants. Mild flocculation is likely to occur in most drilling fluids because of the presence of soda ash and other additives. As shown in the figure on the previous page, aggregation (face to face association) of platelets can occur when high concentrations of salt e.g. KCl are added to bentonite mud. Aggregation will cause a large decrease in viscosity and gel strength because of the decrease in surface area and lower numbers of separate platelets.

2.2.5 Deflocculation

Flocculation can be reversed by adding a deflocculant, or thinner. Thinners are chemicals containing a number of negative charges (polyanions) e.g. polyphosphates and anionic polymers. When added to a flocculated system, the thinner attaches to the edges of the clay particles, increasing the amount of negative charge which causes the clay particles to repel one another and disperse. Too much thinner will destroy gel strengths and carrying capacity of bentonite mud, so only small quantities are needed, and overdosing is not recommended. Excess thinner can also disperse clay particles in the cuttings, which will make them impossible to remove by solids control equipment, adding to the solids burden of the mud.

2.3 Polymers

2.3.1 Properties of Polymers

The wide variation in polymer properties comes about as a result of differences in molecular weight, structure, charge, and the type of chemical groups present on the polymer chain.

2.3.2 Molecular Weight

Molecular weight is the weight of a molecule of a specific substance and is the property that sets polymers apart from other substances—polymers are very large molecules. Most polymers used in drilling fluids are described as water soluble. Because of the large size of polymers, they form colloidal solutions in water just as clays do. The polymer chains strongly attract water and hydrate (swell), and then disperse into individual polymer chains. A polymer must hydrate fully before it will produce the results, we are looking for e.g. viscosity or fluid loss control. The higher the molecular weight of a specific polymer, the longer the polymer will take to hydrate. High molecular weight polymers can be broken down to smaller sizes by high energy mixing equipment because the polymer chain breaks at weak points in its backbone; this is known as shear degradation and will reduce the viscosity of the polymer.

2.3.3 Structure

Polymers can have a wide range of structures, and can consist of mixtures of different structures, but there are 3 basic types:

The structure of a polymer affects how the polymer chain behaves once it is hydrated. This is called its solution conformation (shape). Branched polymers (BARAZAN, NO SAG) generally produce higher viscosity compared with linear polymers (PAC, PHPA) of similar molecular weight. Highly cross-linked polymers can swell to many times their original size (e.g. DIAMOND SEAL) but do not dissolve because there are no individual polymer chains; instead many chains are connected together to form a solid mass.

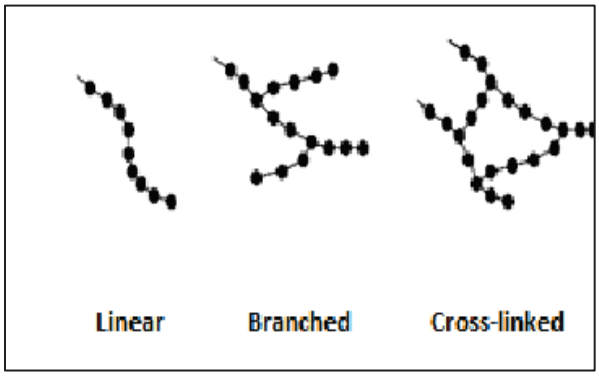

Figure 3: Structure types of polymers

2.3.4 Fluid Loss

Polymer can act as a 'sealant' in filter cakes made of clay platelets, producing a tighter and less permeable cake that further reduces fluid loss to the formation. Polymers of low to medium molecular weight work best as filtration control agents because their size lets them bridge effectively without leaving large numbers of void spaces. The PAC polymers are effective filtration control agents.

2.3.5 Physical Forms of Polymers

Polymers come in 3 forms: DRY POWDER: 100% active polymer. Powders need adequate mixing and hydration time. In some cases, dispersants are added to make the polymer easier to dissolve (QUIK MUD GOLD).

LIQUID DISPERSION: 40-50% active polymer; allows polymer to be added faster than for powders, but still require time to hydrate.

EMULSION: A suspension of polymer and surfactant in oil, usually containing 25-50% active polymer. The surfactant allows the emulsion to undergo inversion when placed into water. Emulsions require sufficient mixing to break the so the polymer can start hydrating.

2.4 Property Control / Measuring the Drilling Fluids

2.4.1 Control of Makeup Water

The most important properties of water to be controlled with respect to drilling fluids are pH, hardness, and salinity.

pH :

The pH of a fluid is a measure of its acidity or alkalinity. The pH scale ranges from 0-14, with a pH below 7 defined as acidic, pH=7 as neutral, and a pH greater than 7 as alkaline. The pH of pure water is 7, but carbon dioxide from air dissolves in the water, making it slightly acidic, while the presence of mineral impurities (e.g. calcium) increases the pH above 7.

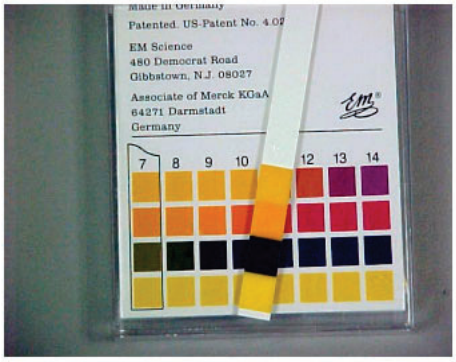

Figure 4: pH strip showing pH = 9

The pH of a liquid can be measured using a pH strip, pH paper, or a pH meter. The pH strip is the most widely used method for measuring pH in the field; it is cheap, easy to use, accurate, and reliable. The strip changes color depending on the pH, and is simply dipped into the solution, then removed and the colors matched to those on the box. For drilling fluids, the desirable pH range is 8.5-9.5.

If the make-up water pH isn't in this range, it can be easily and cheaply treated with soda ash (sodium carbonate) to raise the pH. Usually, 0.5-1 kg of soda ash per 1000 L of water is enough, but it depends on the starting pH What happens if the pH of the water is too high? Uncontaminated water shouldn't have a pH above 9, so too high a pH is unlikely. If the high pH results from adding too much soda ash, the make-up water can be diluted with untreated water to bring the pH into range. Soda ash can only raise the pH to a maximum of around 10.5, no matter how much is added, but too much soda ash (or any dissolved ions) can affect bentonite properties, so large excesses should be avoided. Adding some soda ash and then checking the pH before adding more is the way to avoid overdosing. Using sodium hydroxide (caustic soda) instead of soda ash could easily produce a pH that is too high (around 14) and detrimental to polymers. Caustic soda should not be used instead of soda ash.

Hardness :

Hardness in water usually refers to the concentration of dissolved calcium (Ca2+) and magnesium (Mg2+) ions but can include other metal ions. These ions enter the water supply by leaching of minerals from rock e.g. limestone and sediment in aquifers. Rainwater, distilled water, and de-ionized water don't contain these ions and are referred to as 'soft'. Most people are familiar with the effects of hard water on the properties of

soaps and some detergents, causing them to produce less foam or lather and to leave a layer of scum in sinks or on clothing.

The reaction of detergents and soap with calcium and magnesium ions in water means some of the detergent will be taken out of commission, so we need to add excess product to account for this. The properties of bentonite clay, and anionic (negatively charged) surfactants and polymers used in drilling fluids are also adversely affected by water hardness. We need to use more clay and polymer in hard water for the same reason we need to use more washing detergent. Only polymer, surfactant, or clay mostly free of calcium and magnesium ions works as it should, so the harder the water is, the greater the excess of product needed, and the higher the cost of drilling the hole.

Hardness is usually reported as equivalent calcium carbonate (CaCO3) in parts per million (ppm) or milligrams per liter (mg/L), which are equivalent. This represents a small concentration: 100 ppm is equivalent to 0.01%. Hardness classifications are listed in the table below. A hardness concentration < **100 ppm** is recommended for make-up water to avoid lowering the effectiveness of susceptible drilling fluid components.

In the field, hardness is usually measured using strips like those used for pH measurement. The hardness strip changes color depending on the amount of calcium present, and the result is reported as equivalent calcium carbonate (CaCO3) in ppm or mg/L.

If the make-up water to be used is hard, it can be treated with soda ash to reduce the hardness. Around **0.5-1 kg of soda ash per 1000L** of water should effectively reduce hardness to acceptable levels. Soda ash reacts with calcium ions to produce insoluble calcium carbonate, which can no longer react with the clay and polymers. Because soda ash is used to reduce hardness as well as to raise pH, it is one of the cheapest and most useful chemicals to have on site. Significant cost savings are achieved by treating make-up water with soda ash to avoid having to use excess bentonite and polymer, which are far more expensive.

Salinity

Water salinity is due to the presence of a range of dissolved salts. Chloride ion (Cl-) is often dominant, and mainly due to the presence of sodium chloride (common table salt), although magnesium, calcium and other chlorides may be present. Salinity is usually reported as sodium chloride in parts per million (ppm) or milligrams per liter (mg/L). High salinity affects clay and some polymers adversely; certain types of polymers will not hydrate properly, and bentonite clay will flocculate.

WATER HARDNESS CLASSIFICATION	
Classification	Concentration (as Calcium Carbonate) mg/L
Soft	**< 75**
Moderately hard	**75-150**
Hard	**150-300**
Very hard	**>300**

WATER SALINITY CLASSIFICATION	
Classification	Concentration (as sodium chloride) mg/L
Fresh	**< 100**
Brackish	**500-30 000**
Seawater	**30 000-50 000**
Brine	**> 50 000**

Figure 5: Water hardness and salinity classifications

Salinity can be measured using a test strip, titration (a chemical test), or a conductivity meter. In the field, most operators do not routinely measure salinity. Mud engineers use a strip or do a titration to determine chloride, while a laboratory would use a conductivity meter. Make-up water salinity should be less than **500 ppm**. Unfortunately, it isn't possible to lower salinity by any simple method other than dilution with fresh water. If an alternative water supply can't be located, a salt tolerant drilling fluid system will need to be used.

2.5 Control of The Critical Properties of Drilling Fluid

2.5.1 Density

A mud balance is used to monitor the density of drilling fluids in the field. It is a simple piece of equipment that is quick and easy to use. Monitoring mud density is important for many reasons. If mud density becomes higher than is needed to balance formation pressures, the formation can be fractured. Mud density also provides feedback on the effectiveness of mud recycling equipment. In situations where a mud weighted with barite is being used to control subsurface pressures, monitoring the mud density is extremely important to ensure the correct mud weight is maintained.

Figure 6: Mud balance

2.5.2 Viscosity

In the field, viscosity is usually determined using a Marsh funnel, which measures the time in seconds taken for a quart (500ml) of drilling fluid to flow through a specially designed funnel; the units are given in seconds per quart. A typical water-based drilling fluid has a marsh funnel viscosity of **27-32** sec/quart; water has a Marsh funnel viscosity of 19 sec/500 quart. The Marsh funnel only measures how viscous the mud is, so it only detects whether the mud is thicker or thinner.

Figure 7: Marsh funnel and cup

Viscosity versus Carrying Capacity：

Just because a fluid has a high viscosity, it does not necessarily mean it will have yield point or gel strength adequate to carry and suspend cuttings. This is true for certain polymers used as drilling fluids, which are discussed later. While intuitively it may seem that a high viscosity is needed to suspend cuttings, this is not the case. High viscosity fluids require higher pump pressures to circulate them, which increases wear and tear on pumps and can damage the formation, so keeping the viscosity as low as possible while maintaining adequate YP and gel strength is the goal.

Figure 8: Filter press

2.5.3 Filtration Control

The API filter press (right fig.) is used to measure fluid loss, usually over a 30-minute period. Filter cake thickness is also measured. The API filtration test is a static test, and its results cannot accurately predict down-hole conditions, which are dynamic, but it can monitor trends in filtration control, and is the only practical test for measuring control of filtration in the field. Measurement of the filter cake thickness from the API filtration test can be useful when problems such as tight hole and differential sticking occur.

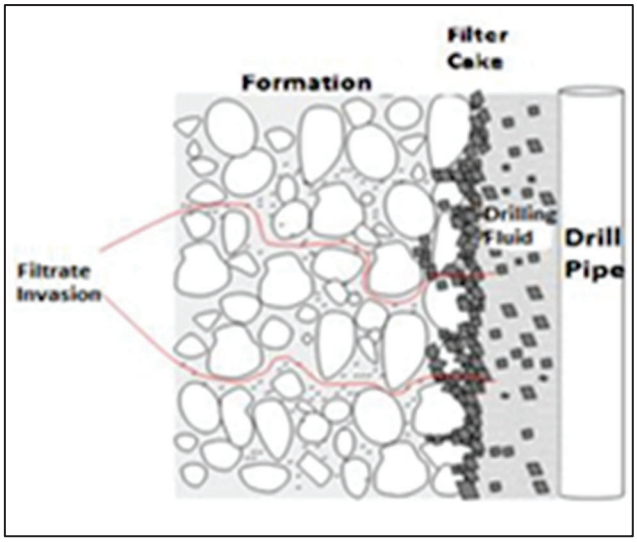

Figure 9: Filtrate invasion

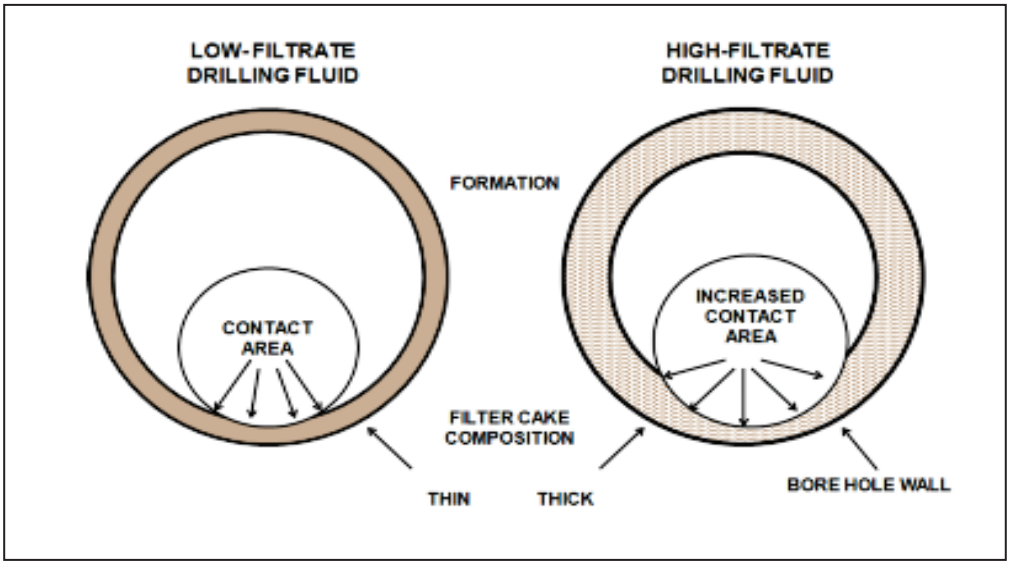

Figure 10: Filter cake thickness

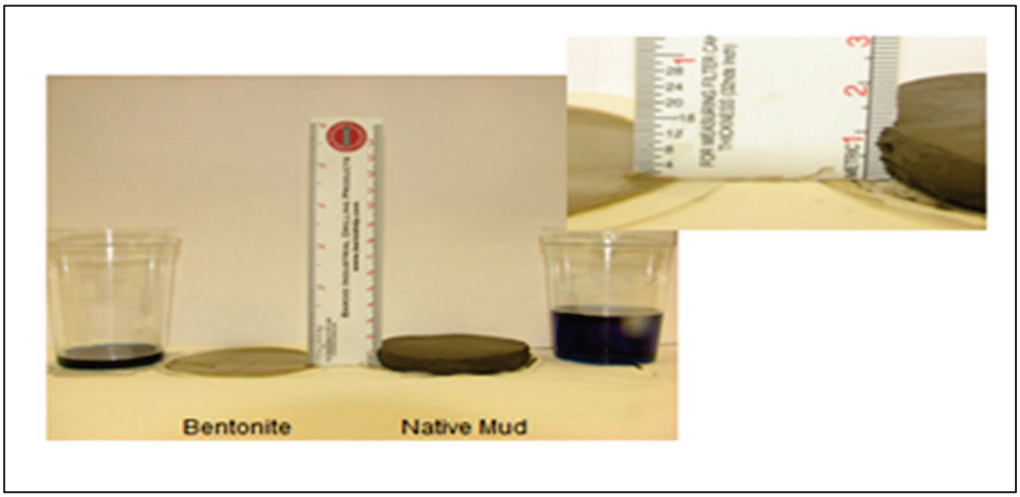

Figure 11: Filter cake deposition and thickness

Date: April 2022

2.5.4 Sand Content

As already mentioned, solids build up in drilling fluid is undesirable for many reasons, including increased density. Sand, defined as particles greater than 74 microns in size, is extremely abrasive and can cause a large amount of damage to pumps and other equipment. The sand content of drilling fluid should be maintained at less than 1%. Sand content can be easily monitored using a sand content kit.

Figure 12: Sand content measuring kit

Self-check 2-3	Identifying types and functions of drilling fluid additives

Name: _____ Date: _____

Time started: _____ Time fished: _____

Directions: Answer all the questions listed below. Use the answer sheet provided in the next page:

3-1 Write "T" if the statement is true or "F" if the statement is false.

1) Loss of circulation can be avoided by making the drilling fluid thick with Bentonite.
2) Polymers like AQUA-CLEAR PFD and polyphosphates can reduce viscosity.
3) Barite is one of thinning materials.
4) Addition of surfactant into drilling fluid helps to reduce penetration rate.
5) lubricating the drilling tools is one of the functions of drilling fluid.
6) We can avoid loss of circulation by adding more bentonite to the system.
7) Weighting material should be added when drilling fluid is become thin.

Answer Sheet

3-1: T / F

1)	2)	3)	4)	5)	6)	7)

Information Sheet 2-3	Identifying types and functions of drilling fluid additives

3.1 Drilling Fluid Additives

Specialty additives aimed at specific applications or to solve various problems e.g. bit balling. A general overview of the different chemicals and products is given in the following sections.

3.1.1 Lost Circulation Material (LCM)

Lost circulation occurs when whole drilling fluid is lost (either partially or completely) to the formation. Lost circulation can happen for several reasons including:

- The formation being drilled contains fractures or caverns.
- The formation is highly permeable (unconsolidated sand and gravel).
- Formation fractures have been caused by pressure imbalance i.e. hydrostatic pressure exerted by the mud is greater than the formation pressure usually due to high mud density, or high surge and swab pressures caused by quickly pulling drill pipe in and out of the hole.

The most obvious signs of lost circulation include reduced, or no fluid returns often accompanied by a reduction in weight on bit and/or loss of pump pressure. Early detection and treatment of lost circulation is extremely important. Lost circulation material (LCM) is used in highly porous formations and those containing fractures and voids to prevent or reduce loss of whole fluid to the formation. LCM plugs fractures and provides a matrix for filter cake development.

If geotechnical logs indicate the presence of fractured or permeable formations, LCM should be on site in case it is needed. LCM can also be added as a preventative (if fractures etc. are known to be present) to avoid losses occurring in the first place, but this increases the costs of drilling and can cause problems due to increased circulating density.

LCM is usually added as a ‘pill’ which is placed down the drill pipe in relatively high concentration. It is not generally added to the whole mud system because it can cause blockages and increases circulating density. N-SEAL fiber can be added to the circulating mud system with minimal effect on fluid properties.

3.1.2 Thinners

Polymers like AQUA-CLEAR PFD and polyphosphates act in a similar way to reduce viscosity. They attach to the edges of clay particles, reducing attractive forces between them which results in dispersion and lowered viscosity.

3.1.3 Water Well Development and Remediation

Well development is the process of removing waste material and enhancing the flow of desired fluids into or out of the well, depending on its end use. The process of drilling and installing a well can leave residual bentonite clay from drilling fluid on the surrounding formation which can cause loss of porosity and permeability, leading to decreased well yield. Thinners (AQUA-CLEAR PFD) are used to disperse residual drilling fluid so it can be flushed from the well.

Well remediation can be defined as restoring a well to its most efficient condition by mechanical and/or chemical means. Well maintenance and rehabilitation generally address declines in well production, water quality, and increased energy costs. Declining well yields are often caused by flow path blockages, which can be caused by the following:

Mineral Scale :

e.g. carbonate manganese and iron scale.

Bacteria :

Slime forming bacteria e.g. iron reducing bacteria are the most common cause of problems because they grow on the pump and well screen and within the surrounding aquifer formation, producing large amounts of brown slimy coating (biofilm) that can have a dramatic effect on water well efficiency.

Silt and Clay Accumulation :

Can be due to insufficient or lack of gravel pack, poor screen design and/or placement, severely corroded screen, insufficient initial well development, high production velocities, and on/off cycling.

Wells are usually plugged by a combination of chemical, biological and physical causes. Scale and bacterial flow path blockages can be successfully treated with chemicals.

3.1.4 Weighing Material

Weighting materials are used to increase the density of drilling fluids and to control formation pressure. Barium sulfate (barite), which has an SG of 4.2, is widely used to weight drilling fluid for the following reasons:

- High specific gravity provides increased fluid density with minimum solids.
- Controls formation pressures.
- Chemically inert and free from corrosive and abrasive material.

Sufficient gel strengths must be developed with bentonite (i.e. full hydration) prior to addition of barite, otherwise the barite will not be held in suspension.

3.1.5 Wetting Agents

Wetting agents are surfactants and can be anionic (negatively charged), cationic (positively charged), or non-ionic (no charge); most drilling fluid surfactants are anionic or non-ionic. Wetting agents have several functions in the industrial drilling sector:

- Reduce bit balling and booting-off
- Counteract clay stickiness
- Change the surface tension around clays / metals
- Increase rate of penetration

Bit balling occurs when drilling through clay or shale. The cuttings absorb water from the drilling fluid and swell, sticking together and to the bit rather than being carried away by the drilling fluid. The problem tends to be worse when drilling quickly through clay, because even if an inhibitive drilling fluid is being used, the drilling fluid to clay ratio may be too low, resulting in a very thick mixture of clay and fluid that can become very sticky. Bit balling has several adverse effects:

- Reduced rate of penetration (sometimes to zero).
- Blocking of bit nozzles, reducing flow of drilling fluid around the bit, which makes bit balling even worse.
- With roller cone bits, individual rollers may stop rotating, leading to excessive shear and bit tooth wear.

Wetting agents are used to reduce the tendency for bit balling to occur. Anionic wetting agents preferentially interact with clay to reduce its tendency to stick together. Non-ionic wetting agents (PENETROL) preferentially interact with metal surfaces, coating them and

reducing the tendency of clay to adhere to the bit and other down hole tooling. Depending on the type of clay, one of these products may be more effective than the other product. In many cases, the best option to reduce or eliminate bit balling is to slow the drilling rate to increase the drilling fluid to cuttings ratio.

Information Sheet 2-4	Identifying contamination prevention and treatment of mud drilling fluids

4.1 Drilling Fluid Contamination and Maintenance

Drilling is a disruptive process. Reactive, non-reactive, fractures, cavities, loose, hard, permeable and semi-permeable formations can be encountered during the process of drilling. Contaminants are encountered at every phase of the drilling operation, which may sometimes contribute to the development of problems and end up with the reduction in well productivity. The contaminants exist in the drilled formation, the water supply, and in the materials used to maintain the drilling fluid properties. Design and maintenance of the drilling fluid system is critical to borehole stability.

Contaminants can rapidly alter the physical and chemical characteristics of a drilling fluid. The severity of the problems experienced depends on the type of contamination, degree of contamination, and the composition of the drilling fluid in use.

In order to minimize these problems, early detection of the presence of contaminants and rapid application of the proper corrective technique is of the utmost importance. Monitoring of drilling fluids at every change of soil formation is highly recommended. In this section, the indicators for you to find the contaminations, possible effects and remedies are suggested. However, care should be taken not to over treat so that the prescribed solutions do not create other problems. Your economic success can depend a great deal on your ability to recognize and remedy contamination before it jeopardizes the drilling of the well.

4.1.1 Common Sources of Contamination

The largest sources of contaminations of drilling fluids are as follows;

- Drilled Solids
- Water
- Calcium
- Cement
- Chlorides

The indicators of contaminations can be;

- Increased density
- Increased viscosity
- Increased filtrate volume
- Thick permeable filter cake

Possible effects of the contamination can be;

- Decreased Rate of Penetration (ROP)
- Loss of circulation
- Increased potential for solids invasion
- Increased filtrate invasion

In order to maintain the drilling fluid system, the following treatment methods can be applied

- Gravity settling in pit system
- Dilute with freshwater
- Add a dispersant such as liquid polymer dispersant or modified polyphosphate
- Dump mud and start over

4.1.2 Major Contaminants, Indicators, Effects, Treatment and Prevention

The indicators to find out a possibility of contamination of drilling fluid, the suggested treatment and prevention methods are summarized in the following table.

Table 4: Indicator and suggested treatment and prevention methods for drilling fluid contamination

Indicators/ Effects	Treatment	Prevention
Drilled solids		
– Increased density – Increased funnel viscosity – Thick filter cake – Increased gel strengths – **Decreased ROP** – **Booting, increased torque & drag, loss of returns** – **Solids not dropping at surface**	– Dilute with freshwater – Dump mud and start over	– Gravity settling in pit system – Remove solids with sell shake
Water		
– Decreased or increased density – Decreased funnel viscosity – Increase in pit volume – Decreased gel strengths – Increased filtrate volume – **Decreased bore hole stability** – **Increased filtrate invasion** – **Increased stickiness, swelling or sloughing of clay and shale**	– Maintain fluid system with bentonite and/or polymer addition – Increase density of drilling fluid with addition of barite to stop water flow (Artesian)	– Timely and proper measurement of density, viscosity, filtration to the drilling fluid by mud testing kit.

Indicators/ Effects	Treatment	Prevention
Calcium		
– Clay becomes flocculated – Increased funnel viscosity – Increased gel strengths (solids not dropping at surface) – Calcium hardness increases – Increased filtrate volume – Thick feathery filter cake	– Add soda ash at 1-4 lb/100 gallons – If necessary, add a thinner to de-flocculate the fluid	– Proper measurement of calcium hardness to makeup water by the dipping hardness indicator or conductivity meter. – A hardness concentration less than 100 ppm must be recommended. for makeup water – Pre-treat system with low viscosity dry modified cellulosic polymer or dry modified cellulosic polymer to reduce the filtrate to less than 10 ml/30 min when formations with high calcium are anticipated.
Chlorides		
– Clay becomes flocculated – Increased funnel viscosity – Increased gel strengths (solids not dropping at surface) – Increased filtrate volume – Thick fluffy filter cake – Increased chloride content – Salty taste	– It isn't possible to lower salinity by simple method other than dilution with fresh water.	– Makeup water salinity should be less than 500 ppm.
Cement		
– Clay becomes flocculated – Viscosity increases dramatically – Fluid system becomes unmanageable – Increased gel strengths – Increased filtration rate – Thick fluffy filter cake – pH increases to 12+ – Calcium increases	– Add a thinner/dispersant to de-flocculate the fluid – Add sodium bicarbonate to decrease pH and precipitate calcium	– Divert cement returns from active system

Operation Sheet 2	Learning Guide #2	Measuring and maintaining mud drilling fluids

Summary

This operation sheet includes the execution procedure of Measurement and maintenance of mud drilling fluids.

Task-1: Measurement and maintenance of mud drilling fluids

Preparation:

- This task can be done both individually and in groups. While demonstration by a trainer can be shown to a whole group, small groups (3-5 trainees per group) can be formed to alternate practices.

The items of the below table need to be prepared.

No	Necessary material and equipment used for LAP test	Quantity
1	Mud balance	1 pc
2	Marsh funnel	1 pc
3	Filter press	1 pc
4	pH and calcium hardness measuring kit	1 set for each
5	Sand content kit	1 pc
6	Make-up water samples from different sources in containers	3 sets
7	Mud samples from different sites	3 sets

Instruction:

Trainer will give demonstration with different fluid measuring tools and equipment. After demonstration by trainer, conduct the given tasks following the below instructions to familiarize yourself with the equipment.

1-1 Measure calcium hardness following the below steps.

Step 1: Prepare make-up water sample testing kit

Step 2: Dip indicator strip into make-up water

Step 3: Compare color on strip to color chart on container

Date: April 2022

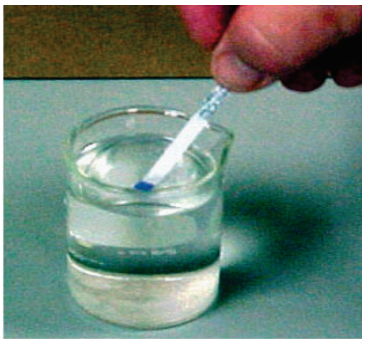

Figure 13: Dipping indicator strip into make-up water (**Step 2**)

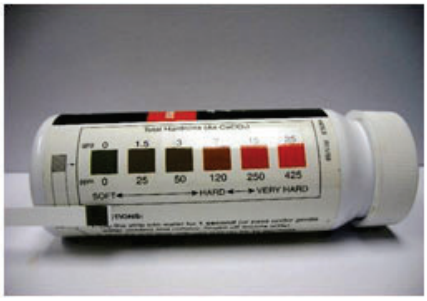

Figure 14: Comparing color on strip to color chart on container (**Step 3**)

Action to be taken

➢If the calcium hardness is above 100 mg / lit (hard water), treat out excess calcium with 0.5 to 1kg soda ash per 1,000 lit of water.

1-2 Measure pH following the below steps.

Step 1: Take drilling make-up water /drilling fluid sample from pit or tanker

Step 2: Dip pH strip in drilling fluid, filtrate or make-up water

Step 3: Compare color to determine pH value (4-5 pH)

Step 4: Read pH value after adjustment (9 pH)

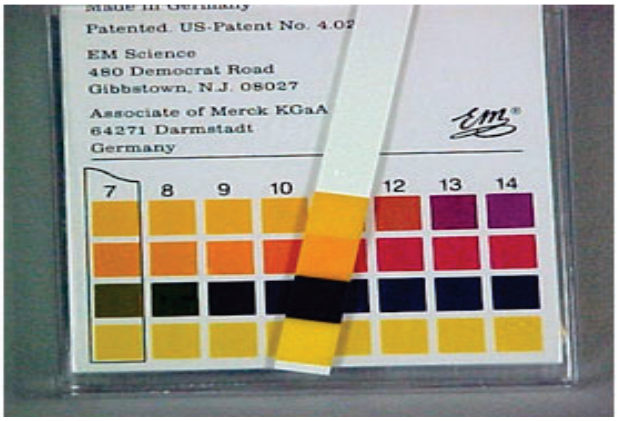

Figure 16: Reading pH value after adjustment (9 pH) (**Step 4**)

Date: April 2022

Figure 15: Comparing color to determine pH value (4-5 pH) (**Step 3**)

Action to be taken

- If the pH value is above 9.5, add sodium bicarbonate $NaHCO_3$.
- If the pH value is below 8.5, add sodium carbonate $NaCO_3$.

1-3 Measure density property following the below steps.

Step 1: Prepare the sample testing kit for measuring density of drilling fluid

Step 2: Over fill cup with sample drilling fluid

Figure 17: **Step 2**

Step 3: Put on cap over the sample drilling fluid, making sure fluid comes out from the hole on the top and clean off the excess fluid

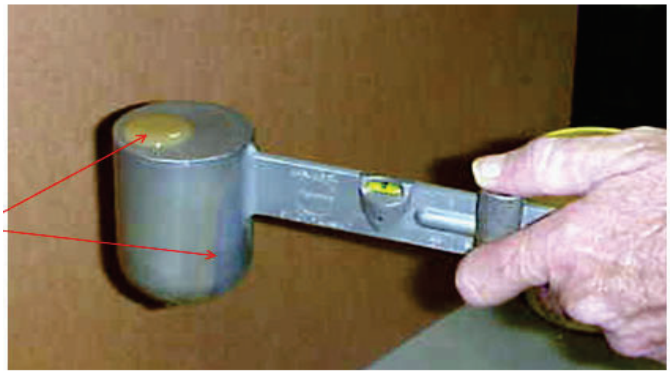

Figure 18: **Step 3**

Step 4: Place mud balance on fulcrum

Figure 19: **Step 4**

Step 5: Slide balance bar until the bubble is centered on line

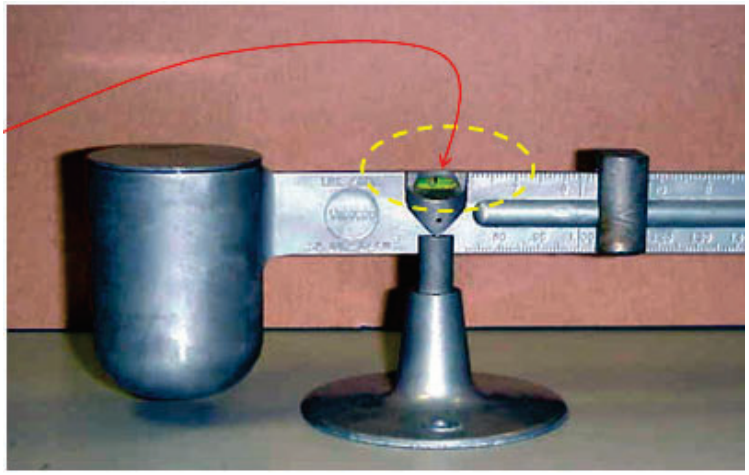

Figure 20: **Step 5**

Action to be taken

- If the density of drilling fluid is round above 1.10 gm/cm3, make longer drainage line and/or another settling pit for the natural sedimentation of drilling cuttings. For fine cuttings that do not naturally settle, dilute the drilling fluid with water and/or replace 1/3 to 1/2 drilling fluid to new fluid.
- If it is round below 1.05, add barite. When using barite, increase the viscosity so that barite does not settle. However, increasing the viscosity causes various obstacles such as an increase in fluid flow resistance. Therefore, polymers such as

organic colloidal agents and deflocculant polymers such as humate are often used.

1-4 Measure viscosity property following the below steps.

Step 1: Prepare the sample testing kit and stopwatch for measuring viscosity of drilling fluid


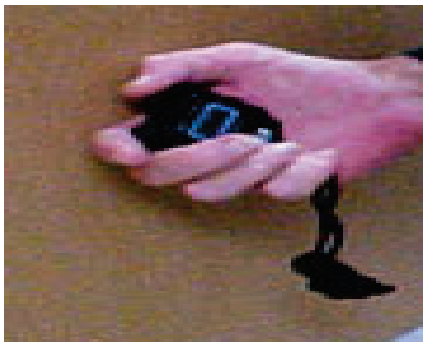

Figure 21: **Step 1**

Step 2: Take a cup of drilling fluid from the mixing pit

Step 3: Close the bottom of the funnel with finger and fill the marsh funnel with drilling fluid

Figure 22: **Step 3**

Step 4: Using a stopwatch, time the seconds for quart of fluid to run out of funnel

Figure 23: **Step 4**

Step 5: Record the result on the reporting format

Action to be taken

- If the viscosity of mud is above 32, adjust the fluid with polymer.
- If the viscosity of mud is below 27, add bentonite volume to the fluid.

1-5 Measure sand content property following the below steps.

Step 1 : Prepare the sample testing kit and fill sand content tube with fluid to "Mud to Here" line

Figure 24: **Step 1**

Step 2: Fill tube with water to "Water to Here" line for dilution and shake to mix

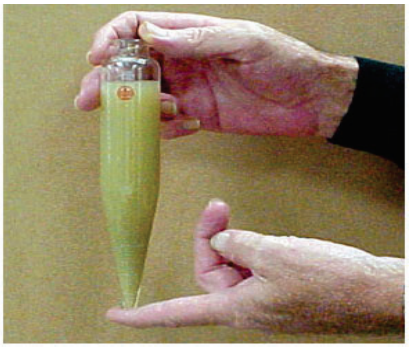

Figure 25: Step 2

Step 3: Pour diluted fluid through 200 mesh screen and funnel assembly

Step 4: Flush with more water if necessary to clear any residual drilling fluid

Figure 26: **Step 3**

Figure 27: **Step 4**

Step 5: Back flush sand retained on screen into sand content tube with water

Step 6: Read and report sand content as % by volume

Figure 28: **Step 5**

Figure 29: **Step 6**

Action to be taken

- If the sand content reading is above 1 %, avoid the solids/cuttings from circulation or re- entering the suction pit by making longer drainage line and/or another settling pit for the natural sedimentation of drilling cuttings.
- For fine cuttings that do not naturally settle, dilute the drilling fluid with water and/or replace 1/3 to 1/2 drilling fluid to new fluid.

1-6 Measure filtration control following the below steps.

Step 1: Fill barrel with fluid to within 1.25 cm from the top

Step 2: Place barrel in stand

Figure 30: **Step 1**

Figure 31: **Step 2**

Step 3: Add pressure regulator assembly and tighten with T-screw

Step 4: Add graduated cylinder

Figure 32: **Step 3**

Figure 33: **Step 4**

Step 5: Hand tighten CO_2 cartridge or a hose end of hand air pump to puncture and pressure up to 100 psi (approx.7kg/cm^2). Then, close the cock on the cover of barrel

Figure34: **Step 5**

Date: April 2022

Step 6: Measure filtrate volume in ml after 30 minutes at 100 psi (approx.7kg/cm2). Then, open the cock on the cover of barrel

Step 7: Measure filtrate to nearest 1/10 ml

Figure 35: **Step 6**

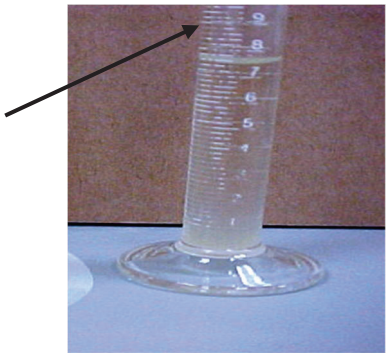

Figure 36: **Step 7**

Step 8: Relieve pressure and remove pressure assembly to discard the fluid, then gently wash the filter cake and measure it in 1/32nd of an inch or mm

Step 9: Examine the composition and texture of the filter cake

Figure 37: **Step 8**

Figure 38: **Step 9**

Action to be taken

- If the filtration rate result is above the standard (15 mm), add viscosifier to protect water entering into the aquifer.
- If the mud cake becomes thicker than 1/32 inch, add thinner (Surfactant) to reduce the thickness.

LAP Test 2	Learning Guide #2	Measuring and maintaining mud drilling fluids

Task-1: Measurement and maintenance of mud drilling fluids

Preparation:

- This task can be done both individually and in groups.
- The items of the below table need to be prepared.

No	Necessary material and equipment used for LAP test	Quantity
1	Mud balance	1
2	Marsh funnel	1
3	Filter press	1
4	pH and calcium hardness measuring kit	1 set for each
5	Sand content kit	1
6	Make-up water samples from different sources in containers	3
7	Mud samples from different sites	3

Instruction:

Assume that the well is going to be drilled in various formations by applying mud rotary drilling system. You are given the following instruction by the trainer.

1-1 Conduct measuring drilling fluid properties using the below materials and equipment and record the results on the given sheet

1-2 Analyze the obtained results and write down the necessary actions to be taken as per the desirable value.

Date: April 2022

Recording Sheet

No	Drilling fluid properties	Desirable Property	Assessment method	Measurement record		Measures to be taken if above or below the standard
				1st trial	2nd trial	
1	Calcium hardness	Below 100 mg/lit	Individual			
2	pH	8.5-9.5	Individual			
3	Density	1.05-1.10 gm/cm3	Individual			
4	Viscosity	27-32 sec	Group			
5	Sand content	Below 1 %	Group			
6	Filtration volume	Below15 ml	Group			
7	Mud cake	0.79 mm	Group			

Date: April 2022

List of Reference Materials

1. Driscoll, F. G, 1986. Groundwater and wells. Second edition, Johnson division, St. Paul, Minnesota 55112.
2. Peter Ball, 2001. Drilled wells. First edition: 2001. SKAT, Swiss Centre for Development Cooperation, in Technology and Management.
3. Ministry of Water Resources, Ethiopian Water Technology Centre. Drilling Technology Textbook.
4. Compressed air and Gas institute, 2002. Air Compressor Selection and Application 5th Edition.
5. SCHRAMM, Drill rig safety.
6. OHS Academy Course 902 Study Guide, 2013. Well site preparation and drilling safety. 2000 - 2014 Geigle Safety Group, Inc.
7. Anti-Entropics, Inc. Revision 1 – 09/2008. Environmental Remediation Drilling Safety Guideline. A summary of industry practices and techniques to help drillers enhance safety performance, environmental performance.

Date: April 2022

Ethiopian Water Technology Institute (EWTI)

TTLM for Gen-Set Operation and Maintenance

(For Trainer)

June, 2024

The Project for Strengthening Capacity for Training Operation and Management for EWTI

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LEARNING MODULE

EWTI PROGRAMME TITLE: Gen-set Operation and Maintenance

MODULE TITLE Operating & Maintaining a Gen-set

MODULE CODE: EIS EMM GOM2 0422

NOMINAL DURATION:10 working days

MODULE DESCRIPTION:

This module aims to provide the learner with the knowledge, skills and right attitudes required to operate and maintain a generator set.

LEARNING OUTCOMES

At the end of the module the learner will be able to:

LO 1 Demonstrate and Testing functionality of Diesel Engine parts and supporting system

LO 2 Demonstrate and Testing functionality of Electrical parts and main Alternator

LO 3 Operate a gen-set

LO 4 Perform generator maintenance

MODULE CONTENTS:

Introduction to the Module

LO 1 Demonstrate and Testing functionality of Diesel Engine parts and supporting system

1.1 Identification of tools, instruments, consumables materials and spare parts

1.2 Engine Major parts, components & its classification

1.3 Diesel engine working principle

1.4 Diesel engine supporting/Auxiliary systems

LO 2 Demonstrate and Testing functionality of Electrical parts and main Alternator

2.1 Alternator construction, working principle, types and main parts
Generator/Alternator construction

2.1.1 Generator Construction

2.1.2 Working principle of a generator

LO 3 Operate a gen-set

3.1 Operation of a gen-set and checklists

3.1.1 Inspections and checklists

Operational checklist and operation log

LO 4 Perform gen-set maintenance

4.1 Plan and prepare for generator maintenance

4.1.1 Types and purposes of maintenance

4.1.2 Classifying maintenance activities and scheduling of work activities

4.1.3 Maintenance log and reporting

4.2 Troubleshooting technique on generator maintenance Troubleshooting and checking malfunctioning of the generator

4.2.2 Generator problems and remedies

LEARNING METHODS:

- Discussion question and answering (Q & A)
- Case Studies
- Group discussion
- Self-study
- Demonstration and re-demonstration with guidance
- On job Practical Exercise

ASSESSMENT METHODS:

- Written Test
- Demonstration with Oral questioning
- LAP test

ASSESSMENT CRITERIA:

LO 1 Demonstrate and Testing functionality of Diesel Engine parts and supporting system

- Demonstrate tools, instruments, consumables & spare parts for operation and maintenance
- Demonstrate & Testing functionality engine assembly of the Gen-set and main components
- Demonstrate & Testing functionality parts of engine supporting/auxiliary systems

LO 2 Demonstrate and Testing functionality of Electrical parts and main Alternator

- Demonstrate alternator assembly and parts in the main alternator of a gen-set
- Demonstrate controlling and displaying instruments on control panel

- Demonstrate parts on controlling device and starting mechanism

LO 3 Operate a gen-set

- Perform visual inspection, pre operational tests and field preparation for operation in accordance with manufacturer and enterprise/site procedures
- Operate the generator within limits of its design, regulators requirements, and enterprise or site requirements
- Adjust the generator output to achieve its required operating requirements and demand by observing operational requirements
- Evaluate generator operation to detect deviations from required operating conditions
- Correct operational abnormalities in accordance with manufacturer and enterprise/site procedures
- Record the operation data on the generator operation log sheet

LO 6 Perform gen-set maintenance

- Identify and categorize maintenance activities based on complexity of internal and external capacities
- Examine and identify Malfunctioning of the generator
- Select and perform proper maintenance techniques from simple to complex by following standard procedures
- Perform post maintenance check/evaluation of functionality of the generator is within limits of its design, regulators requirements, and enterprise or site requirement
- Record the maintenance activity on the generator maintenance log sheet

	RESOURCE REQUIREMENTS FOR LEARNING MODULE			
Module Title	**Operating and Maintaining a Gen-set**			
Module Code	**EIS EMM GOM2 0422**			
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A. Learning Materials				
1	TTLM			1:1
2	References Book	See last pages of LG 1, LG 2, LG 3, LG 4 & LG 5		-
3	Operation & service manuals	Available nearby the Generator		-
B. Learning Facilities and Infrastructure				
1	Lecture room			1:15
2	Workshop room			1:15
3	Audio visual room	For the future		
C. Consumable Materials				
1	First aid kit			1:15
2	Personal Protective Equipment (PPE)			1:1
3	Fire extinguisher			1:15
4	Cleaning rag			1:15
5	Engine oil			5lt/LG
6	Fuel			5lt/LG
7	Different size cables			-
8	Rag			5kg/LG
9	Filters (fuel and oil)			-
10	Baking soda			5kg/LG
11	Distilled water			5lt/LG
12	Battery acid			
13	Insulation tape & connectors			5lt/LG
D. Tools and Equipment				
1	Wrenches (open, close & adjustable)			5pcs/LG
2	Pliers (combination, long			5pcs/LG

	nose, cutter)			
3	Insulated & mechanical screw drivers (flat & Philips)			5pcs/LG
4	Allen keys (hexagonal & star)			5pcs/LG
5	Adjustable wrenches			5pcs/LG
6	Socker wrenches (different size)			
7	Power / power factor meter			
8	Digital multi-meter and clamp-meter			5pcs/LG
9	Insulation resistance tester (megger)			5pcs/LG
10	Crimping tools			5pcs/LG
11	Wire striper			
12	Rectifier			5pcs/LG
13	Cable lug			5pcs/LG
14	Bench vice			5pcs/LG
15	Air cleaner			1pcs/LG
16	Faulty/dead battery and functional battery			3pcs/LG
17	Faulty gen-set (not working properly) with its starting key			2pcs/LG
18	Genset with battery			2pcs/LG
19	Engine cut model			1pcs/LG
20	Alternator and starter cut models			5pcs/LG
21	Disassembled Generator set parts			5pcs/LG
22	Open container for battery solution preparation			2pcs/LG
23	Battery load tester			1pcs/LG
24	Hydrometer			2pcs/LG
25	Printing paper			-
26	Note book			-
27	Pen			-
28	Printer			-
29	Ink (printer tonner)			-
30	Computer set			1pcs/LG
31	Operation checklists			1pcs/trainee
32	Operation log sheet			1pcs/trainee
33	Maintenance log sheet			1pcs/trainee

	Training Schedule								
	operating and maintening Gen-set								
	From Month, XXth to XXth, 202X								
Date	Day	Time	Training Content	Trainer	Assistant Trainer	Knowledge	Skill	Others	Total Hrs.	Remarks
Day1	M/D	9:00-12:00	Registration					1:00	7:00	
			Pre Test/Questionnaire					1:00		
			LGs distribution					1:00		
		12:00-14:00	Lunch break					1:00		
		14:00-17:00	Registration	Mr/Ms. XX	Mr/Ms. XX			1:00		
			Pre-Test/Pre-Questionnaire	Mr/Ms. XX	Mr/Ms. XX			1:00		
			LGs distribution	Mr/Ms. XX	Mr/Ms. XX			1:00		
Day2	M/D	9:00 - 9:30	General orentation	-	Mr/Ms. XX			0:30	5:00	
		9:30-10:00	course guidance		Mr/Ms. XX			0:30		
		10:00-10:30	CM: Self-Check 1 self learning (self check and information sheet)		Mr/Ms. XX	0:30				
		10:30-11:00	Break			0:00	0:00	0:00		
		11:00-12:00	CM: Performing teamwork, OHS & Kaizen / Quistion and Answer session, self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-14:30	CM: Self-Check 1 self learning(self check and information sheet)		Mr/Ms. XX	0:30				
		14:30-15:30	CM: Performing teamwork, OHS & Kaizen / Quistion and Answer session, self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	1:00				
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:45	LG1: Operation Sheet Performing teamwork, OHS & Kaizen /	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	LG 1 LAP test 1(kaizen)		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		
Day3	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-9:15	General orientation, including Brief overview of LG-1 & structure of this training program	Mr/Ms. XX	Mr/Ms. XX			0:05		
		9:15-9:45	LG 1: Self-Check 1.1 self learning(self check and information sheet)		Mr/Ms. XX	0:30				
		9:45-10:30	LG 1: Self-Check 1.1 Quistion and Answer session, self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	0:45				
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LG1: Demo & Practice	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-14:30	LG 1: Self-Check 1.2 and 1.3 self learning(self check and information sheet)		Mr/Ms. XX	0:30				
		14:30-15:30	LG 1: Self-Check 1.2 and 1.3 Quistion and Answer session, self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	1:00				
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:15	LG 1: Self-Check 1.4 self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	0:15				
		16:15-16:45	LG 2: Self-Check 1.4 Quistion and Answer session, self learning(self check and information sheet)		Mr/Ms. XX	0:30				
		16:45-16:55	CM LAP test 1(kaizen)		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		
Day4	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-10:30	LG1: Operation Sheet >Task 1 Demonstrate parts of engine assembly and Auxiliary system for the Gen-set	Mr/Ms. XX	Mr/Ms. XX		1:20			
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LG2: Operation Sheet >Task 2 Testing functionality of supporting/auxiliary systems for the Gen-set	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-15:30	LG1 : LAP test (Raiting sheet & Oral questions) >Task1~2	Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:45	LG1 : LAP test (Raiting sheet & Oral questions) >Task1~2	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	CM LAP test 1(kaizen)		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		

Date	Day	Time	Training Content	Trainer	Assistant Trainer	Knowledge	Skill	Others	Total Hrs.	Remarks
Day5	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-9:15	General orientation, including Brief overview of LG-2 & structure of this training program	Mr/Ms. XX	Mr/Ms. XX			0:05		
		9:15 - 9:40	LG 2: Self-Check 3.1 self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	0:25				
		9:40-10:30	LG 2: Self-Check 3.1 Quistion and Answer session, self learning(self check and information sheet)	Mr/Ms. XX	Mr/Ms. XX	0:50				
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LO2: operation sheet Identify and locate main alternator assembly and parts in the alternator of a gen-set	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-14:45	LG 2: operation sheet Identify and locate controlling and displaying instruments on control panel	Mr/Ms. XX	Mr/Ms. XX		0:45			
		14:45-15:30	LG 2:operation sheet Identify and locate parts on controlling device and starting mechanism		Mr/Ms. XX		0:45			
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:45	LG 2: LAP Test (Raiting sheet & Oral questions) >Task1~3	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	CM LAP test 1(kaizen)		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		
Day6	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-9:15	General orientation, including Brief overview of LG-3 & structure of this training program		Mr/Ms. XX			0:05		
		9:15-9:25	LG : Self-Check 3.1 self learning(self check and information sheet)		Mr/Ms. XX	0:10				
		9:25-9:40	LG 3: Self-Check 3.1 Quistion and Answer session, self learning(self check and information sheet)		Mr/Ms. XX	0:15				
		9:40-10:30	LG3: Operation Sheet >Task: -1. Perform pre operation checks to start the genset and record the operation activity before starting	Mr/Ms. XX	Mr/Ms. XX		0:50			
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LG3: Operation Sheet Task: -2. Starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-10:45	LG4: Operation Sheet Task: -3. Shutdown the gen-set by following the correct shutdown steps and use the operation log sheet to record the operation data or readings after shutdown		Mr/Ms. XX		0:45			
		14:45-15:30	LG3 : LAP test (Raiting sheet & Oral questions) >Task1~3	Mr/Ms. XX	Mr/Ms. XX		0:45			
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:45	LG3 : LAP test (Raiting sheet & Oral questions) >Task1~3(cont….)	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	CM LAP test 1(kaizen)	Mr/Ms. XX	Mr/Ms. XX		0:10			
		16:55-17:00	daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:05		
Day7	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-9:15	General orientation, including Brief overview of LG-4& structure of this training program		Mr/Ms. XX			0:05		
		9:15-9:30	LG4: Self-Check 4.1 self learning(self check and information sheet)		Mr/Ms. XX	0:15				
		9:30-9:45	LG4: Self-Check 4.1 and 4.1 Quistion and Answer session, self learning(self check and information sheet)		Mr/Ms. XX	0:15				
		9:45-10:30	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start	Mr/Ms. XX	Mr/Ms. XX		0:45			
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….)	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-15:30	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….).	Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:45	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….).	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	CM LAP test 1(kaizen)		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		

Date	Day	Time	Training Content	Trainer	Assistant Trainer	Knowledge	Skill	Others	Total Hrs.	Remarks
Day8	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-10:30	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….).	Mr/Ms. XX	Mr/Ms. XX		1:20			
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	Mr/Ms. XX	Mr/Ms. XX	1:00				
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-15:30	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Tea break	-		0:00	0:00	0:00		
		16:00-16:45	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	CM LAP test 1(kaizen)		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		
Day9	M/D	9:00-9:10	Recap and daily reflaction	Mr/Ms. XX	Mr/Ms. XX			0:10	5:00	
		9:10-10:30	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	Mr/Ms. XX	Mr/Ms. XX		1:20			
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-12:00	LG4 : LAP test (Raiting sheet & Oral questions) >Task1~2	Mr/Ms. XX	Mr/Ms. XX		1:00			
		12:00-14:00	Lunch break	-		0:00	0:00	0:00		
		14:00-15:30	Post-Test/Post-Questionnaire	Mr/Ms. XX	Mr/Ms. XX		1:30			
		15:30-16:00	Action Plan Session	-		0:00	0:00	0:00		
		16:00-16:45	Tea break	Mr/Ms. XX	Mr/Ms. XX		0:45			
		16:45-16:55	KAIZEN Reflection session		Mr/Ms. XX		0:10			
		16:55-17:00	Daily Reflection	Mr/Ms. XX	Mr/Ms. XX			0:05		
Day10	M/D	9:00-10:00	Presentation of Action Plan	Mr/Ms. XX				1:00	5:00	
		10:00-10:30	Presentation of Action Plan	Mr/Ms. XX				0:30		
		10:30-11:00	Tea Break	-		0:00	0:00	0:00		
		11:00-11:15	Course Evaluation Sheet	Mr/Ms. XX				0:15		
		11:15-12:00	Certificate preparation	-				0:45		
		12:00-14:00	Lunch break	Mr/Ms. XX		0:00	0:00	0:00		
		14:00-15:00	Course Reflection Session					1:00		
		15:00-15:30	Tea break			0:00	0:00	0:00		
		15:30-17:00	Course Closing Ceremony	-				1:30		
						9:40	27:10	15:10	52:00	
						19%	52%	29%	100%	

Performance Evaluation Guide Ver.4

This is Guide for Individual or Group Performance Evaluation. Based on given design of the performance evaluation, trainers must prepare necessary equipment, material and consumables and its setting. During the actual performance evaluation, must fill-in in the consecutive Rating Sheet.
The results of the 1st trial, if participant's failure, you can give chance for 2nd trial and its results will be filled-in using "Trainees' Assessment Data Sheet" (Template TM- of the Guidelines for Training Operation and Management)

Module Title	Operating and Maintaining a Gen-set
Learning Guide number and title	LG #01 - Demonstrate and Testing functionality of diesel engine parts and supporting systems
Assessment	■ Individual ☐ Group
Venue of assessment	Classroom □ Workshop ■ Machine site □ Practice field □ Others……

Preparation and setting for the performance assessment

- Prepare or avail the gen-set and cut models related with its components for the assessment
- Ensuring if there is suitable area for the assessment
- Avail the necessary tools, material, instruments
- Avail the rating sheet for demonstration per each trainee

Necessary material and equipment

No	Material, consumables and equipment	Quantity
1	Personal Protective Equipment (PPE)	1/Trainee
2	First aid kit	1set/LG
3	fire extinguisher	1pcs/LG
4	wrenches (open, close, socket & adjustable)	1set/trainee
5	Pliers (combination, long nose, cutter)	3 pcs/trainee
5	Insulated & mechanical screw drivers (flat & Philips)	2set/LG
6	Allen keys (hexagonal & star)	2set/LG
7	cleaning rag	2kg/LG
8	Genset with battery	2set/LG
9	Engine cut model	1set/LG

Rating Sheet for Demonstration Ver.4

This is the sheet for recording the rating of the performance evaluation of the trainees.

Assessment	■ Individual □ Group
Date of 1st trial	
Date of 2nd trial	
Venue of Assessment	Classroom □ Workshop ■ Machine site □ Practice field □ Others……

Instruction for demonstration

- Read the instruction written in the LAP test
- Open the canopy of Gen-set
- Identify the engine assembly of the Gen-set and engine components (components found in cylinder head assembly, in cylinder block assembly, oil sump)
- Identify and locate parts of engine supporting/auxiliary systems (starting system, air intake and exhaust system, fuel system, cooling system, lubrication system, charging system)
- clean the work area and return the materials task

No	During the demonstration of skills, did the learner ※Circle Y for Yes and N for No)	1st trial	2nd trial
1	Select & use the necessary tools and PPE (Satisfactory when 1.1 – 1.2 are Yes)	Y／N	Y／N
1.1	Select the necessarily tools and PPE	Y／N	Y／N
1.2	Use the necessarily tools and PPE	Y／N	Y／N
2	Identify and locate parts of engine assembly and Auxiliary system for the Gen-set (Satisfactory when 2.1 – 2.7 are Yes)	Y／N	Y／N
2.1	*cylinder head assembly*	Y／N	Y／N
2.2	*cylinder block assembly*	Y／N	Y／N
2.3	*oil sump*	Y／N	Y／N
2.4	Fuel filter, Feed pump, Injection pump and Injection nozzle	Y／N	Y／N
2.5	starter motor	Y／N	Y／N
2.6	Radiator and Thermostat	Y／N	Y／N
2.7	Turbo charger	Y／N	Y／N

3	Testing functionality of supporting/auxiliary systems for the Gen-set (Satisfactory when 3.1 – 3.4 are Yes)	Y／N	Y／N
3.1	air intake and exhaust system	Y／N	Y／N
3.2	fuel system	Y／N	Y／N
3.3	cooling system	Y／N	Y／N
3.4	lubricating system	Y／N	Y／N
4	clean the working area from unnecessary things & return the materials taken	Y／N	Y／N
The trainee's demonstration was:		☐satisfy ☐No	☐satisfy ☐No

Oral Questions Ver.4

Q	The trainee should answer the following questions	Satisfactory response	
		1st Trial	2nd Trial
1	When you open the gen-set hood/cover and identifying the parts what are the things that you should care for?	Y/N	Y/N
2	What will happen if you connect the positive battery terminal with the negative terminal	Y/N	Y/N
The trainee's response for oral questions was:		☐satisfy ☐No	☐satisfy ☐ No
Feedback to trainee			

The trainee's overall performance was:	1st Trial	2nd Trial
	☐ Satisfactory ☐ Not yet Satisfactory	☐ Satisfactory ☐ Not yet Satisfactory

Recommended answers for oral questions

A	Recommended Answer
1	- Remove unnecessary things away from the gen-set - open the hood/cover using proper tools - be careful not to make a short the positive and negative terminals of the battery - protect cables & sensitive devices from damage
2	- Connecting the positive terminal of each battery to the negative terminal of the other battery will result in a huge surge of electrical current between the two batteries. This will cause the batteries to heat very quickly, and in lead-acid type batteries -- the most common type -- it will result in the generation of a large amount of hydrogen gas within the charged battery. The heat can melt internal and external battery parts, while the pressure from the hydrogen gas can crack the battery casing. Once the casing is cracked, escaping hydrogen can potentially ignite and explode.

Performance Evaluation GuideVer.4

This is Guide for Individual or Group Performance Evaluation. Based on given design of the performance evaluation, trainers must prepare necessary equipment, material and consumables and its setting. During the actual performance evaluation, must fill-in in the consecutive Rating Sheet.

The results of the 1st trial, if participant's failure, you can give chance for 2nd trial and its results will be filled-in using "Trainees' Assessment Data Sheet" (Template TM- of the Guidelines for Training Operation and Management).

Module Title	Operating and Maintaining a Gen-set
Learning Guide number and title	LG #02 - Demonstrate and Testing functionality of Electrical parts and main Alternator
Assessment	■ Individual □ Group
Venue of assessment	Classroom □ Workshop ■ Machine site □ Practice field □ Others……

Preparation and setting for the performance assessment

- Prepare or avail the gen-set and cut models related with its components for the assessment
- Ensuring if there is suitable area for the assessment
- Avail the necessary tools, material, instruments
- Avail the rating sheet for demonstration per each trainee

Necessary material and equipment

No	Material, consumables and equipment	Quantity
1	Personal Protective Equipment (PPE)	1/Trainee
2	First aid kit	1set/LG
3	Fire extinguisher	1pcs/LG
4	Wrenches (open, close)	1set/trainee
5	Pliers (combination, long nose, cutter)	3 pcs/trainee
5	Adjustable wrenches	2set/LG
6	Multi-meter	2 pcs/LG
7	Socker wrenches	2 set/LG
8	Insulation resistance tester (megger)	2 pcs/LG
9	Crimping tools	2 pcs/LG
10	Clamp-ammeter	2 pcs/LG

11	Bench vice	2 pcs/LG
12	Genset with battery	2 pcs/LG
13	Alternator cut model	2 pcs/LG
14	Insulated & mechanical screw drivers (flat & Philips)	2 pcs/LG
15	Allen keys (hexagonal & star)	2 pcs/LG
16	Cleaning rag	2 Kg/LG
17	Rectifier	2 pcs/LG
18	Multi-meter	2 pcs/LG
19	Insulation Tester	2 pcs/LG
20	Heater	2 pcs/LG

Rating Sheet for Demonstration Ver.4

This is the sheet for recording the rating of the performance evaluation of the trainees.

Assessment	■ Individual (Oral questions) □ Group
Date of 1st Trial	
Date of 2nd Trial	
Venue of Assessment	Classroom □ Workshop ■ Machine site □ Practice field □ Others……

Instruction for demonstration

- Read the instruction written in the LAP test
- Open the canopy of Gen-set
- Identify and explain alternator assembly of the Gen-set
- Identify and explain the purpose of parts in the alternator *(armature core & windings, field coil, exciter, rectifiers, AVR)*
- Identify and explain the purpose of controlling and displaying instruments (*Circuit breakers, control panel instruments)*
- clean the work area and return the materials taken

No	During the demonstration of skills, did the trainee (circle Y for Yes and N for No)	1st trial	2nd trial
1	Select & use the necessary tools and PPE (Satisfactory when 1.1 – 1.2 are Yes)	Y/N	Y/N
1.1	*Select the necessarily tools and PPE*	Y/N	Y/N
1.2	*Use the necessarily tools and PPE*	Y/N	Y/N
2	Demonstrate each part on main alternator assembly (Satisfactory when 2.1 – 2.4 are Yes)	Y/N	Y/N
2.1	*Demonstrate Excitor coil and main field coil*	Y/N	Y/N
2.2	*Demonstrate Armature core and main alternator*	Y/N	Y/N
2.3	*Demonstrate each part on this AVR*	Y/N	Y/N
2.4	*Demonstrate displaying instruments on control panel*	Y/N	Y/N
3	Test the functionality components and systems (Satisfactory when 3.1 – 3.6 are Yes)	Y/N	Y/N
3.1	*Rectifiers*	Y/N	Y/N
3.2	*Starting system*	Y/N	Y/N
3.3	*Charging system*	Y/N	Y/N
3.4	*Switches (Temperature, oil pressure)*	Y/N	Y/N

3.5	*Relay, Fuel solenoid, Temperature senser, pressure senser*	Y/N	Y/N
3.6	*Exciter coil*	Y/N	Y/N
4	Clean the working area from unnecessary things & return the materials taken	Y/N	Y/N
The trainee's demonstration was	☐satisfy ☐No	☐satisfy	☐No

Oral Questions

Q	The trainee should answer the following questions	Satisfactory response	
		1st Trial	2nd Trial
1	When you open the gen-set hood/cover and identifying the parts what are the things that you should care for?	Y/N	Y/N
2	When you perform testing the functionality of sensors what things you must consider	Y/N	Y/N
The trainee's response for oral questions was:		☐satisfy ☐No	☐satisfy ☐ No
Feedback to trainee			

The trainee's overall performance was:	1st Trial	2nd Trial
	☐ Satisfactory ☐ Not yet Satisfactory	☐ Satisfactory ☐ Not yet Satisfactory

Recommended answers for oral questions

A	Recommended Answer
1	- Remove unnecessary things away from the gen-set - open the hood/cover using proper tools - be careful not to make a short the positive and negative terminals of the battery - protect cables &sensitive devices from damage
2	- To check pressure senser/switch we use by pressurized air. At that time when the pressure increases beyond the setting range the Normally contact point becomes open - To check temperature sensor/switch we should ready some heat and close to the sensor. At that time when the temperature increases beyond the setting range the Normally contact point becomes open

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	Training Session Plan				
modul title	**Operating and Maintening a Gen-set**				
Learning Outcome	**LO1.Identify and Testing functionality of parts on operation and supporting systems of diesel engine**				
Session Objectives	At end of the session, the trainee will be able to: 1. Demonstrate tools, instruments, consumables & spare parts for operation and maintenance 2. Demonstrate & Testing functionality engine assembly of the Gen-set and main components 3. Demonstrate & Testing functionality parts of engine supporting/auxiliary systems.				
Trainers	MR…				
Day 1					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-9:15	General orientation, including Brief overview of LG-1 & structure of this training program	5min	pressentation	coordinating and facilitating sessain	
9:15-9:50	LG 1: Self-Check 1.1 self learning(self check and information sheet)	35min	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	TG1: Self-checks, and Information Sheet
9:50-10:30	LG 1: Self-Check 1.1 Quistion and Answer session, self learning(self check and information sheet)	40min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG1: Self-checks, and Information Sheet
10:30-11:00	Tea break	30min			
11:00-12:00	LO1: Demonstrate tools, instruments, consumables & spare parts for operation and maintenance	60min	workshop practice	demonestrating how to identify tools and instruments	TG1:Operation sheet
12:00-14:00	Lunch break	120min			
14:00-14:30	LG 1: Self-Check 1.2 and 1.3 self learning(self check and information sheet)	30min	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	TG1: Self-checks, and Information Sheet
14:30-15:15	LG 1: Self-Check 1.2 and 1.3 Quistion and Answer session, self learning(self check and information sheet)	45min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG1: Self-checks, and Information Sheet
15:15-15:45	Tea break	30min			
15:45-16:10	LG 1: Self-Check 1.4 self learning(self check and information sheet)	25min	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	TG1: Self-checks, and Information Sheet
16:10-16:45	LG 1: Self-Check 1.4 Quistion and Answer session, self learning(self check and information sheet)	35min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG1: Self-checks, and Information Sheet
16:45-16:55	CM LAP test 1(kaizen)	10min	self evaluation and scoring	evaluating the group and scoring	kaizen sheet
16:55-17:00	Daily Reflection	5min	training evaluation	collecting and compiling the filled sheet	TM-10 daily reflection sheet
Day 2					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-10:30	LG1: Operation Sheet >Task 1 Demonstrate parts of engine assembly and Auxiliary system for the Gen-set	80min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG1: Operation sheet
10:30-11:00	Tea break	30min			
11:00-12:00	LG1: Operation Sheet >Task 2 Testing functionality of supporting/auxiliary systems for the Gen-set	60min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG1: Operation sheet
12:00-14:00	Lunch break	120min			
14:00-15:30	LG1 : LAP test (Raiting sheet & Oral questions) >Task1~2	90min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~2 (*This process can be repeated several until the trainees perform the given tasks as per the standard) - Keeping record on PEG E36	TG1: PEG LG1: LAP Test
15:30-16:00	Tea break	30min			
16:00-16:45	LG1 : LAP test (Raiting sheet & Oral questions) >Task1~2	45min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~2 (*This process can be repeated several until the trainees perform the given tasks as per the standard) - Keeping record on PEG	TG1: PEG LG1: LAP Test
16:45-16:55	CM LAP test 1(kaizen)	10min	self evaluation and scoring	evaluating the group and scoring	kaizen sheet
16:55-17:00	Daily Reflection	5min	training evaluation	collecting and compiling the filled sheet	TM-10 daily reflection sheet

	Training Session Plan
modul title	**Operating and Maintening Gen-set**
Learning Outcome	**LO 2. Demonstrate and Testing functionality of Electrical parts and main Alternator**
Session Objectives	At end of the session, the trainee will be able to:
	1. Demonstrate alternator assembly and parts in the main alternator of a gen-set
	2. Demonstrate controlling and displaying instruments on control panel
	3. Demonstrate parts on controlling device and starting mechanism
Trainers	MR….

Day 1

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-9:15	General orientation, including Brief overview of LG-2 & structure of this training program	5min	pressentation	coordinating and facilitating sessain	
9:15-9:45	LG 2: Self-Check 2.1 self learning(self check and information sheet)	30min	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	TG2: Self-checks, and Information Sheet
9:45-10:30	LG 2: Self-Check 2.1 Quistion and Answer session, self learning(self check and information sheet)	40min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG2: Self-checks, and Information Sheet
10:30-11:00	Tea break	30min			
11:00-12:00	LO2: operation sheet Task 1.1 Demonstrate each part on main alternator assembly	60min	workshop practice	demonestrating how to identify main alternator and parts in the alternator	LG2:operation sheet
12:00-14:00	Lunch break	120min			
14:00-14:45	LG 2: operation sheet Task 1.2 Test the functionality components and systems	45min	workshop practice	demonestrating how to identify controlling and displaying instruments on control panel	LG2:operation sheet
14:45-15:30	LG 2:operation sheet Identify and locate parts on controlling device and starting mechanism	45min	workshop practice	demonestrating how to identify parts on controlling device and starting mechanism	LG2:operation sheet
15:30-16:00	Tea break	30min			
16:00-16:45	LG 2: LAP Test (Raiting sheet & Oral questions) >Task1~3	45min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~3 (*This process can be repeated several until the trainees perform the given tasks as per the standard) - Keeping record on PEG	TG2: PEG LG2: LAP Test
16:45-16:55	CM LAP test 1(kaizen)	10min	self evaluation and scoring	-Consulting and providing technical advice to each indiviuals on performingkaizen activity - evaluating the group and scoring	kaizen sheet
16:55-17:00	Daily Reflection	5min	training evaluation	collecting and compiling the filled sheet	TM-10 daily reflection sheet

	Training Session Plan
modul title	**Operating and Maintening a Gen-set**
Learning Outcome	**LO3-Operation of a gen-set**
Session Objectives	At end of the session, the trainee will be able to:
	1. Perform visual inspection, pre operational tests and field preparation for operation in accordance with manufacturer and enterprise/site procedures
	2. Operate the generator within limits of its design, regulators requirements, and enterprise or site requirements.
	3. Adjust the generator output to achieve its required operating requirements and demand by observing operational requirements
	4. Evaluate generator operation to detect deviations from required operating conditions.
	5. Correct operational abnormalities in accordance with manufacturer and enterprise/site procedures
	6. Record the operation data on the generator operation log sheet
Trainers	MR…

Day 1

Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-9:15	General orientation, including Brief overview of LG-3 & structure of this training program	5min	pressentation	coordinating and facilitating sessain	
9:15-9:35	LG 3: Self-Check 3.1 self learning(self check and information sheet)	`20min	Individual work	Instructing how to take Self-check using Moodle and conduct self-learning (including how to try the Self-checks several times)	TG3: Self-checks, and Information Sheet
9:35-10:00	LG 3: Self-Check 4.1 Quistion and Answer session, self learning(self check and information sheet)	25min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG3: Self-checks, and Information Sheet
10:00-10:30	LG3: Operation Sheet >Task: -1. Perform pre operation checks to start the genset and record the operation activity before starting	30min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG3: Operation sheet
10:30-11:00	Tea break	30min			
11:00-11:20	LG3: Operation Sheet >Task: -1. Perform pre operation checks to start the genset and record the operation activity before starting(cont….)	20min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG3: Operation sheet
11:10-12:00	LG3: Operation Sheet Task: -2. Starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist	40min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG3: Operation sheet
12:00-14:00	Lunch break	120min			
14:00-14:30	LG3: Operation Sheet Task: -3. Shutdown the gen-set by following the correct shutdown steps and use the operation log sheet to record the operation data or readings after shutdown	30min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG3: Operation sheet
14:30-15:30	LG3 : LAP test (Raiting sheet & Oral questions) >Task1~3	60min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~2 (*This process can be repeated several time until the trainees perform the given tasks as perthe standard)	TG3: PEG LG3: LAP Test
15:30-16:00	Tea break	30min			
16:00-16:45	LG3 : LAP test (Raiting sheet & Oral questions) >Task1~3(cont….)	45min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~2 (*This process can be repeated several time until the trainees perform the given tasks as perthe standard)	TG3: PEG LG3: LAP Test
16:45-16:55	CM LAP test 1(kaizen)	10min	self evaluation and scoring	evaluating the group and scoring	kaizen sheet
16:55-17:00	Daily Reflection	5min	training evaluation	collecting and compiling the filled sheet	TM-10 daily reflection sheet

	Training Session Plan				
modul title	**Operating and Maintening a Gen-set**				
Learning Outcome	**LO4-Perform generator maintenance**				
Session Objectives	At end of the session, the trainee will be able to: 1. Identify and categorize maintenance activities based on complexity of internal and external capacities. 2. Examine and identify Malfunctioning of the generator. 3. Select and perform proper maintenance techniques from simple to complex by following standard procedures. 4. Perform post maintenance check/evaluation of functionality of the generator is within limits of its design, regulators requirements, and enterprise or site requirements. 5. Record the maintenance activity on the generator maintenance log sheet				
Trainers	MR…				
Day 1					
Model Time	Activities	Nominal Duration	Training method	Trainer role	Training materials
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-9:15	General orientation, including Brief overview of LG-4& structure of this training program	5min	pressentation	coordinating and facilitating sessain	
9:15-9:35	LG4: Self-Check 4.1 and 4.1 Quistion and Answer session, self learning(self check and information sheet)	20min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG4: Self-checks, and Information Sheet
10:35-9:55	LG4: Self-Check 4.1 and 4.1 Quistion and Answer session, self learning(self check and information sheet)	20min	Question & Answer	Asking whether Learners answered Self-check correctly and which question was the most challenging and explaining them about the correct answers. (If they feel nothing difficult, ask them questions to confirm their understanding)	TG4: Self-checks, and Information Sheet
9:55-10:30	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start	35min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
10:30-11:00	Tea break	30min			
11:00-12:00	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….)	60min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
12:00-14:00	Launch time	120min			
14:00-15:30	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….).	75min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
15:30-16:00	Tea break	30min			
16:00-16:45	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….).	45min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
16:45-16:55	CM LAP test 1(kaizen)	10min	self evaluation and scoring	evaluating the group and scoring	kaizen sheet
16:55-17:00	Daily Reflection	5min	training evaluation	collecting and compiling the filled sheet	TM-10 daily reflection sheet
Day 2					
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-10:30	LG4: Operation Sheet >Task: -1. we are given to solve the problem for “engine fails to start (cont….).	80min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
10:30-11:00	Tea break	30min			
11:00-12:00	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	60min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
12:00-14:00	Launch time	120min			
14:00-15:30	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	80min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
15:30-16:00	Tea break	30min			
16:00-16:45	LG4: Operation Sheet Task: -2 we are given to solve the problem A generator is not delivering electricity /No output. (cont….).	45min	workshop practice	Prodiving assistance to Learners if there is any lack of explanation on th given tasks - Observing the group work progress and giving necessary advice (discussing common mistakes and sharing tips)	TG4: Operation sheet
16:45-16:55	LG 1 LAP test 1(kaizen)	10min	self evaluation and scoring	evaluating the group and scoring	kaizen sheet
16:55-17:00	Daily Reflection	5min	training evaluation	collecting and compiling the filled sheet	TM-10 daily reflection sheet

Day 3					
9:00-9:10	Recap and daily reflaction	10min	pressentation	coordinating and facilitating sessain	TM-10 daily reflection sheet
9:10-10:30	LG4 : LAP test (Raiting sheet & Oral questions) >Task1~2	80min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~2 (*This process can be repeated several time until the trainees perform the given tasks as perthe standard)	TG4: PEG LG4: LAP Test
10:30-11:00	Tea break	30min			
10:45-10:45	LG4 : LAP test (Raiting sheet & Oral questions) >Task1~2	75min	oral Question & individual work /re demonistration	-Consulting and providing technical advice to each indiviuals on performingTask1~2 (*This process can be repeated several time until the trainees perform the given tasks as perthe standard)	TG4: PEG LG4: LAP Test
12:00-14:00	Launch time	120min			
14:00-15:30	Post-Test/Post-Questionnaire	60min			TG9: Post Test TG11: Post questionaire
15:30-16:00	Action Plan Session	30min			TM-10 Action plan preparation
16:00-16:45	Tea break	30min			
16:45-16:55	KAIZEN Reflection session	60min	self evaluation and scoring	evaluating the group and scoring	kaizen sheet
9:00-10:30	Presentation of Action Plan	90min			
10:30-11:00	Tea Break	30min			
11:00-11:15	Course Evaluation Sheet	15min			
11:15-12:00	Certificate preparation	45min			
12:00-14:00	Lunch break	120min			
14:00-15:00	Course Reflection Session	60min			
15:00-15:30	Tea break	30min			
15:30-17:00	Course Closing Ceremony	90min			

Answers Box self-check 1.1

Part I		
NO	Your Answer	Correct answer if false
1	F	The screw driver should be insulated
2	T	
3	T	
4	F	Filler gauge has different size
5	F	Multi meter measure voltage, resistance, current, continuity ….
6	F	Tachometer used to measure the rotating speed
7	F	Clamp meter used to measure current

Part II											
1	**E**	2	**H**	3	**G**	4	**C**	5	**A**	6	**B**

Answer Boxes self-check 1.2

Part I		
NO	Your Answer	Correct answer if false
1	F	Cylinder Head located at the top of the engine which consists tunnel for push road
2	T	
3	F	Exhaust Manifold is a set of tubes that carry the exhaust gases away from the cylinder head
4	T	
5	F	Exhaust Valve is smaller than intake valve
6	T	
7	T	
8	T	

Answer Boxes self-check 1.3

Part I							
NO	Your Answer						
1	C	2	D	3	D	4	B

Part II		
NO	Your Answer	Correct answer if false
1	F	An engine is a machine, which converts the chemical of fuel in to mechanical /heat energy
2	T	
3	F	The engine-driven injection pump supplies high pressure diesel fuel to the injectors
4	T	
5	T	
6	F	Air cleaner which cleans & filters the air before interring the combustion Chamber of an engine?
7	F	Internal combustion is combustion of fuel takes place inside the engine cylinder

Answer Boxes self-check 1.4

Part I			
NO	Your Answer	NO	Your Answer
1	B	5	C
2	A	6	D
3	C	7	C
4	D	8	B

Part II			
1	E	4	G
2	F	5	C
3	D		

Answers Box self-check LG 2

Part I		
NO	Your Answer	Correct answer if false
1	F	An alternator can produce electricity only if the prime mover is working
2	F	Alternator converts mechanical energy into electrical energy
3	T	
4	F	The function of main field coil is in the production of magnetic field and armature winding is in the production of electricity
5	F	Armature part of the main alternator is called stator.
6	F	If there is no magnetic field is created means, the produced voltage becomes ZERO

Part II									
1	D	2	E	3	F	4	A	5	B

Answers Box answer LG 3

Part I		
NO	Your Answer	Correct answer if false
1	F	Pre operation checks or inspections are performed before operating a generator
2	T	
3	T	
4	F	During idling time, the current on the control panel reads minimum
5	T	
6	F	Inspection of operation status during engine warming time (IDLE operation) is needed for smooth start up the engine
7	T	

Part II			
NO	Your Answer	NO	Your Answer
1	C	2	B

Answers Box Self check LG 4.1

Part I		
NO	Your Answer	Correct answer if false
1	T	
2	F	It has purpose for the future also
3	F	Breakdown maintenance implies that repairs are made after the equipment is failed
4	F	Preventive maintenance doing before the machine failed
5	T	

Answers Box self-check 4.2

Part I							
NO	Your Answer		NO	Your Answer		NO	Your Answer
1	G		3	E		5	A
2	C		4	B			

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**PRE-TEST**	**Score: _____** **Rating: _____**

Name: _____ Date: _____

Time started: _____ Time fished: _____

***Use the Answer Box at the end of this sheet to fill out your answers.**

Directions-1: Answer all the questions listed below:

I) Check *True/False and* make corrections if the statement is *false.*

1. An alternator can produce electricity even though the prime mover is not working.
2. Piston pin connects piston and connecting rod and should be place in the center of the piston part carrying the load to obtain uniform distribution of pressure between piston and cylinder.
3. Breakdown maintenance implies that repairs are made before the equipment is failed.
4. We measure Specific Gravity of the electrolyte to check the concentration of the acid in a battery.
5. In the production of electricity main field coil and armature winding have the same function.
6. Glow plugs are used to help start a cold diesel engine and help prevent excessive white smoke during warm-up.
7. Filler gauge consist a number of small lengths steel the same thicknesses with measurements marked on each piece.
8. Internal combustion is combustion of fuel takes place out of the engine cylinder.
9. A voltage is induced in a coil as a result of either, a coil cutting through a magnetic field, or a magnetic field cutting through a coil.
10. Pre operation checks or inspections are not performed before operating a generator.
11. Operation checklist contains checklist items which are used as a guide to perform an operation.
12. Maintenance log shows necessary status information of the generator set maintained and it has no purpose for next maintenance.

II) Choose the best answers for the questions listed below.

1. An indirect injection diesel engine uses

A. spark plug B. pre chamber and a glow plug.

C. compression Ignition D. electric spark

2. _____is a chemical reaction in which certain elements of the fuel combine with oxygen, causing an increase in temperature of the gases.

   A. Bottom Dead Center　　B. Compression Ratio

   C. Combustion chamber　　D. Combustion

3. _____is a kind of check valve which opens & closes with the effect of temperature

   A. by pass valve　B. thermostat　C. temperature switch　D. temperature senser

4. _____ is a combination of mechanical and electrical components that work together to start the engine.

   A. lubricating system　　B. solenoids (magnetic switches),

   C. starting system　　D. intake and exhaust system

5. It draws fresh air through the radiator and thus increases the efficiency of the radiator in cooling hot water

   A. Air cooling system　B. Water cooling system　C. Fan　D. Cooling fins

6. When is the performance tests done?

   A. Before starting the generator　　B. After the generator is started

   C. After the generator is stopped/shutdown　　D. When the generator is under maintenance

7. _____ supplies fuel to the injectors according to the firing order at the constant stroke correct time in the cycle.

   A. primary pump　　B. injection nozzle

   C. fuel solenoid　　D. injection pump

8. The current will increase as far as connected loads increased and this change should be recorded on

   A. Pre-operation checks　　B. Maintenance log sheet

   C. Generator operation log　　D. Inspection checklist

III) Matching: choose the right corresponding match for the components of learning guide listed under item A, with their possible quality parameters listed under item B.

Item A	Item B
1. AVR 2. Engine fails to start 3. Engine Stops After it starts 4. generator has no electrical output 5. Starter motor does not stop running 6. Armature 7. Field winding 8. vernier caliper 9. starting system 10. Rectifier	A. used to turn the engine crankshaft until the engine starts. B. Magnetic field producing component of electrical machine C. Electrical regulator designed to automatically maintain a constant voltage level. D. Faulty/dead battery E. Electrical device, consists of diodes that convert AC to DC F. Faulty lines coming to the AVR G. Linear dimension H. Output-producing component of an electrical machine I. Running clutch sticks to shaft J. Air exists in fuel system

Pre-test answer sheet

I) True/false

No.	Your answer	Make Correct answer if false
1	F	An alternator can produce electricity only if the prime mover is working
2	T	
3	F	Breakdown maintenance implies that repairs are made after the equipment is failed
4	T	
5	F	The function of main field coil is in the production of magnetic field and armature winding is in the production of electricity
6	T	
7	F	Filler gauge has different size
8	F	Internal combustion is combustion of fuel takes place inside the engine cylinder
9	T	
10	F	Pre operation checks or inspections are performed before operating a generator
11	T	
12	F	It has purpose for the future also

II) Multiple chooses

1	2	3	4	5	6	7	8
B	D	B	C	C	B	D	C

III) Matching

1	2	3	4	5	6	7	8	9	10
C	D	J	F	I	H	B	G	A	E

ETHIOPIAN WATER TECHNOLOGY INSTITUTE EWTI	**Post-TEST QUESTION SHEET**	**Score: _____** **Rating: _____**

Name: _____ Date: _____

Time started: _____ Time fished: _____

***Use the Answer Box at the end of this sheet to fill out your answers.**

I) Choose the best answers for the questions listed below.

1. An indirect injection diesel engine uses
   A. spark plug B. pre chamber and a glow plug.
   C. compression Ignition D. electric spark
2. _____is a chemical reaction in which certain elements of the fuel combine with oxygen, causing an increase in temperature of the gases.
   A. Bottom Dead Center B. Compression Ratio
   C. Combustion chamber D. Combustion
3. _____is a kind of check valve which opens & closes with the effect of temperature
   A. by pass valve B. thermostat
   C. temperature switch D. temperature senser
4. _____ is a combination of mechanical and electrical components that work together to start the engine.
   A. lubricating system B. solenoids (magnetic switches)
   C. starting system D. intake and exhaust system
5. It draws fresh air through the radiator and thus increases the efficiency of the radiator in cooling hot water
   A. Air cooling system B. Water cooling system C. Fan D. Cooling fins
6. When is the performance tests done?
   A. Before starting the generator B. After the generator is started
   C.After the generator is stopped/shutdown D. When the generator is under maintenance
7. _____ supplies fuel to the injectors according to the firing order at the constant stroke correct time in the cycle.
   A. primary pump B. injection nozzle
   C. fuel solenoid D. injection pump

8. The current will increase as far as connected loads increased and this change should be recorded on

A. Pre-operation checks B. Maintenance log sheet

C. Generator operation log D. Inspection checklist

II) Check True/False, and make corrections if the statement is false.

1. An alternator can produce electricity even though the prime mover is not working.
2. Piston pin connects piston and connecting rod and should be place in the center of the piston part carrying the load to obtain uniform distribution of pressure between piston and cylinder.
3. Breakdown maintenance implies that repairs are made before the equipment is failed.
4. We measure Specific Gravity of the electrolyte to check the concentration of the acid in a battery.
5. In the production of electricity main field coil and armature winding have the same function.
6. Glow plugs are used to help start a cold diesel engine and help prevent excessive white smoke during warm-up.
7. Filler gauge consist a number of small lengths steel the same thicknesses with measurements marked on each piece.
8. Internal combustion is combustion of fuel takes place out of the engine cylinder.
9. A voltage is induced in a coil as a result of either, a coil cutting through a magnetic field, or a magnetic field cutting through a coil.
10. Pre operation checks or inspections are not performed before operating a generator.
11. Operation checklist contains checklist items which are used as a guide to perform an operation.
12. Maintenance log shows necessary status information of the generator set maintained and it has no purpose for next maintenance.

III) Matching: choose the right corresponding match for the components of learning guide listed under item A, with their possible quality parameters listed under item B.

Item A	Item B
1. AVR 2. Engine fails to start 3. Engine Stops After it starts 4. generator has no electrical output 5. Starter motor does not stop running 6. Armature 7. Field winding 8. vernier caliper 9. starting system 10. Rectifier	A. used to turn the engine crankshaft until the engine starts. B. Magnetic field producing component of electrical machine C. Electrical regulator designed to automatically maintain a constant voltage level. D. Faulty/dead battery E. Electrical device, consists of diodes that convert AC to DC F. Faulty lines coming to the AVR G. Linear dimension H. Output-producing component of an electrical machine I. Running clutch sticks to shaft J. Air exists in fuel system

Post-test answer sheet

I) Multiple chooses

1	2	3	4	5	6	7	8
B	D	B	C	C	B	D	C

II) True/false

No.	Your answer	Make Correct answer if false
1	F	An alternator can produce electricity only if the prime mover is working
2	T	
3	F	Breakdown maintenance implies that repairs are made after the equipment is failed
4	T	
5	F	The function of main field coil is in the production of magnetic field and armature winding is in the production of electricity
6	T	
7	F	Filler gauge has different size
8	F	Internal combustion is combustion of fuel takes place inside the engine cylinder
9	T	
10	F	Pre operation checks or inspections are performed before operating a generator
11	T	
12	F	It has purpose for the future also

III) Matching

1	2	3	4	5	6	7	8	9	10
C	D	J	F	I	H	B	G	A	E

Pre-Questionnaire

Module title: - Operating & Maintaining a Gen-set
Trainee's Name: _____Date _____

Common Module: - Teamwork, OH & S and KAIZEN	Please check (✓) the degree of your past experiences			
During your job experiences so far, did you:	**Had no related Experiences**	**Observed someone performing**	**Assisted someone performed**	**Performed yourself successfully**
Organize team work and Communication?	☐	☐	☐	☐
Apply occupational Safety and Personal Protection?	☐	☐	☐	☐
Conduct Kaizen based activity in work place?	☐	☐	☐	☐
Overall, I think I am:	(Check one ✓) Confident to do this job now ☐ **>95%** ☐ **>80%** ☐ **>65%** ☐ **>55%** ☐ **< 55%**			

LO1: - Demonstrate and Testing functionality of Diesel Engine parts and supporting system	Please check (✓) the degree of your past experiences			
During your job experiences so far, did you:	**Had no related Experiences**	**Observed someone performing**	**Assisted someone performed**	**Performed yourself successfully**
Demonstrate the necessary tools, equipment and consumable materials needed for gen-set operation & maintenance?	☐	☐	☐	☐
Demonstrate engine assembly of the Gen-set and main components	☐	☐	☐	☐
Testing functionality of supporting/auxiliary systems for the Gen-set	☐	☐	☐	☐
Overall, I feel I am:	(Check one ✓) Confident to do this job now ☐ **>95%** ☐ **>80%** ☐ **>65%** ☐ **>55%** ☐ **< 55%**			

LO2: - Demonstrate and Testing functionality of Electrical parts and main Alternator	Please check (✓) the degree of your past experiences			
During your job experiences so far, did you:	**Had no related Experiences**	**Observed someone performing**	**Assisted someone performed**	**Performed yourself successfully**
Demonstrate each part on main alternator assembly	☐	☐	☐	☐
Testing functionality of supporting/auxiliary systems for the Gen-set	☐	☐	☐	☐
Overall, I feel I am:	(Check one ✓) Confident to do this job now ☐ **>95%** ☐ **>80%** ☐ **>65%** ☐ **>55%** ☐ **< 55%**			

LO3: - Operate a gen-set	Please check (✓) the degree of your past experiences			
During your job experiences so far, did you:	**Had no related Experiences**	**Observed someone performing**	**Assisted someone performed**	**Performed yourself successfully**
Perform pre operation checks to start the genset and record the operation activity before starting	☐	☐	☐	☐
Perform Starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist	☐	☐	☐	☐
Shutdown the gen-set by following the correct shutdown steps and use the operation log sheet to record the operation data or readings after shutdown	☐	☐	☐	☐
Use the operation log sheet to record the operation activity (before and after)?	☐	☐	☐	☐
Overall, I feel I am:	(Check one ✓) Confident to do this job now ☐ **>95%** ☐ **>80%** ☐ **>65%** ☐ **>55%** ☐ **< 55%**			

LO4: - Perform gen-set maintenance	Please check (✓) the degree of your past experiences			
During your job experiences so far, did you:	**Had no related Experiences**	**Observed someone performing**	**Assisted someone performed**	**Performed yourself successfully**
Propose possible causes for the problem Engine fails to start occurred	☐	☐	☐	☐
Propose possible causes for the problem A generator is not delivering electricity /No output	☐	☐	☐	☐
Use the maintenance log sheet to record the maintenance activity	☐	☐	☐	☐
Uses the proper tools & measuring instruments, perform troubleshooting	☐	☐	☐	☐
Solve the identified failure by the help of proper tools, measuring instruments, consumable materials and spare parts	☐	☐	☐	☐
Overall, I feel I am:	(Check one ✓) Confident to do this job now ☐ **>95%** ☐ **>80%** ☐ **>65%** ☐ **>55%** ☐ **< 55%**			

Post Questionnaire

Module title: - Operating & Maintaining a Gen-set
Trainee's Name: _____Date _____

Common Module: - Teamwork, OH & S and KAIZEN	Please check (√) to show if evidence is demonstrated			
When back to your job place, will you:	**No, I can' t**	**I can perform with the help of**	**I can perform as as an assistant**	**I can perform by myself successfull**
Organize team work and Communication?	☐	☐	☐	☐
Apply occupational Safety and Personal Protection?	☐	☐	☐	☐
Conduct Kaizen based activity in work place?	☐	☐	☐	☐
Overall, I feel I am:	☐**Competent to do this job now**	☐ **Not Competent to do this job now**		

LO1: - Demonstrate and Testing functionality of Diesel Engine parts and supporting system	Please check (√) to show if evidence is demonstrated			
When back to your job place, will you:	**No, I can' t**	**I can perform with the help of**	**I can perform as as an assistant**	**I can perform by myself successfull**
Demonstrate the necessary tools, equipment and consumable materials needed for gen-set operation & maintenance?	☐	☐	☐	☐
Demonstrate engine assembly of the Gen-set and main components	☐	☐	☐	☐
Testing functionality of supporting/auxiliary systems for the Gen-set	☐	☐	☐	☐
Overall, I feel I am:	☐**Competent to do this job now**	☐ **Not Competent to do this job now**		

LO2: - Demonstrate and Testing functionality of Electrical parts and main Alternator	Please check (√) to show if evidence is demonstrated			
When back to your job place, will you:	**No, I can' t**	**I can perform with the help of**	**I can perform as as an assistant**	**I can perform by myself successfully**
Demonstrate each part on main alternator assembly	☐	☐	☐	☐
Testing functionality of supporting/auxiliary systems for the Gen-set	☐	☐	☐	☐
Overall, I feel I am:	☐**Competent to do this job now**	☐ **Not Competent to do this job now**		

LO4: - Operate a gen-set	Please check (√) to show if evidence is demonstrated			
When back to your job place, will you:	**No, I can' t**	**I can perform with the help of**	**I can perform as as an assistant**	**I can perform by myself successfull**
Perform pre operation checks to start the genset and record the operation activity before starting	☐	☐	☐	☐
Perform Starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist	☐	☐	☐	☐
Shutdown the gen-set by following the correct shutdown steps and use the operation log sheet to record the operation data or readings after shutdown	☐	☐	☐	☐
Use the operation log sheet to record the operation activity (before and after)?	☐	☐	☐	☐
Overall, I feel I am:	☐**Competent to do this job now**	☐ **Not Competent to do this job now**		

LO5: - Perform generator maintenance	Please check (√) to show if evidence is demonstrated			
When back to your job place, will you:	**No, I can' t**	**I can perform with the help of**	**I can perform as as an assistant**	**I can perform by myself successfull**
Propose possible causes for the problem Engine fails to start occurred	☐	☐	☐	☐
Propose possible causes for the problem A generator is not delivering electricity /No output	☐	☐	☐	☐
Use the maintenance log sheet to record the maintenance activity	☐	☐	☐	☐
Uses the proper tools & measuring instruments, perform troubleshooting	☐	☐	☐	☐
Solve the identified failure by the help of proper tools, measuring instruments, consumable materials and spare parts	☐	☐	☐	☐
Overall, I feel I am:	☐**Competent to do this job now**	☐ **Not Competent to do this job now**		

Ethiopian Water Technology Institute (EWTI)

Electromechanical Machineries Maintenance Technology Training

Learning Guide #01

Unit of Competence: Gen-set Operation & Maintenance

Module Title: Operating & Maintaining a Gen-set

LG Code: EMMT/GEN/LM01/0421 V1

TTLM Code: EMMT/GEN/TTLM 0421 V1

LO1: - Demonstrate and Testing functionality of Diesel Engine parts and supporting system

Instruction Sheet LG #1	Demonstrate and Testing functionality of Diesel Engine parts and supporting system

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

1.1 Demonstration of tools, instruments, consumables materials & spare parts
1.2 Engine major parts, components & its classification
1.3 Diesel engine working principle
1.4 Engine supporting/Auxiliary systems

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

1. Demonstrate & Testing functionality engine assembly of the Gen-set and main components
2. Demonstrate & Testing functionality parts of engine supporting/auxiliary systems

Learning Instructions:

1. There are 4 parts of basic knowledge and skills that underpin performance related to the job in this Learning Guide. You are expected to go through all the parts to prepare yourself for starting operation and LAP test at the end of this Learning Guide.
2. Try to answer to “Self-check 1” to confirm your current knowledge. Leave any items blank that you cannot answer now, which is for you to learn in this Guide.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed, and answer all items in “Self-check 1,” including the items you could not answer when you tried for the first time. You may be tested using “Self-check 1” to confirm your understanding of the basics,
4. Demonstrate operation sheet and conduct the LAP test to complete this learning guide.
5. For more information see the reference material listed at the end of the learning guide.

Self-check 1.1	Identification of tools, instruments, consumables materials & spare parts

Time started:_____ **Time finished:**_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) <u>Check True/False and make correction if the statement is false.</u>

1. uninsulated Screwdriver protects the user from touching live parts of a circuit and the grounded walls of the box or other equipment.
2. Crimping tool is a device used to conjoin two pieces of metal by deforming one or both of them in a way that causes them to hold each other.
3. Micrometer is a device incorporating a calibrated screw widely used for accurate measurement of components in mechanical engineering and machining.
4. Filler gauges consist of a number of small lengths steel the same thicknesses with measurements marked on each piece.
5. A typical multi meter can measure only current and resistance.
6. Tachometer is a device used to test the state of charge of a battery cell.
7. Clamp meter is used to measure the insulation resistance of windings.

II) <u>Match tools listed in A with their functions listed in B</u>

Item A	Item B
1. Wrench 2. Megger 3. wire striper 4. Allen key 5. vernier caliper 6. belt wrench	A. Linear dimension B. Remove filters C. L-shaped tool D. Micrometer E. Open and close spanner F. Bench vice G. Remove electrical insulation H. measures insulation resistance

Answer Box

Part I		
NO	Your Answer	Correct answer if false
1		
2		
3		
4		
5		
6		
7		

Part II											
1		2		3		4		5		6	

Information Sheet- 1.1	Identification of tools, instruments, consumables materials & spare parts

INTRODUCTION

Tool - an instrument for making material changes on other objects, as by cutting, shearing, striking, rubbing, grinding, squeezing, measuring, or other processes. Tools include hand tools, digging tools, hot line tools, miscellaneous & special tools, and tackle.

Hand tools: A hand tool is a small manual instrument traditionally operated by the muscular strength of the user. A good set of hand tools includes an assortment of wrenches, screwdrivers, pliers, wire cutters, wire strippers, channel locks, punches, hammers and other common hand tools.

Tools and instruments

1. **Insulated Screwdriver: -** This is a specially designed screwdriver that has a tough, non-conductive plastic cover over the shaft and handles. Only the tip of an insulated screwdriver is exposed. The insulation protects the user from the possibility of touching live parts of a circuit and the grounded walls of the box or other equipment. By having the shaft of the screwdriver protectively coated, it is safe to hold the screwdriver here to balance the screwdriver. In addition to the personal safety benefit, insulated screwdrivers also can prevent damage to delicate electronic parts that might be destroyed by an electrical short.

Figure 1.1 Insulated Screwdriver

2. **Combination pliers: -** are heavy-duty, side-cutting pliers, also known as lineman pliers or side cutters, which are designed for all regular wire-cutting needs. They have gripping jaws, a cutting edge, and insulating handle grips that reduce (but don't eliminate) the risk of electric shock from contact with live wires.

Figure 1.2 Combination pliers

3. **Wrenches: -** A wrench or spanner is a tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners, such as nuts and bolts or keep them from turning. In Commonwealth English, spanner is the standard term. The most common shapes are called open-ended spanner and ring spanner.

Figure 1.3 Wrenches

4. **Allen key: -** An Allen wrench is one of the simplest wrenches tool used to drive bolts and screws with hexagonal sockets in their heads. The Allen wrench itself is a small L-shaped wrench with six sides. If you look at a cross-section of the Allen wrench, it looks like a hexagon. Since the Allen wrench has such a specific shape, it can only be used with items especially designed for it. If you've ever bought furniture you've had to put together yourself, the manufacturer likely included an Allen wrench for you to use when you have to assemble it.

Figure 1.4 Allen key

5. **Crimper: -** A crimping tool is a device used to conjoin two pieces of metal by deforming one or both of them in a way that causes them to hold each other. The result of the tool's work is called a crimp. A good example of crimping is the process of affixing a connector to the end of a cable.

Figure 1.5 Crimper

6. **Belt wrench: -** a special tool used to remove oil and fuel filters.

Figure 1.6 Belt wrench

7. **Battery Hydrometer: -** A battery hydrometer is used to test the state of charge of a battery cell. This is performed by measuring the density of the

electrolyte, which is accomplished by measuring the specific gravity of the electrolyte. The greater the concentration of sulfuric acid, the denser the electrolyte becomes.

Figure 1.7 Battery Hydrometer

8. **Vernier caliper: -** A Vernier caliper is a measuring device used to precisely measure linear dimensions. It is a very useful tool to use when measuring the diameter of a round objects like cylinders because the measuring jaws can be secured on either side of the circumference. Vernier calipers have both a fixed main scale and a moving Vernier scale. The main scale is graduated in either milli-meters or tenths of an inch. The Vernier scale allows much more precise readings to be taken (usually to the nearest 0.02mm or 0.001 inch) in comparison to a standard ruler (which only measures to the nearest 1mm or 0.25 inch). The Vernier scale was invented by French mathematician Pierre Vernier in 1631. As part of the Vernier caliper, it is used together with the main scale, and helps to provide very precise measurements. Vernier calipers usually show either imperial or metric measurements, but some measure in both.

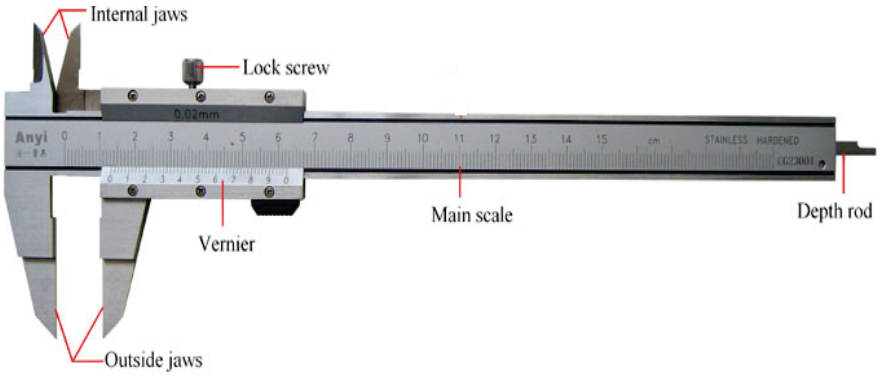


Figure 1.8 Vernier caliper

9. **Micrometer: - A** micrometer, sometimes known as a micrometer screw gauge, is a device incorporating a calibrated screw widely used for accurate

measurement of components in mechanical engineering and machining as well as most mechanical trades, along with other metrological instruments such as dial, Vernier, and digital calipers.

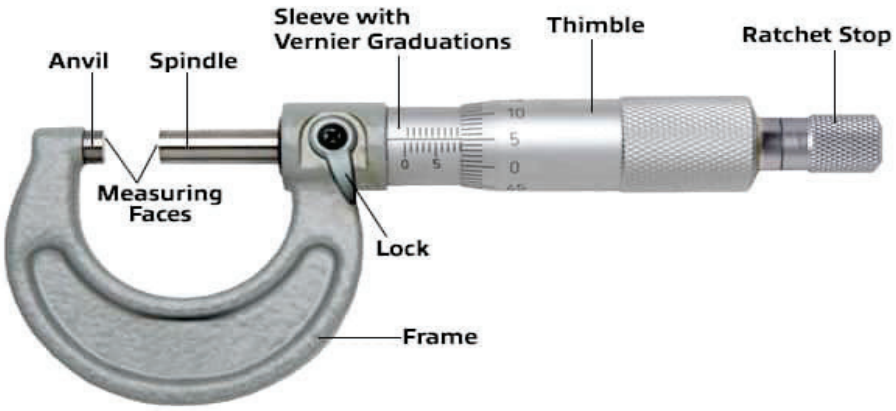


Figure 1.9 Micrometer

10. **Battery: -** An automotive battery is a rechargeable battery that supplies direct current (DC) to a starter motor and dc electrical devices. Its main purpose is to feed the starter, which starts the engine. Once the engine is running, power for the car's (in our case gen-set) electrical systems is supplied by the alternator.

Figure 1.10 Battery

11. **Battery charger: -** used to recharge starting batteries.

Figure 1.11 Battery charger

12. **Filler gage**: - is a tool used to measure gap widths. Feeler gauges are mostly used in engineering to measure the clearance between two parts. They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. They are flexible enough that, even if they are all on the same hinge, several can be stacked together to gauge intermediate values. The same device with wires of specific diameter instead of flat blades is used to set the gap during valve adjustment to the correct size; this is done by increasing or decreasing the gap until the gauge of the correct size just fits inside the gap. The lengths of steel are sometimes called leaves or blades, although they have no sharp edge.

Figure 1.12 Filler gage

13. **Bench Vice** - is a mechanical apparatus used to secure an object to allow work to be performed on it.

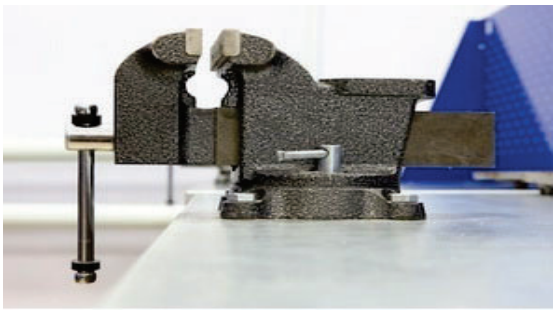


Figure 1.13 Bench Vice

14. **Multimeter** – A multimeter or a multimeter, also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current and resistance. A multimeter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high degree of accuracy.
15. **Clamp meter** - In electrical and electronic engineering, a current clamp or current probe is an electrical device with jaws which open to allow clamping around an electrical conductor. This allows measurement of the current in a conductor without the need to make physical contact with it, or to disconnect it for insertion through the probe.
16. **Megger (insulation resistance tester)** – is used to measure the insulation resistance of windings.
17. **Power/Power meter:** - is used to measure the existing capacity of generator that delivered po.

fig 1.14a volt-meter

fig 1.14b clapmp meter

fig 1.14c Megger

fig 1.14d Power/power factor meter

18. **Tachometer**: - is a device used to measure speed of rotation. The speed at which shafts rotate can be a key indicator of performance.

Figure 1.15 Tachometer

19. **Wire striper**: - is a small, hand-held device used to strip the electrical insulation from electric wires.

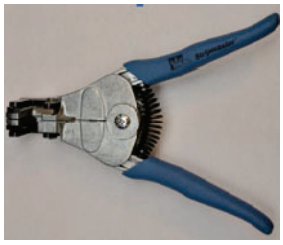


Figure 1.16 Wire striper

20. **Diagonal plier**: - Diagonal pliers (or wire cutters or diagonal cutting pliers or diagonal cutters or side cutting pliers) are pliers intended for the cutting of wire.

Figure 1.17 Diagonal plier

Spare parts and consumables

1. **Oil filter**: -an oil filter is a filter designed to remove contaminants from engine oil, transmission oil, lubricating oil, or hydraulic oil. Oil filters are used in many different types of hydraulic machinery. A chief use of the oil filter is in internal combustion engine, in on- and off-road motor vehicles, light aircraft, and various naval vessels. Other vehicle hydraulic systems, such as those in automatic transmissions and power steering, are often equipped with an oil filter. Gas turbine engines, such as those on jet aircraft, also require the use of oil filters. Aside

Figure 1.18 Oil filter

from these uses, oil production, transport, and recycling facilities also employ filters in the manufacturing process.

2. **Fuel filter**: -A fuel filter is a filter in the fuel line that screens out dirt and dust particles from the fuel, normally made into cartridges containing a filter paper. They are found in most internal combustion engines.

Figure 1.19 Fuel filter

3. **Air cleaner: -** allows the engine to get clean air during air intake, a key component in the combustion process. It prevents airborne contaminants such as dirt, dust and leaves from getting pulled into an engine and potentially damaging it.

Figure 1.20 Air cleaner

4. **Others: -**rest of spare parts that will be used for operation and maintenance will be devices or items that will be changed due to damage or poor functioning. These may include oil and/or fuel injection pumps, small alternator or its parts, starter motor or its parts, sensors and switches, fuel shut off solenoid, relays, circuit breaker, rectifiers, Automatic Voltage Regulator,

5. **Consumable Materials**: - Some of consumable material which will be used during operation and maintenance are Fuel, Engine Oil, gaskets, Rag for cleaning, Grease, Penetrating Oil to loosen stacked mechanical connections, Cables, Cable connectors, Cable lug, coolant for radiator, Battery acid and/ or Distilled water, Soda ash for cleaning corroded battery terminals.

Self-check 1.2	Engine major parts, components & its classification

Time started:_____ Time finished:_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) Check True/False and make correction if the statement is false.

1. Cylinder Head located at the top of the engine which consists of bores for the pistons.
2. Crank shaft is the main rotating part of an engine, which converts the reciprocating motion of the piston to straight-line motion.
3. Exhaust Manifold is a set of tubes that carry the exhaust gases away from the cylinder head towards the intake manifold.
4. Flywheel is a heavy disc bolted to the engine crankshaft.
5. Exhaust Valve is larger than intake valve to provide enough space for the high-pressure exhaust gases to get out of the cylinder.
6. Rocker Arm is pivoted lever that transfers cam or pushrod motion to the valve stem that the valves will open and close.
7. Cylinder Block is considered the foundation block of the engine which consists of bores for the pistons, passages for the water to cool the cylinder, galleries for the lubrication system, and tunnels for push rods.
8. Piston pin connects piston and connecting rod and should be place in the center of the piston part carrying the load to obtain uniform distribution of pressure between piston and cylinder.

Answer Boxes

Part I		
NO	Your Answer	Correct answer if false
1		
2		
3		
4		
5		
6		
7		

Information sheet 1.2	Engine major parts, components & its classification

INTRODUCTION

- A generator set is the combination of the prime mover (engine - for the case of engine driven generators) and alternator - electricity generation parts. Those are the two major parts of the generator set (Gen-set). For the case of engine driven generators, the engine assembly is one of the major parts and the generator/alternator assembly is the second major part.
- Engine - An engine is a machine, which converts the chemical energy of the fuel in to heat energy and then into mechanical energy it is usually called heat engine. The combustion of fuel such as coal, petrol and diesel generate heat. This heat is supplied to a working substance at high temperature.

Engine components

- **Cylinder Head Assembly** (located at the top of the engine) - consists of valve & spring, camshaft, rocker arm, and combustion chamber.

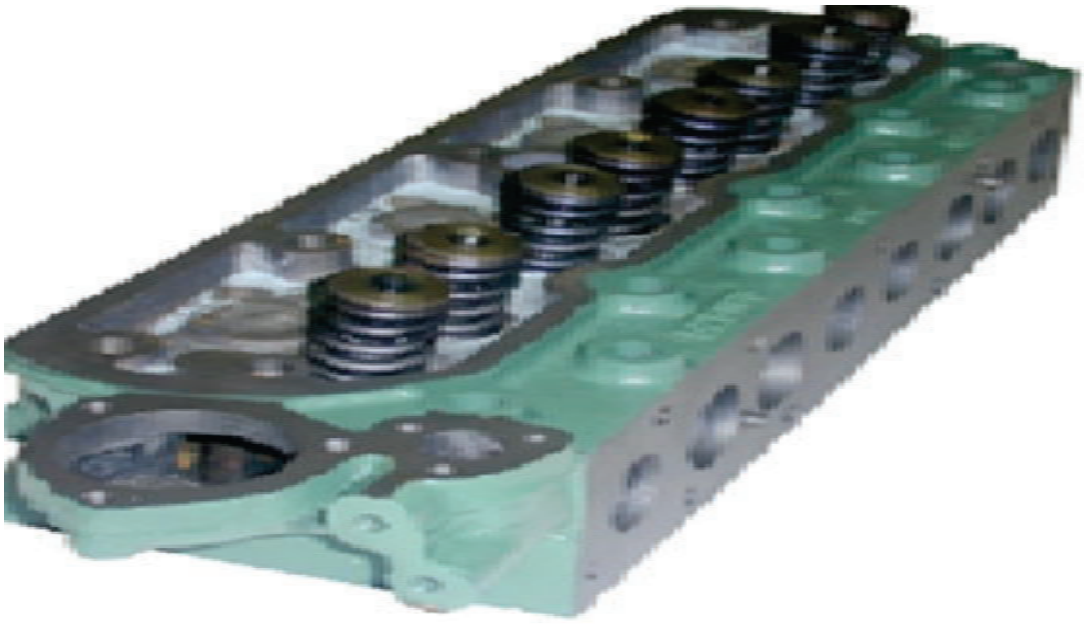


Figure 1.21: cylinder head

- **Intake valves** – opens at the proper time to let in air. Open and seal the intake ports. Intake Valve is usually larger than exhaust valve to produce greater atmospheric pressure so that more air/fuel will enter the engine cylinder.
- **Exhaust valves** – open at the proper time to release the exhaust. Open and seal the exhaust ports. Exhaust Valve is smaller than intake valve to provide enough space for the high-pressure exhaust gases to get out of the cylinder.
- **Valve springs** – both close the valves and hold them open.
- **Spring retainers** – hold the springs on the end of the valves.

Figure 1.22: intake and exhaust valves

- **Cylinder Block Assembly: -** Cylinder block Works to place various engine compartments that support the working process of the machine. It is considered the foundation block of the engine. It has bores for the pistons, passages for the water to cool the cylinder, galleries for the lubrication system, and tunnels for push rods.

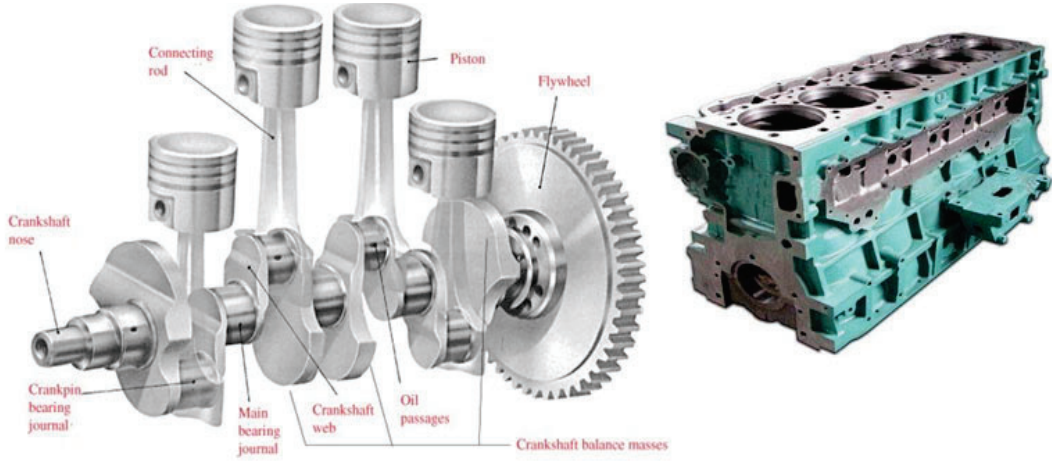


Figure 1.23: Inside cylinder block assembly

- **Cylinder –** hollow, stationary, in which piston moves up and down within it. It is fined machined part which is usually cast as part of crank case. The piston moves up and down within so the clearance very small. the nucleus of all activities, but principally for receiving and burning fuel.

- Is usually made up of cast iron which is called semi steel whose tensile strength ranges.
- from 10,000 to 30,000 psi and with elastic limits in tension from 10,000 to 30,000.

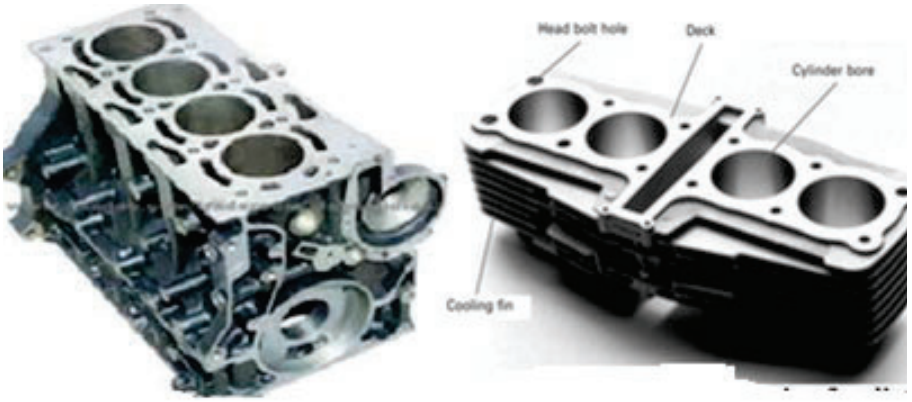


Figure 1.24: Cylinder

- **Piston -** Forms a movable seal between the engine's combustion chamber and its crankcase. It transmits the gas pressure which occurs during combustion to the connecting road and hence to the crankshaft. At the same time, it must transmit any lateral forces which arise to the cylinder wall. It dissipates the heat which enters the piston crown when it is in contact with the combustion gases as completely and rapidly as possible to the cylinder wall and to the coolant. It is a cylindrical casting closed at the top and open at the bottom, moving up and down or back and forth in the engine cylinder.

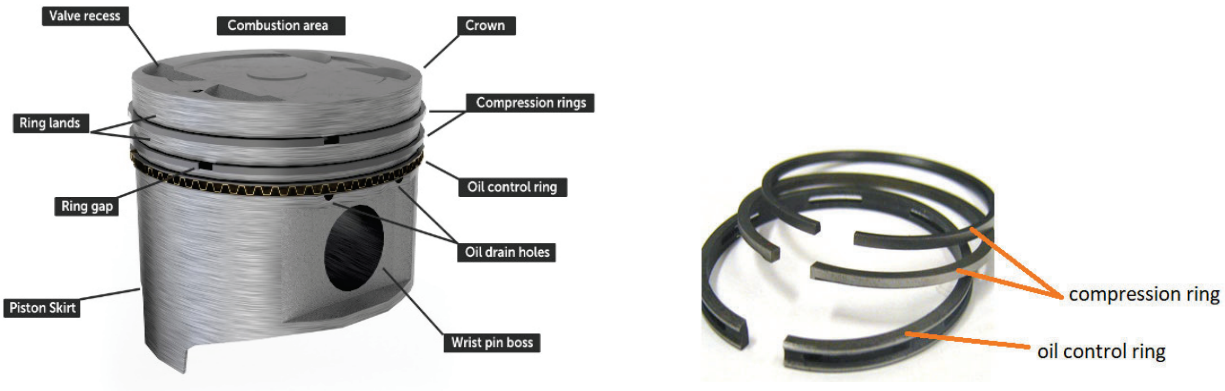


Figure1.25: Piston and piston rings

- **Piston Pin** - connects piston and connecting rod and should be place in the center of the piston part carrying the load to obtain uniform distribution of pressure between piston and cylinder. It also transmits the force of explosion in the piston to the connecting rod as it serves as the pivoting point. It will provide a complete tight seal between the piston and the cylinder wall.

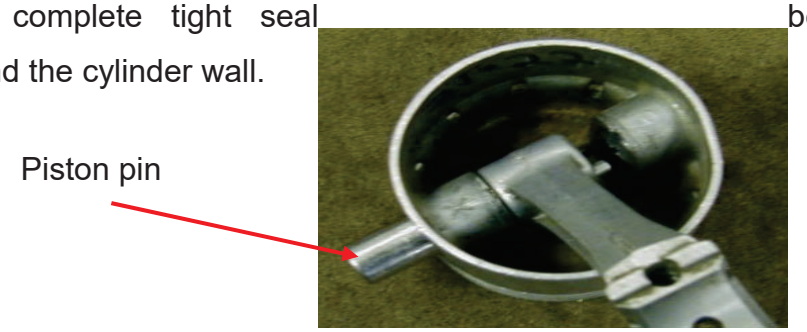


Figure 1.26: piston pin

- **Connecting rod -** It connects the piston to the crankshaft and, since its lower or 'big' end is attached to an offset crankpin on the crankshaft. It converts linear movement of the piston into rotary movement of the crankshaft. By doing so, it transforms the linear force of the piston into a rotary force or torque.

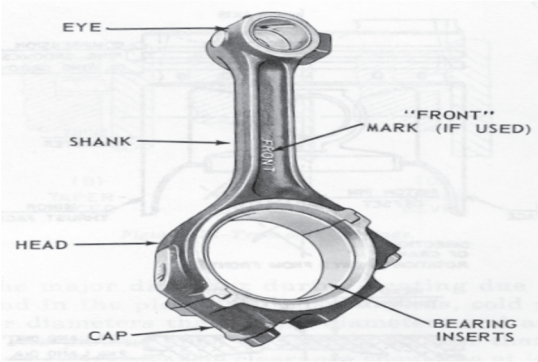


Figure 1.27: Connecting rod

- **Crankshaft -** It is the main shaft of an engine which converts the reciprocating motion of the piston into rotary motion of the flywheel.

  ✧ Engine speed– speed at which the crankshaft rotates (measured in revolutions per minute)

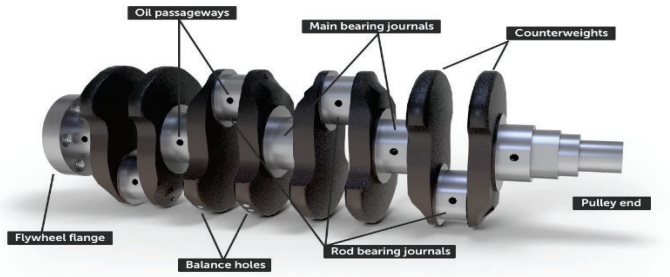


Figure 1.28a: Crankshaft

- **Flywheel –** It stores up energy to help the engine over idle strokes of the piston i.e., suction, compression and exhaust. It dampens out speed fluctuations of the crankshaft due to the varying effect of the firing impulses during the engine cycle. It provides a convenient mounting point for the clutch and starter ring gear.

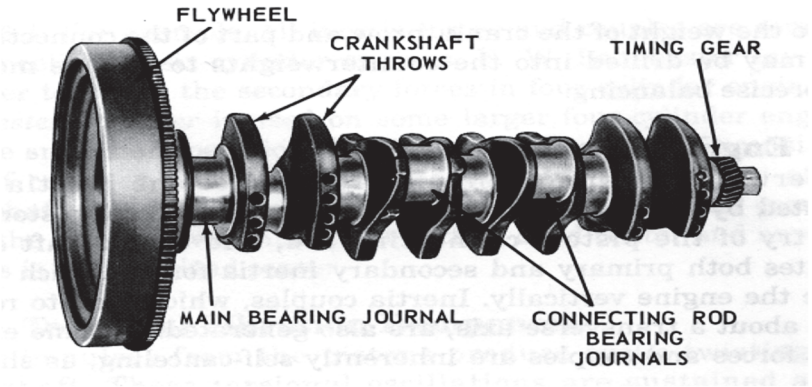


Figure 1.28b: Flywheel

- **Timing Belt–** is a part of an internal combustion engine that synchronizes the rotation of the crankshaft, the camshaft(s) and alternator.

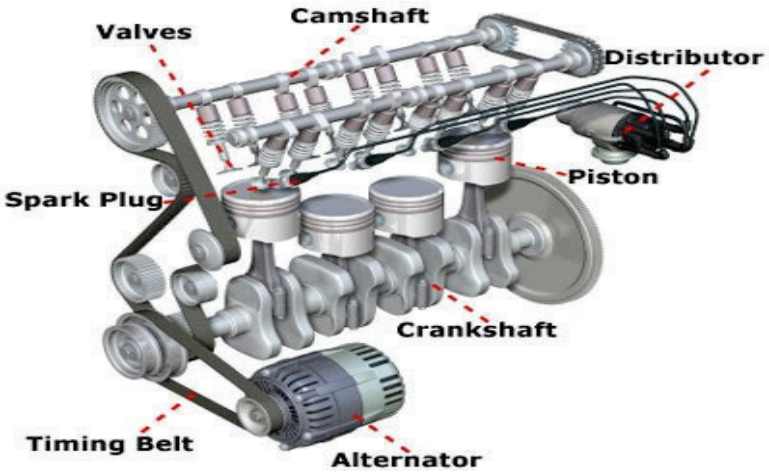


Figure 1.29: timing belt/chain

- **Camshaft** – a round shaft with lobes, that rotates to open and close the intake and exhaust valves in correct sequence. Camshaft is driven from the crankshaft by a timing chain or gears and runs at half crankshaft speed. It will be found either in cylinder block or cylinder head.
- **Rocker Arm**-It is pivoted lever that transfers cam or pushrod motion to the valve stems so that the valves will open and close.

Figure 1.30a: camshaf Figure 1.30b: rocker arm on the rocker shaft

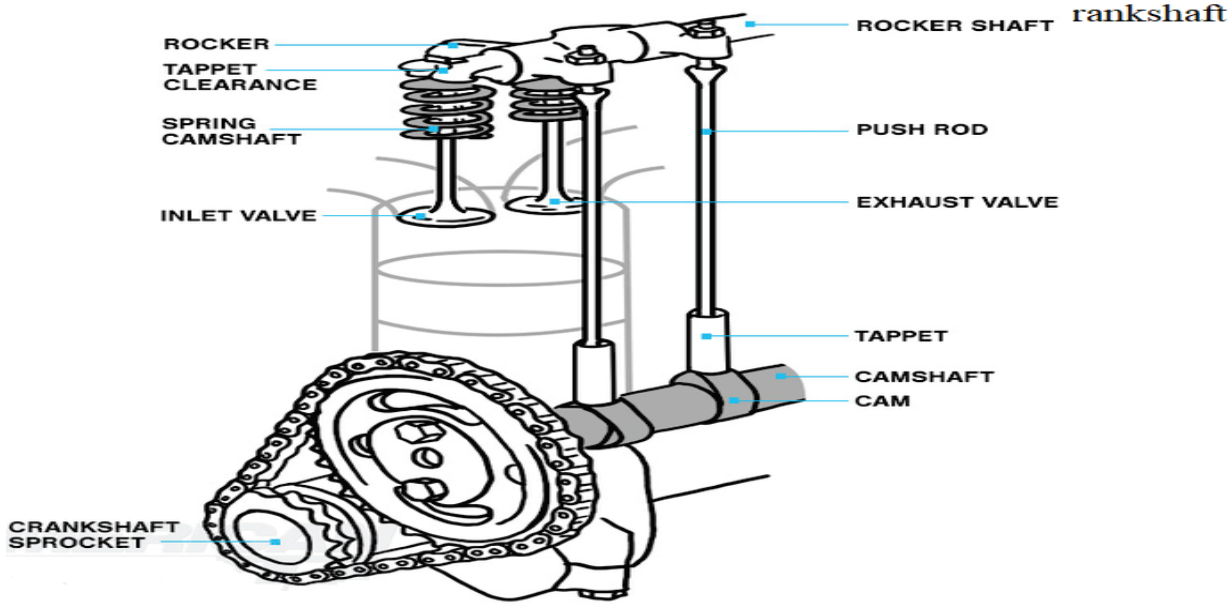


Figure 1.30c: camshaft in cylinder block and related parts

- **Oil Pan** - Serves as a sealed reservoir to contain the engine oil used to lubricate the moving parts in the engine, made of aluminum, steel or plastics.

Figure 1.31: oil pan

- **Intake Manifold -** It is a set of tubes that carry the air/fuel to the engine cylinder.
- **Exhaust Manifold -** It is a set of tubes that carry the exhaust gases away from the cylinder head towards the exhaust system.

Figure 1.32a intake Manifold

Figure 1.32b Exhaust Manifold

- **Engine Bearings (Sleeve Bearings) -** They are shaped like sleeves that fit around the rotating shaft. The part of the shaft that rotates in the bearing is called journal.
- **Thrust Bearings** - It has the purpose to keep from moving back and forth in the block.
- **Valve Train** - It is an engine moving mechanism that drives the valve assembly to open or close, which is operated by the camshaft located either in the cylinder block or in the cylinder head. Valve train can be installed in two type's engines.
- **Overhead-Valve Engine** - It uses push rods and valve lifters as linkage to drive the valves to open and close. Likewise, the installation of the camshaft is situated inside the cylinder block, which is driven either chain or gear.

- **Single or Double Overhead Camshaft (SOHC/DOHC) Engines** - this refers to a single or double camshaft, which is installed in the top of the cylinder head. This type of valve train is likewise driven by a chain or belt.

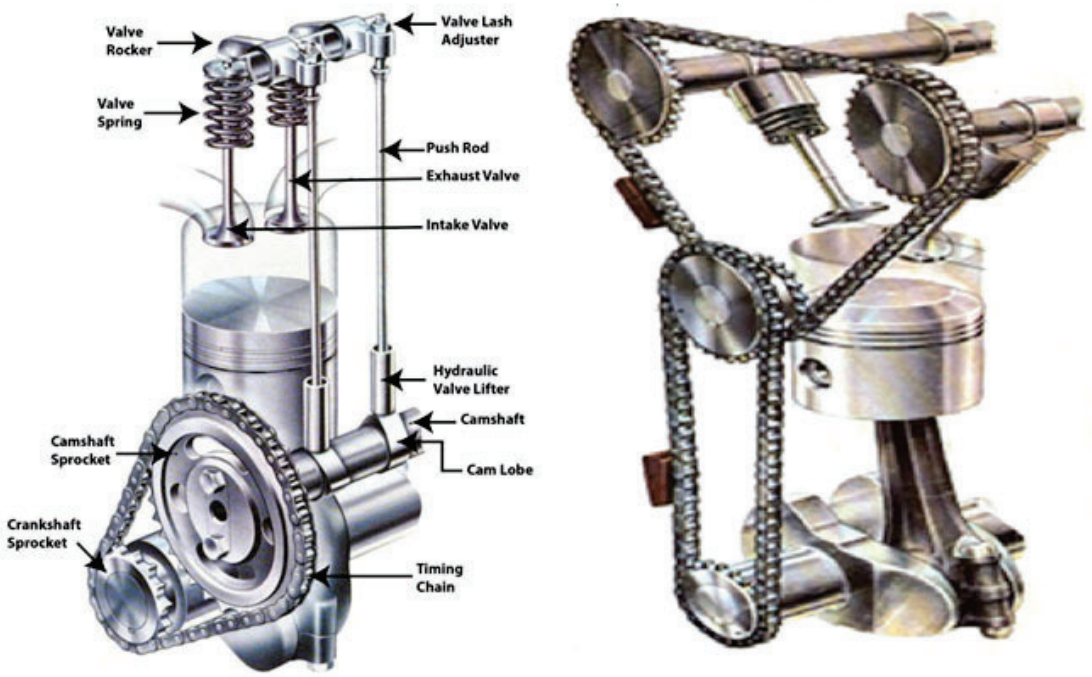


Figure 1.33: Valve Train (Overhead Valve Engine)

- **Oil Pump** - It is a device that draws oil with high pressure from the oil pan in order to lubricate the engine parts.
- **Radiator** - A heat transfer device.

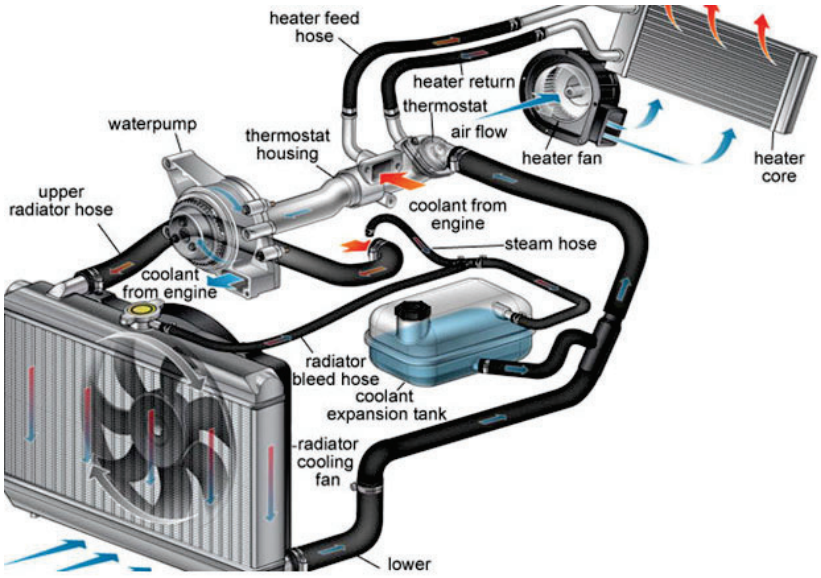
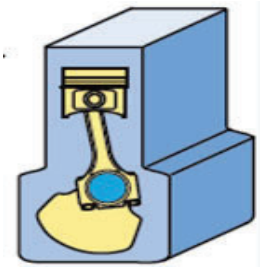
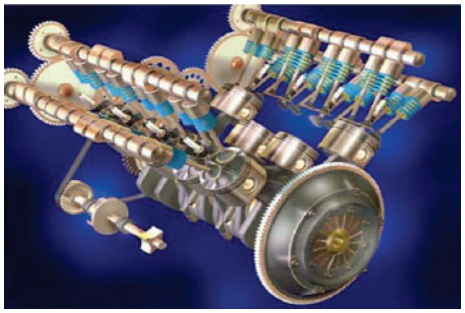
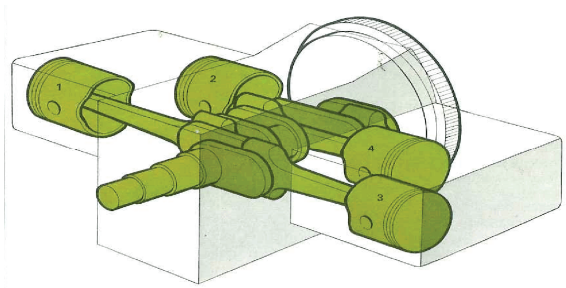
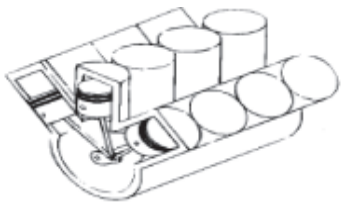
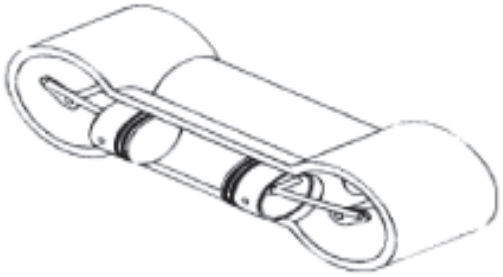
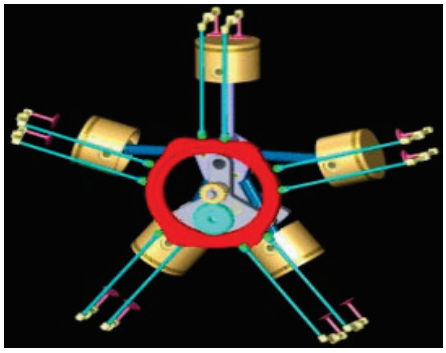


Figure 1.34-Radiator

- **Classification of Engines** - Depending on different points of view, some of the classification of engines described as follows.

Table 1.1 Engines Classification

<table>
<tr><th colspan="2">A. Engine Classification by type of combustion</th></tr>
<tr><td colspan="2">1. External combustion (EC)</td></tr>
<tr><td colspan="2">2. Internal combustion (IC)</td></tr>
<tr><th colspan="2">B. Engine Classification by type of fuel used</th></tr>
<tr><td colspan="2">1. Petrol or Gasoline engine</td></tr>
<tr><td colspan="2">2. Diesel engine</td></tr>
<tr><td colspan="2">3. Gas engine</td></tr>
<tr><th colspan="2">C. Engine Classification by method of Ignition</th></tr>
<tr><td colspan="2">1. Spark Ignition: combustion process starts in each cycle by the use of a spark plug. uses electric spark to ignite air and fuel mixture.</td></tr>
<tr><td colspan="2">2. Compression Ignition: the combustion process in a CI engine starts when the liquid fuel is injected in the cylinder self-ignites due to high temperature in the combustion chamber caused by high compression.</td></tr>
<tr><th colspan="2">D. Engine Classification by Cylinder arrangement</th></tr>
<tr><td>1. In-line: all cylinders arranged in one row, one behind the other along the length of the crankshaft.
 
Figure 1.35a</td><td>2. “V” arrangement: Two banks of cylinders at an angle with each other along a single crankshaft.
 
Figure 1.35b</td></tr>
<tr><td>3. Opposed Cylinder: Two banks of cylinders opposite to each other on a single crankshaft.
 
Figure 1.35c</td><td>4. “W” arrangement: Similar to that of V engine except with three banks of cylinders on the same crankshaft.
 
Figure 1.35d</td></tr>
</table>

5. **Opposed piston:** Two pistons in each cylinder with the combustion chamber located centrally between the pistons.  Figure 1.35e	6. **Radial arrangement:** Engine with pistons positioned in a circular plane around the central crankshaft.  Figure 1.35f
E. Engine Classification by type of Cooling System	
1. **Air cooled:** air is circulated over cooling fins cast into the outside of cylinders and cylinder heads.	
2. **Liquid cooled:** has cavities in the block and head castings called water jackets. Water pump pumps coolant through the system. Coolant mixture is designed to prevent rust and electrolysis: 50% water and 50% anti-freeze	
F. Engine Classification by Valve Location	
1. **L-head:** Valves in block (flat head)-common in motor vehicles during the first half of the twentieth century.	2. **I-head:** Valves in head (overhead valve) - used in today's automobiles. Have less exhaust emissions and higher compression.
3. **F-head:** One valve in head (usually intake) and one in block.	4. **T-head:**
G. Engine Classification by Camshaft Location	
2. **Cam-in-block engine:** pushrod engine – Camshaft has valve lifters that move pushrods that operate rocker arms to open the valves. – Found most often on V-type engines.	3. **Cam-in-head engine**: overhead cam engine – Camshaft is mounted on top of the cylinder head, just above the valve. – Found in in-line engines
H. Engine Classification by working cycle /strokes/	
1. Double/two stroke	
2. Four stroke	

Self-check 1.3	Diesel engine working principle

Time started:_____ **Time finished:**_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) Choose the best answers for the questions listed below.

1. External combustion (EC) engine

   A. Diesel engine B. gasoline engine C. Steam engine D. Generator

2. _____ engine where the cycle is completed in two strokes of the piston.

   A. Compression stroke B. Power stroke

   C. four stroke D. Two strokes

3. _____is a chemical reaction in which certain elements of the fuel combine with oxygen, causing an increase in temperature of the gases.

   A. Bottom Dead Center B. Compression Ratio

   C. Combustion chamber D. Combustion

4. An indirect injection diesel engine uses

   A. spark plug B. pre chamber and a glow plug.

   C. Compression Ignition D. electric spark

II) Check True/False and make correction if the statement is false.

1. An engine is a machine, which converts the electrical power in to heat energy.
2. A diesel engine uses heat of compression to ignite the diesel fuel when it is injected into the compressed air in the combustion chamber.
3. The engine-driven injection pump supplies low pressure diesel fuel to the injectors.
4. Glow plugs are used to help start a cold diesel engine and help prevent excessive white smoke during warm-up.
5. Air intake System allows pure & fresh air to enter the engine.
6. Air cleaner which cleans & filters the air after interring the combustion Chamber of an engine?
7. Internal combustion is combustion of fuel takes place out of the engine cylinder.

Answer Boxes

	Part I						
NO	Your Answer						
1		2		3		4	

Part II		
NO	Your Answer	Correct answer if false
1		
2		
3		
4		
5		
6		
7		

Information sheet 1.3	Diesel engine working principle

- **Engine Combustion system** - An engine is a machine, which converts the chemical energy of the fuel in to heat energy and then into mechanical energy it is usually called heat engine. The combustion of fuel such as coal, petrol and diesel generate heat. This heat is supplied to a working substance at high temperature. By the expansion of this substance in suitable machines, heat energy is converted into useful work. Heat engines can be further divided into two types:

(i) External combustion (EC) and

(ii) Internal combustion (IC).

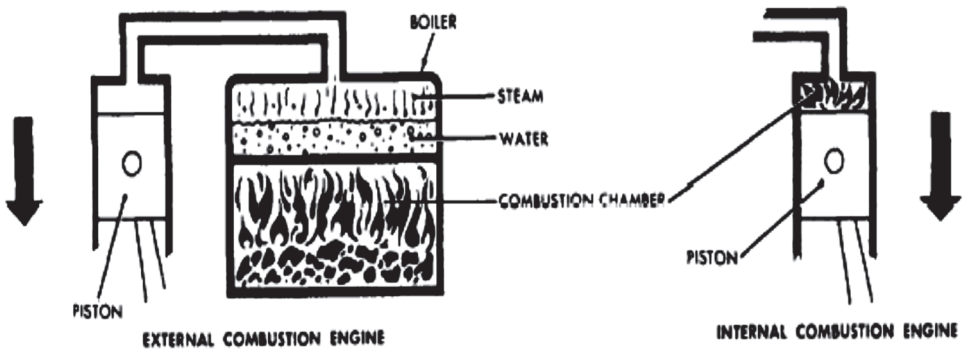
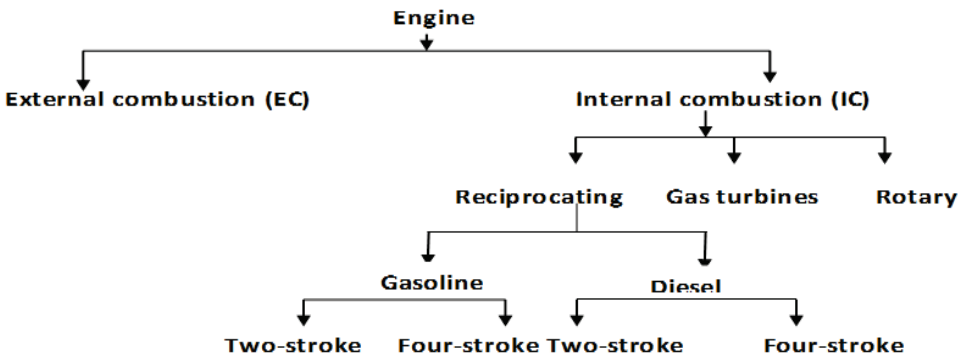


Fig 1.36

- **External combustion (EC) -** the combustion of fuel takes place outside of the engine. E.g., Steam engine
- **Internal combustion (IC) -** the combustion of fuel takes place inside the engine cylinder itself. E.g., Diesel engine and Gasoline engine.



Engine classification block diagram

➢ **Diesel engines**

In 1892, a German engineer named Rudolf Diesel perfected the compression-ignition engine that bears his name. The diesel engine uses heat created by compression to ignite the fuel

➢ **Engine Operating Cycles**

The movement of the piston from the top of the cylinder to the bottom, or from bottom to top is called a stroke. The top of a stroke is Top Dead Center (TDC). The bottom of a stroke is Bottom Dead Center (BDC). Each stroke of the piston turns the crankshaft one-half revolution, or 180 degrees. Two piston stokes turn the crankshaft 360 degrees or one complete revolution. The term revolutions per minute (r/min) indicate the number of revolutions that the crankshaft makes in one minute.

The engine operation cycle is the process of drawing air and fuel into a cylinder, compressing it, burning it to develop power, and exhausting the burned gases. In a reciprocating engine, an operating cycle is measured in the number of pistons stokes needed for one complete cycle. If an engine requires only two stokes to complete the cycle, it is called two stoke cycle engine. If the engine requires 4 strokes to complete the cycle, it is called a four stoke cycle engine. Most diesel engines operate on a four stoke cycle principle.

➢ **Basic Piston Engine Operation**

There are two kinds of piston engines. Spark ignition and compression ignition. The differences between the two are:

a) The type of fuel used
b) The way of the fuel gets into the cylinder
c) The way the fuel is ignited.

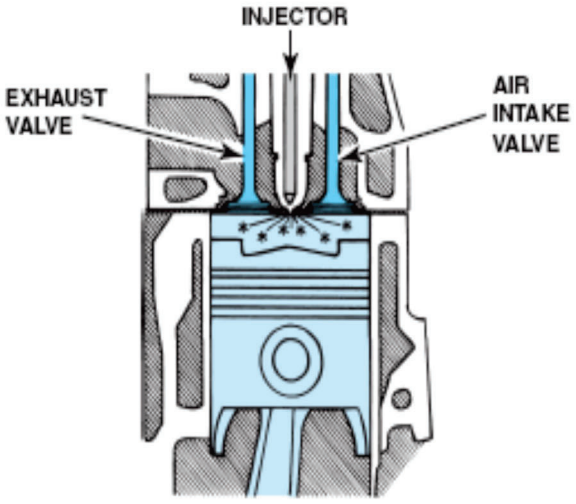
- **The spark ignition engine -** uses a highly volatile fuel, which turns to vapor easily, such as gasoline. The fuel is mixed with air before it enters the engine cylinders. The fuel turns into a vapor and mixes with air to form a combustible air- fuel mixture. This mixture then enters the cylinders and is compressed. combustion process starts in each cycle by the use of a spark plug or, an electric spark, produced by the ignition system burns the compressed air- fuel mixture.

- **In the compression ignition, or diesel, engine -** The fuel is mixed with the air after the air enters the engine cylinders. Air alone is taken into the cylinder. Then it is compressed. The temperature goes up. Then the fuel is injected (sprayed) into the engine cylinder. The hot air or heat of compression ignites the fuel. This is why the diesel engine is called a compression ignition engine.

  In both types of engines, when the fuels burn inside the engine cylinder, the chemical energy stored in the fuel is converted into heat energy. The heat energy is converted into mechanical energy by the expansion of gases against pistons. The movement of the pistons is carried by connecting rods to the engine crankshaft.

➢ **Diesel engines (Indirect and Direct Injection)**

- In an **indirect injection** (**IDI**) - diesel engine, fuel is injected into a small pre chamber, which is connected to the cylinder by a narrow opening.
- In a **direct injection** (**DI**) - diesel engine, fuel is injected directly into the cylinder.



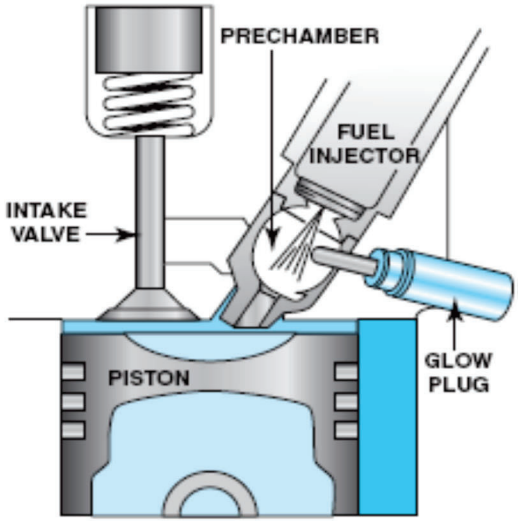
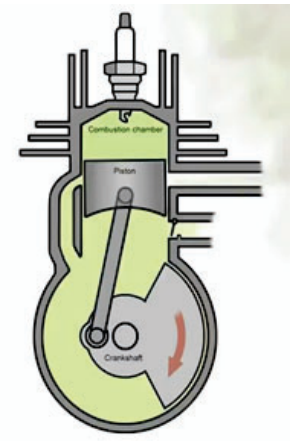


Figure 1.37a direct injection Figure 1.37a indirect injection

➢ **Two- Stroke Cycle Diesel Engine Operation**

In a two-stroke cycle diesel engine a blower, or rotary air pump, is used to create an initial pressure on the incoming air. The piston serves as a valve for the intake ports through which the air enters the cylinder. There is an exhaust valve in the top of the cylinder. The burned gases are forced past the exhaust valve after it opens, and the piston opens the intake ports. Now fresh air can sweep any

remaining exhaust gases from the cylinder and out of the exhaust port. This is called scavenging the cylinder.



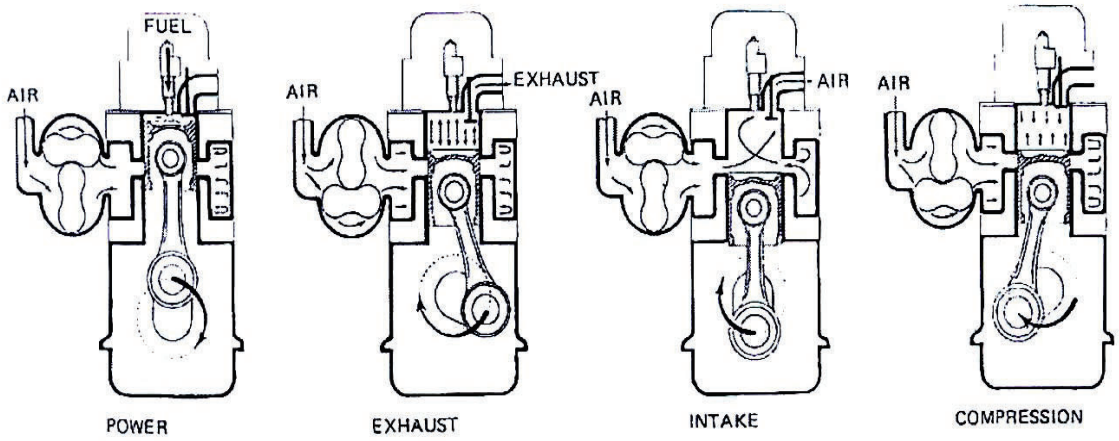


Figure 1.38a: two- stroke diesel engine operation

As the piston moves upward, it closes off the intake ports, and the exhaust valve closes. The air trapped in the cylinder becomes highly compressed as the piston moves up to TDC. Now fuel is injected into the cylinder, and the power stroke takes place.

➢ **Four-Stroke- Cycle Diesel Engine Operation**

Four stroke - these are engines where the cycle is completed in four (4) strokes of the piston. This means that the piston has to move four (4) times to complete the cycle.

Piston Stroke

- Intake stroke - Compression stroke
- Power stroke - Exhaust stroke

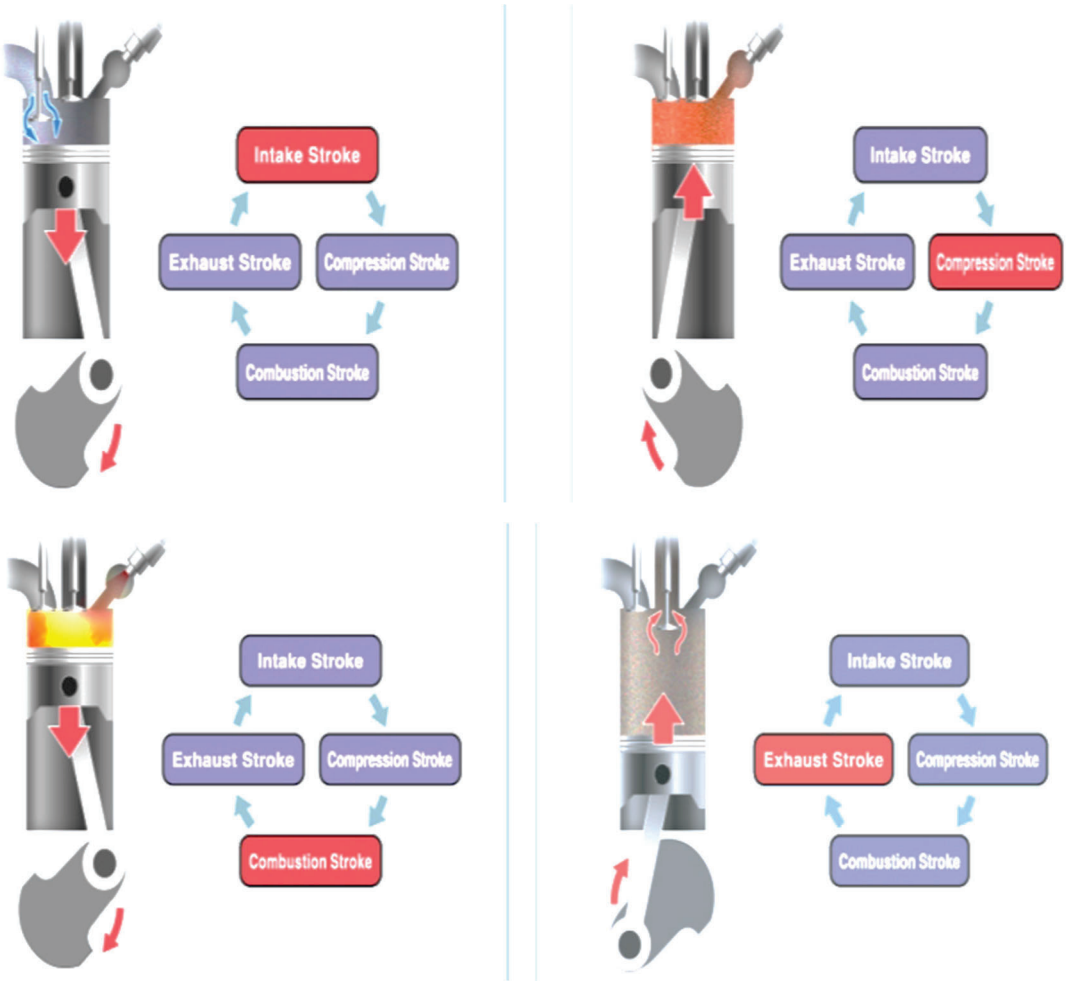


Figure 1.38b: four- stroke diesel engine operation

Table: 1.2 four- stroke diesel engine

Stroke	Movement of the Piston	Position of the Valve		Purpose
		Intake Valve	Exhaust Valve	
Intake	Going Down	Open	Close	Suck air
Compression	Going Up	Close	Close	Compress the air to increase its temperature
Power	Going Down	Close	Close	fuel is injected into the cylinder combustion takes place
Exhaust	Going Up	Close	Open	Burned gases pushed out from the engine cylinder

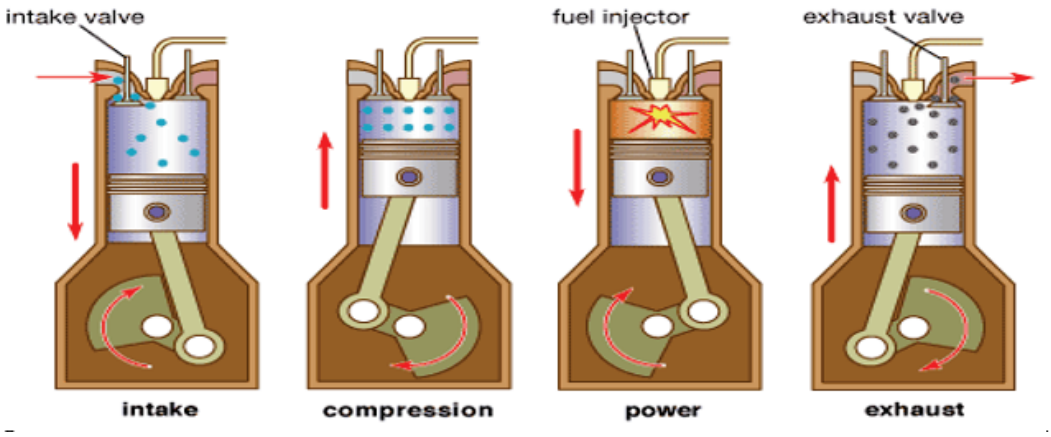


Figure1.39 Four strokes of diesel engine

Diesel engines are similar in construction to gasoline engines, except that they are generally heavier in construction in order to withstand the higher pressure resulting from the higher compression ratios used. These compression ratios may be as high as bout 22 to 1. When air is compressed this much, its temperature goes as high as 600^0C.

In diesel engine, only air enters the cylinder on the intake stroke and only air is compressed on the compression stroke. At the proper time, fuel is sprayed into the heated air under pressure. The heat of compression ignites the fuel, and the air fuel mixture then burns the same as it does in a gasoline engine, to produce power. The injection of fuel into the cylinder must be “timed” in accordance with engine speed and load in the same way as the spark at the spark plug of a gasoline engine must be “timed”.

Four- stroke- cycle diesel engines follow the same cycle as a gasoline engine and use both intake and exhaust valves.

- **Firing Order and Cylinder Numbering**

As we have seen, power interval is the amount of crankshaft rotation between ignitions in each cylinder. Firing order is the sequence in which ignition occurs in the various cylinders. The crankshaft throws are arranged in a particular order so that the cylinder’s fire at regular intervals and each cylinder fires once every 720 degrees. This crankshaft throw arrangement creates the firing order, and it varies depending on the number of cylinders and the engine block design.

- **Engine Valve Timing**

During the discussion of the four- stroke cycle principle, it was assumed that the valves opened and closed at TDC or BDC and that a cycle was 720^0 in length. In

practice, the valves do not open and close on the dead centers, but open before or close after dead center is reached.

The charging of the stroke length increases volumetric efficiency and engine power. This may seem odd at first, as the power stroke is shortened, for instant, by 45^0 (these degrees are different for different engines). However, by the time the power stroke reaches 45^0 before BDC, the pressure in the cylinder has dropped considerably, and the crankshaft throw is not in apposition to effectively produce turning effort. It is more advantageous, therefore, to open the exhaust valve earlier and allow the remaining pressure to force the exhaust gases through the exhaust system. Leaving the exhaust valve for 5^0 after TDC takes advantage of inertia of the moving goes to further remove exhaust gases form the cylinder.

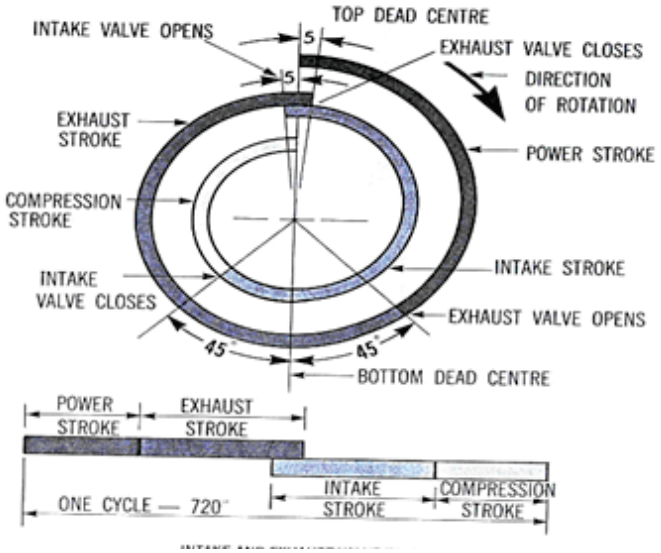


Figure 1.40 Valve timing diagram

Table: 1.3 Intake and exhaust valve timing

stroke	Theoretical length	Start of stroke	End of stroke	Actual length
power	180	TDC 45^0before BCD 5^0 before TDC 45^0 after BDC	45^0before BCD 5^0 after TDC 45^0 after BDC TDC	135
exhaust	180			230
intake	180			230
Compression	180			135
one cycle	720			730

Engine Displacement

- **Basic measurements**

A. Bore - is the inside diameter of the cylinder, usually measured in millimeters.

B. Stroke - is the distance in millimeters traveled by the piston in its movement from TDC (Top Dead Center) to BDC (Bottom Dead Center),

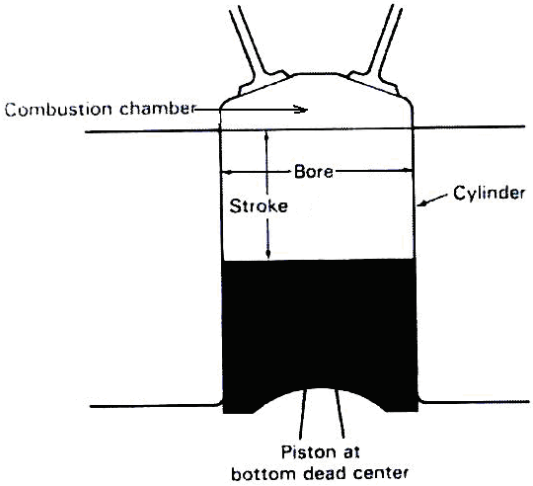


Figure 1.41: Bore and Stroke of a cylinder

C. Relationship of Bore and Stroke

Early automobile engines were designed with a small bore and a long stroke. This type of construction had high friction losses because of the length of the stroke, and greater inertia and centrifugal loads on the crankshaft bearings.

In the modern engine the bore is usually larger than the stroke and it is referred to as an “over square” engine. A “square” engine is one in which the bore and stroke measurements are the same. The over square engine not only reduces frictional losses and reduces inertial and centrifugal forces; it also permits lower engine hood body design.

Despite the advantages of the shorter- stroke, over square engine, concern for atmospheric pollution has forced automobile manufacturers to lengthen the stroke on some engines. The longer stroke provides more burning time for better combustion, so fewer pollutants are emitted.

D. Throw

Throw is the distance in millimeters from the center of the crankshaft main bearing to the center of the crank pin or connecting rod bearing. The length of the throw is equal to one-half of the stroke.

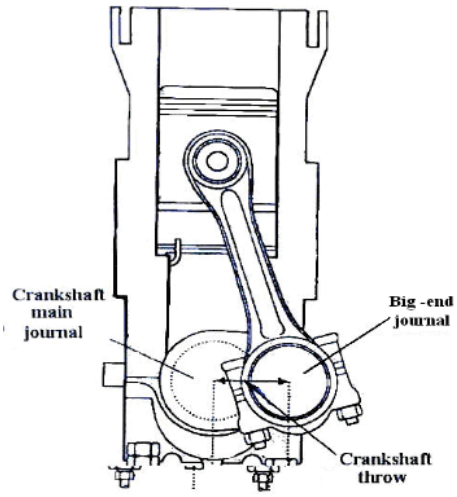


Figure 1.42 Crankshaft throw

E. Piston Displacement

Piston displacement (PD) for one cylinder refers to the volume that the piston displaces as it travels from BDC to TDC and is expressed in cubic centimeter (cc) or in liters. To calculate piston displacement for one cylinder, the following formula is used.

$$PD = \frac{\pi \times bore \times stroke}{4}, c.c.$$ Bore and stroke are in cm.

To determine engine displacement, multiply the displacement of one cylinder by the total number of engine cylinders:

PD_T = (x bore^2 x stroke x number of cylinders , where PD_T – piston displacement of an engine

Example: Calculate the engine displacement of 6-cylinder engine having 75 x 70 mm cylinder.

PD_T = (x bore^2 x stroke x number of cylinders= 3.14 x $(7.5)^2$ x 7 x 6PD_T = 1854.56 cc

4 4

- **Engine Efficiency**

Engine efficiency is the relationship between the potential energy supplied and the amount of work done. The amount of work to be done is the movement of the vehicle along the road. During each step of the process of converting fuel to mechanical energy to rotate the wheels of the vehicle, energy is lost. These

losses occur in many ways such as: mechanical, thermal, engine accessories, drive line friction, rolling resistance, air resistance, and acceleration.

- **Valve timing: -**Valve timing is a system developed for measuring valve operation in relation to crankshaft position (in degrees), particularly the points when the valves open, how long they remain open, and when they close,
- **Importance of valve overlap (3 advantages): -**

  Valve overlap takes place between exhaust and intake stroke -

  - being aware of the course of valve motions during valve overlap, the direction of rotation of an engine can be determined.
  - knowing the direction of rotation, the firing order of a given engine can be determined again by using the valve overlap.
  - using the clear understanding of valve overlap and the strokes, it is easy to set every engine to the correct position for VALVE ADJUSTMENT
- **Interrelation of valve clearance and valve timing: -**

  The wider the valve clearance, the smaller the opening angle of a valve, with wide clearance the valve opens late and closes early.

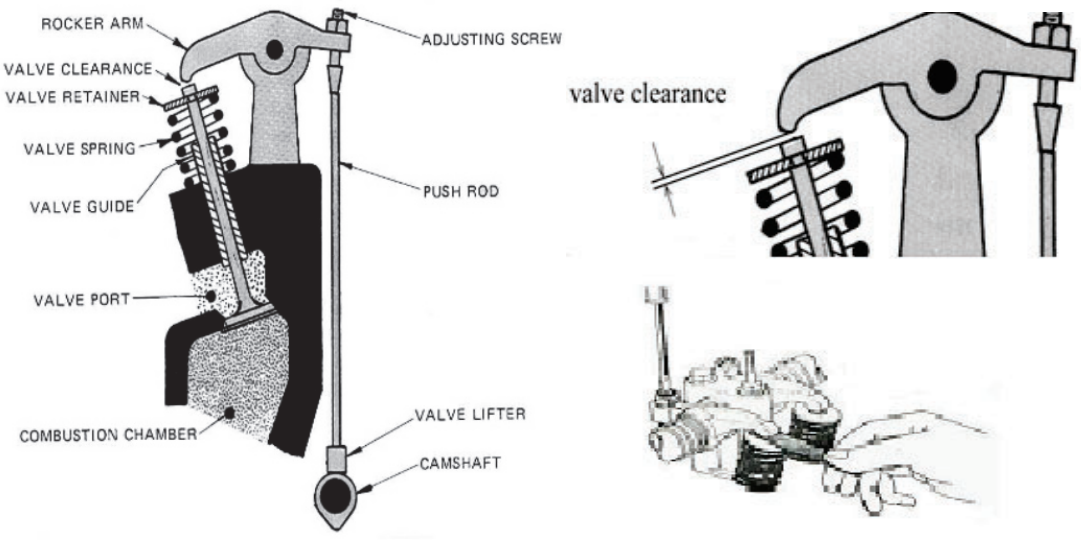


Figure 1.43 valve adjustment

Self-check 1.4	Engine supporting/Auxiliary systems

Time started:_____ Time finished:_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) Choose the best answer for the questions listed below.

1. _____is a device that draws oil with high pressure from the oil pan in order to lubricate the engine parts.

   A. Water jacket B. Oil pump C. Piston D. Water pump

2. The purpose of the _____ is used to cool down the water received from the engine.

   A. Radiator B. Coolant C. Lower hose D. Gallery

3. It draws fresh air through the radiator and thus increases the efficiency of the radiator in cooling hot water.

   A. Air cooling system B. Water cooling system C. Fan D. Cooling fins

4. _____is an exhaust gas driven turbine which drives a centrifugal compressor wheel.

   A. Exhaust manifold B. Exhaust pipe
   C. Super Charger D. Turbo Charger

5. _____reduces the noise of the exhaust gases by reducing the pressure of the used gases by low expansion & cooling.

   A. Exhaust valve B.Exhaust port C. Muffler D. Tail pipe

6. _____is placed on the engine to check the oil level in the engine sump.

   A. Fullmarked dipstick B. Halfmarked dipstick
   C. Low marked dipstick D. Dipstick

7. _____ is a combination of mechanical and electrical components that work together to start the engine.

   A. lubricating system B. solenoids (magnetic switches),
   C. starting system D. intake and exhaust system

8. _____is the lowest part of the engine which use for containing lubricating oil.

   A. Lubrication System B. Oil sump/oil pan
   C. Oil filter D.Strainer

II) Match item listed in A with their listed in B

Item A	Item B
1. Charging system 2. Air cooling system 3. Coolant 4. Starting system 5. Injection nozzle	A. Superchargers B. Water jacket C. A single unit used to metre, atomize & inject the required amount of fuel D. Circulating water and antifreeze to keep the temperature regulated E. Maintains the batteries state of charge/re-charging F. Cooling fins G. Used to turn the engine crankshaft until the engine starts.

Answer Boxes

PART I			
NO	Your Answer	NO	Your Answer
1		5	
2		6	
3		7	
4		8	
PART II			
1		4	
2		5	
3			

Information sheet 1.4	Engine supporting/Auxiliary systems

Cooling System

A system which controls the engine temperature is known as a cooling system.

Types of cooling systems: -

I) air cooling system

II) Water cooling system

➢ **Air Cooing system**

In this type of cooling system, the heat which is conducted to the cuter parts of engine is radiated & conducted away by the stream of air which is obtained from the atmospheres.

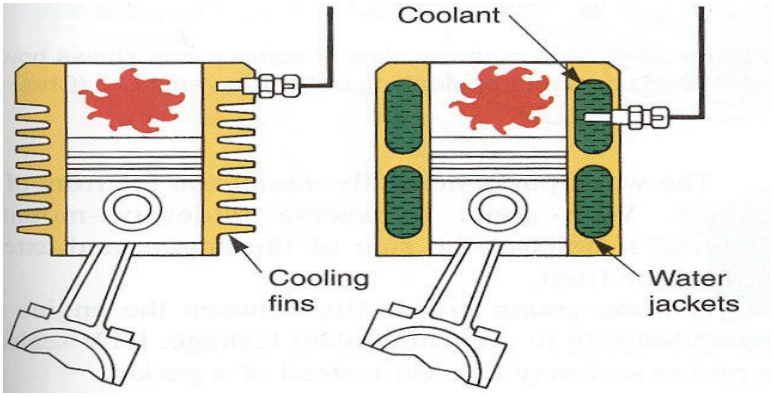


Figure 1.44a air cooling Figure 1.44b water cooling

The amount of heat carried off by the air cooling depends upon the following factors.

- ✓ The total area of the tin surface
- ✓ The velocity & amount of the cooling air
- ✓ The temperature of the tins & of the cooling air

Air cooling is mostly used in motorcycles scooters small cars & small aircraft engines, where the forward motion of the machine gives good velocity to cool the engine.

➢ **Liquid cooling system**

- ✓ It takes away the excessive heat generated in the engine and saves it from over heating.

- ✓ It keeps the engine at working temperature for efficient & economical working.

- **Water Pump: -Is a centrifugal type of pump, it increases the flow rate of the water.**
- **Coolant- circulating water and antifreeze to keep the temperature regulated.**
- **Fan: -**It draws fresh air through the radiator and thus increases the efficiency of the radiator in cooling hot water
- **Radiator:** -The purpose of the radiator is to cool down the water received from the engine, it has three main parts: -upper tank, Lower tank, and Tubes

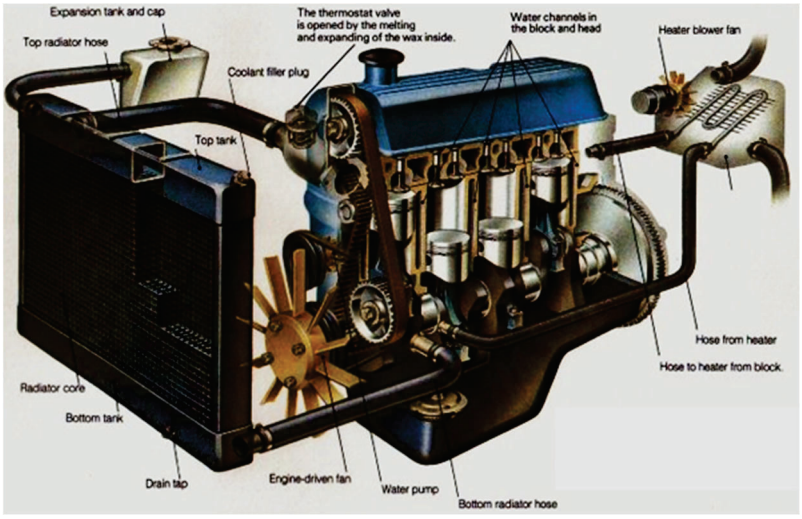


Figure 1.45 radiator

- **Thermostat: -It is a kind of check valve which opens & closes with the effect of temperature**

The normal operating temperature of an engine is 80-900c.

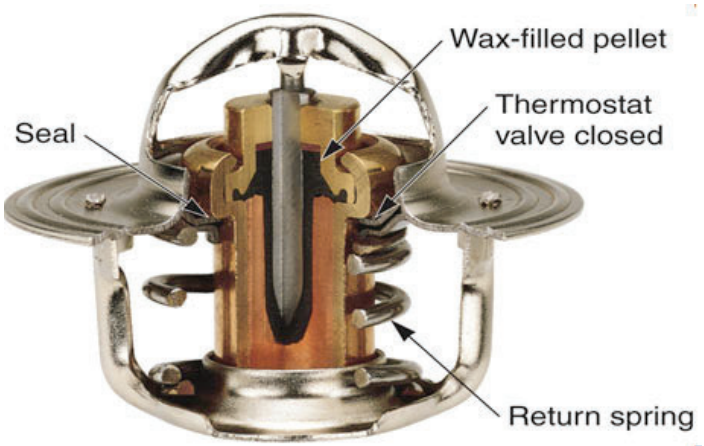


Figure 1.46 thermostat

- **Water Jacket: -It provided a way for the coolant to circulate & take off the heat from the engine component.**

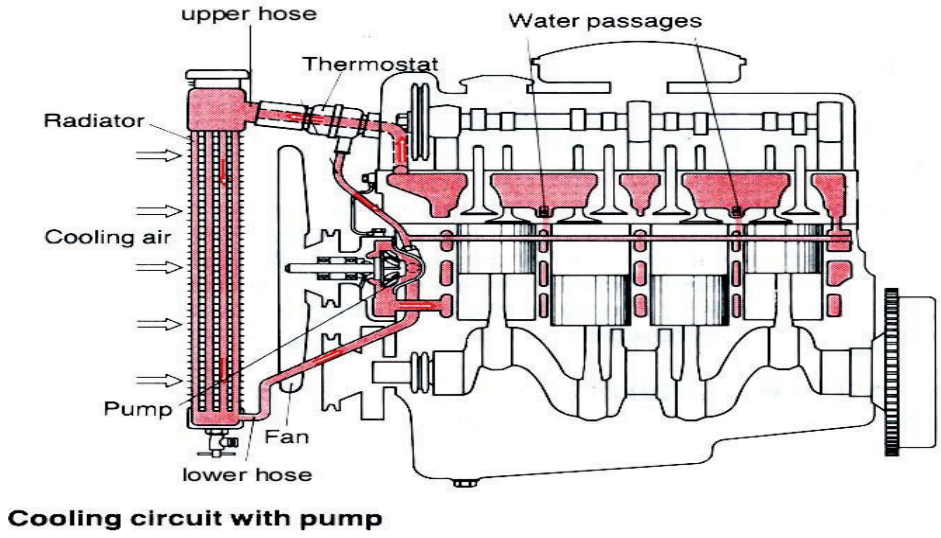


Figure 1.47 cooling circuit

Air intake System

This system allows clean & fresh air to enter the engine. It consists of air cleaner, Supercharger, intake manifold intake portand intake valve.

- **Air cleaner:** -Which cleans & filters the air before entering the combustion chamber of an engine
- **Superchargers: -** it increases the air pressure into the engine so that more fuel can be burnt & the engine output increases
- **Intake manifold:** -is required to deliver air into the cylinder from the air cleaner
- **Intake valve: -** opens at the proper time to let in air. Open and seal the intake ports

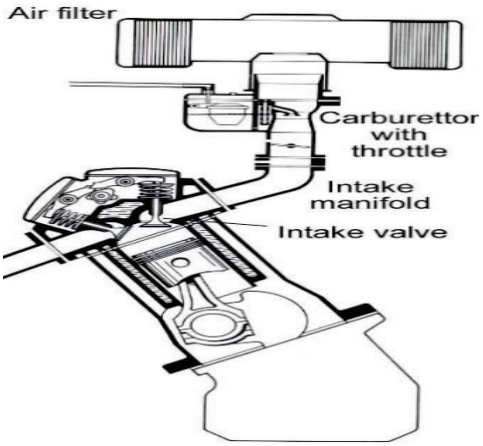


Figure 1.48

Diesel Fuel System

- **Fuel tank:** -It is a reservoir of fuel which is made of sheet metal of sufficient capacity.

It maintains the fuel pressure in the system at a sufficient high level to circulate the fuel through the filters.

- **Injection Pump:** -The pump supplies fuel to the injectors according to the firing order at the constant stroke correct time in the cycle.
- **Nozzle:** -A single unit used to metre, atomize & inject the required amount of fuel into the combustion chamber of the cylinder.

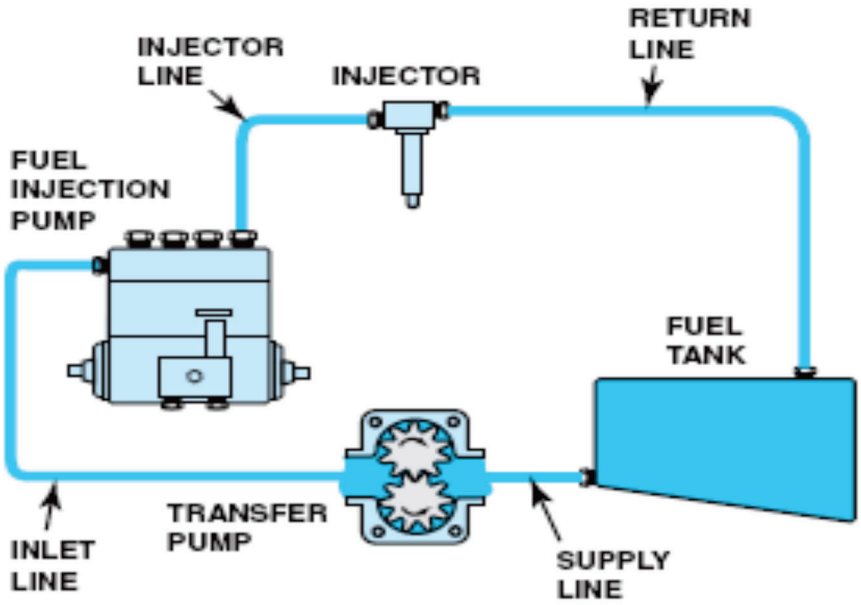


Figure 1.49 fuel system

Exhaust System

Removes the exhaust gases and particles from the combustion chamber. The Exhaust manifold collects gasses from one or more individual cylinders. Exhaust pipe connects exhaust manifold to the muffler which is the sound deadening device used to quite engine operations. So, the exhaust system collects exhaust gases from the engine & expels them out.

- **It consists of: -**Exhaust valve, Exhaust port, Turbo charger, muffler, and tail pipe
- **Exhaust manifold:** -The exhaust manifold collects exhaust gases from the exhaust of various cylinders & conducts them from each and to a central exhaust passage

- **Exhaust valves –** open at the proper time to release the exhaust. open and seal the exhaust ports
- **Turbo Charger: -** Is an exhaust gas driven turbine which drives a centrifugal compressor wheel
- **Muffler: -**reduces the noise of the exhaust gases by reading the pressure of the used gases by low expansion & cooling. The muffler must not cause any appreciable restriction to the flow of oil that could raise back pressure excessively.

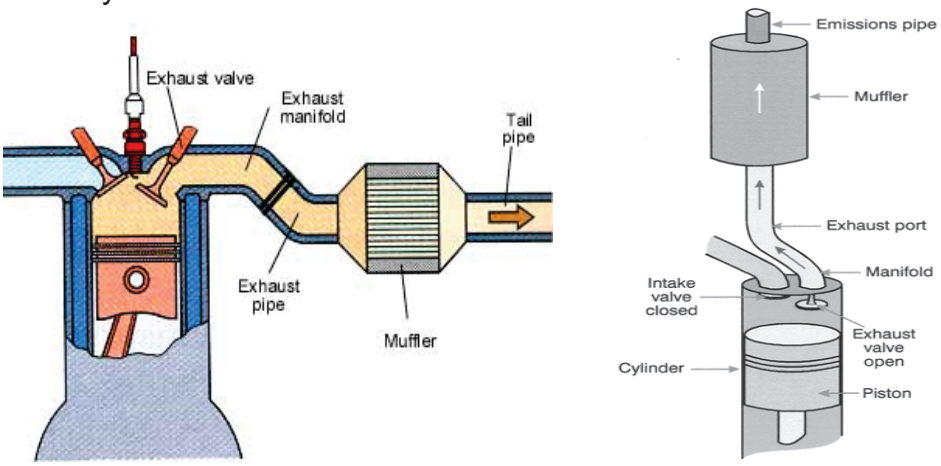


Figure 1 .50 exhaust

Lubrication System

The purpose of lubrication is to substitute fluid friction for solid friction, since it takes less force to overcome fluid than solid friction the result is less heat & wear between the moving parts.

- **Oil sump/ oil pan - is the lowest part of the engine which contain lubricating oil**
- **Oil Pump: -** Which supplies the oil to the moving parts under pressure
- **Oil Filters: -** Which traps particles of foreign material such as carbon deposits, dust dirt & metal rubbings out of the oil
- **Dipstick: -** Is placed on the engine to check the oil level in the engine sump.

Starting system

The starting system is used to turn the engine crankshaft until the engine starts. It is a combination of mechanical and electrical components that work together to start the engine. The starting system is designed to change electrical energy that is being stored in the battery into mechanical energy and to crank the engine. To

accomplish this conversion, a starter motor is used. This system consists of starter switch/key, battery, Relays or solenoids (magnetic switches), Starter motor, Wiring.

Battery

Store's energy in the form of chemical energy and then converts it into electrical energy when it is discharging. So, it is used to supply power to the cranking motor to start the engine. It supplies the extra power necessary when the engine's electrical load exceeds the supply from the charging system.

- **Specific gravity (SG) -** SG indicates electrolyte weight. Heavier electrolyte means a heavier charge. Low SG indicates plate sulfation, cell deterioration and reduced battery capacity.

Starter motor and solenoid

- **Starter motor: -** is a powerful electric motor that provides the initial impulse to turn over the engine to start it. It requires a very high current to crank the engine, so it is attached to the battery with large cables.

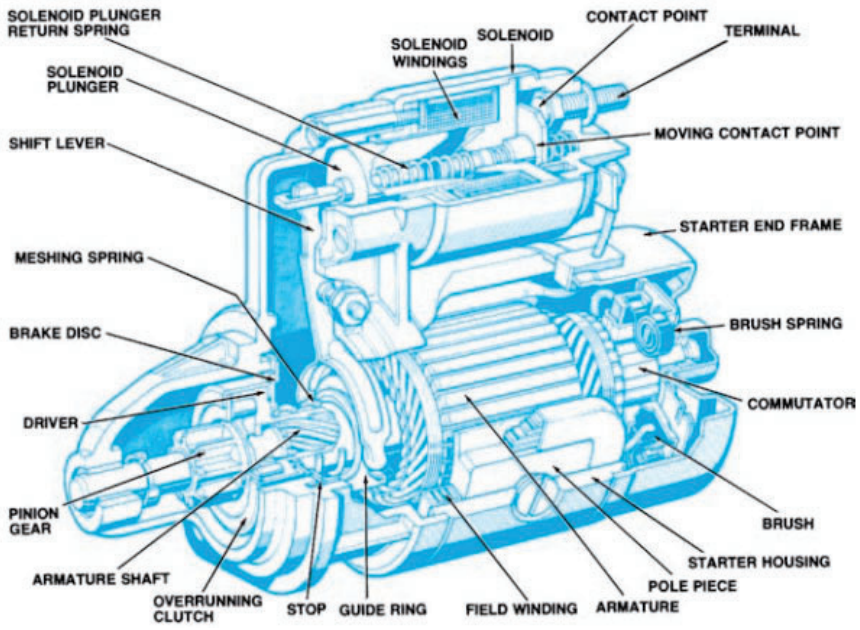


Figure 1.51 Starter motor cutaway

The function of the starter motor is to start up the combustion engine. An electric motor forms the basis of the starter motor. The modern starter motor is either a permanent-magnet or a series-parallel wound direct current electric motor with a starter solenoid (similar to a relay) mounted on it. When current from the starting battery is applied to the solenoid, usually through a key-operated switch, the

solenoid engages a lever that pushes out the drive pinion on the starter driveshaft and meshes the pinion with the starter ring gear on the flywheel of the engine, therefore crank it up.

- **The starting system has the following two circuits,**

a. Starter circuit - The circuit between the battery and the starter motor is controlled by a magnetic switch (a relay or solenoid). Switch design and function vary from system to system. A gear on the starter motor armature engages with gear teeth on the engine flywheel. When current reaches the starter motor, it begins to turn. This turns the engine crankshaft, which can quickly fire and run by itself. Heavy-gauge cables are used because this circuit allows high current to pass to the motor field coil.

b. Control circuit - It allows the driver to use a small amount of battery current, about three to five amperes, to control the flow of a large amount of battery current to the starter motor. Control circuits usually consist of an ignition switch connected through normal-gauge wiring to the battery and the magnetic switch. When the ignition switch is in the start position, a small number of current flows through the coil of the magnetic switch. This closes a set of large contact points within the magnetic switch and allows battery current to flow directly to the starter motor.

- **Types of starters motor.**
  - ✧ Conventional type /common type/
  - ✧ Gear Reduction type

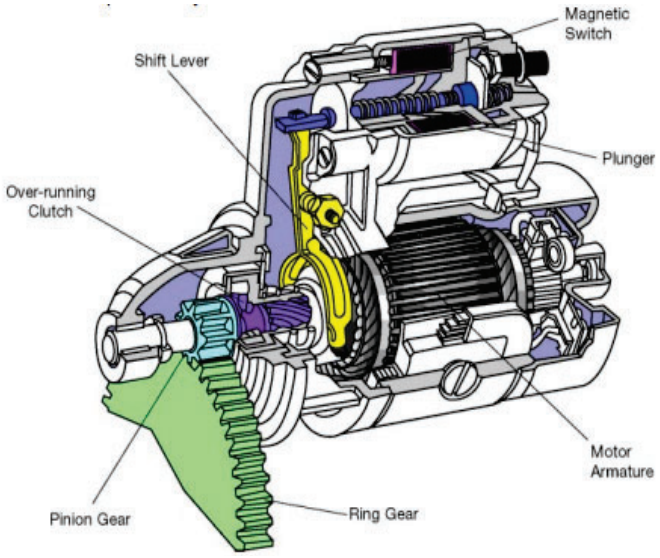


Figure. 1.52a) Conventional type starter motor

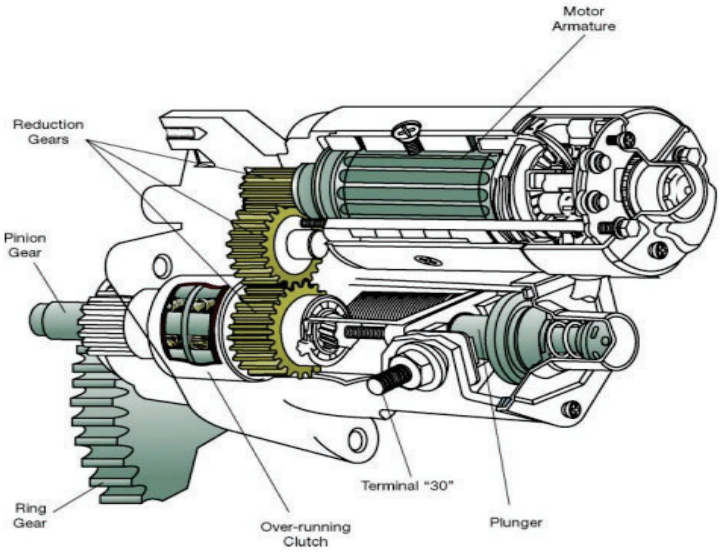


Figure. 1.52b) Reduction type starter motor

Charging system

The charging system maintains the batteries state of charge/re-charging the battery and to power the dc electrical system (especially for vehicles) when the engine is running. This system consists of a battery, alternator assembly, charge indicator gauge or warning light, and the wiring that connects the components to each other and to the units they serve.

Small alternator /Charging generator/ assembly

It is a small generator which generates electricity which is needed to recharge the battery after slight discharging due to engine starting and to power the dc electrical system when the engine is running. It consists of a spinning set of electrical windings called a rotor, a stationary set of windings called a stator, a rectifier assembly, voltage regulator, a set of brushes to maintain electrical contact with the rotor, and a pulley. All of these parts except the pulley are contained in aluminum housing.

Figure 1.53a: charging generator/ small alternator

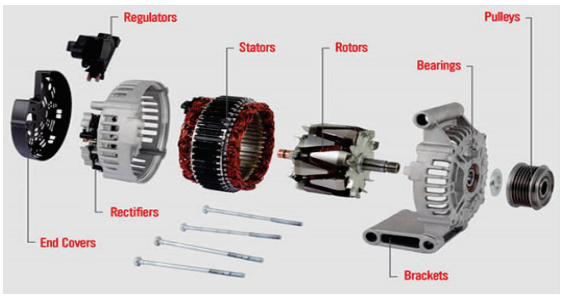


Figure 1.54b: inside an alternator

Operation sheet 1	Demonstrate and Testing functionality of diesel engine parts and supporting systems

Summary

This operation sheet contains methods of testing functionality of diesel engine parts and supporting systems. This operation sheet is used for prime -mover part demonstration and testing supporting system.

Preparation

- To perform the tasks the following listed tools & necessary materials, instruments, consumable materials & documents are necessarily to

Personal Protective Equipment (PPE)	Crimping tools
First aid kit	Air cleaner
fire extinguisher	Bench vise
wrenches (open, close)	Genset with battery
Pliers (combination, long nose, cutter)	Engine cut model
Adjustable wrenches	Insulated & mechanical screw drivers (flat & Philips)
Belt wrench	Allen keys (hexagonal & star)
Socker wrenches	cleaning rag
Insulation resistance tester (megger)	Filter (fuel, oil)

Instruction

Before we start our tasks, we have to use personal protective equipment. Then the necessary tools, consumable materials, documents and equipment are provided by the technical assistant, and we will take a look on them and Demonstrate and Testing functionality of diesel engine parts and supporting systems for operation and maintenance work.

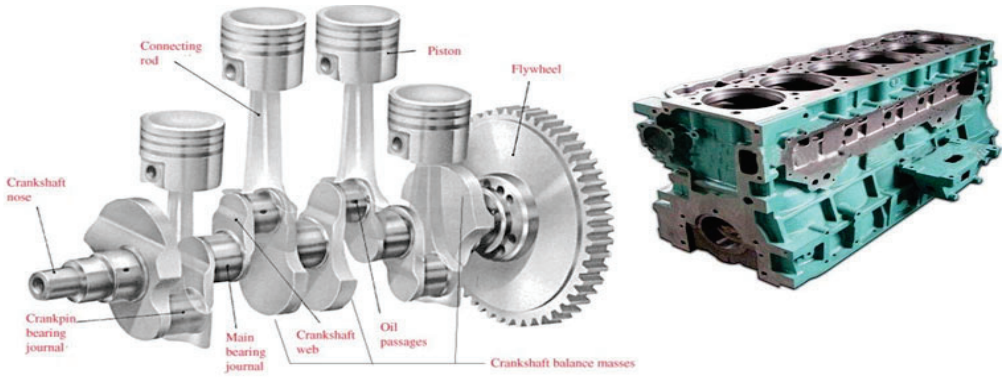
- Then to start Demonstration and Testing functionality of diesel engine parts and supporting systems we have to get the appropriate tools to open the gen-set hood(cover), service(user) manual for reference, related cut models. then open the hood/cover follow the steps listed below.

- During the time of opening and closing the gen-set hood/cover we should take care of cables & sensitive components/devices from damage and be careful not to make short between battery terminals.

Task 1. Demonstrate parts of engine assembly and Auxiliary system for the Gen-set

Exercise: -1

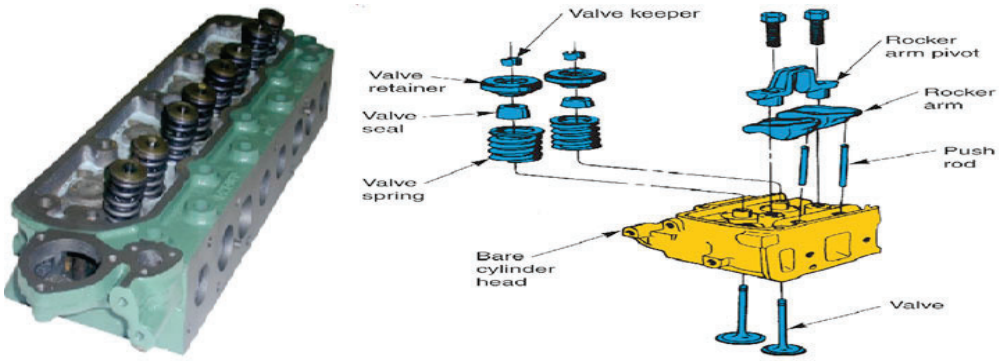
Task 1. 1- Cylinder Head Assembly it located at the top of the engine and consists of valve & spring, camshaft, rocker arm, and combustion chamber.



Fig; -1.1 Cylinder

Task 1.2 - Cylinder Block Assembly Works to place various engine compartments that support the working process of the machine. It is considered the foundation block of the engine. It has bores for the pistons, passages for the water to cool the cylinder, galleries for the lubrication system, and tunnels for push rods.

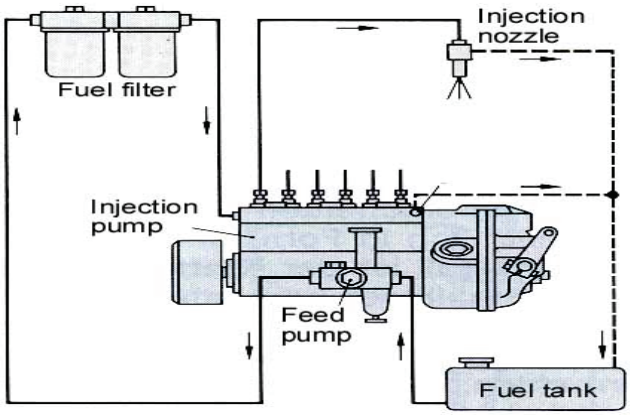
Task 1. 3- Oil sump Serves as a sealed reservoir to contain the engine oil used to lubricate the moving parts in the engine, made of aluminum, steel or plastics



Fig; -1.2 Cylinder Block

Fig; -1.3 Oil sump

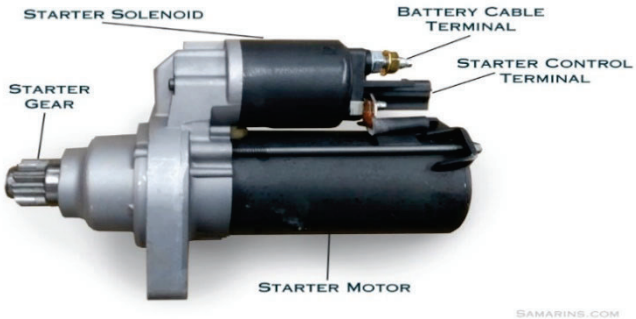
Task 1. 4 - Fuel filter, Feed pump, Injection pump and Injection nozzle



Fig; -1.4 fuel system

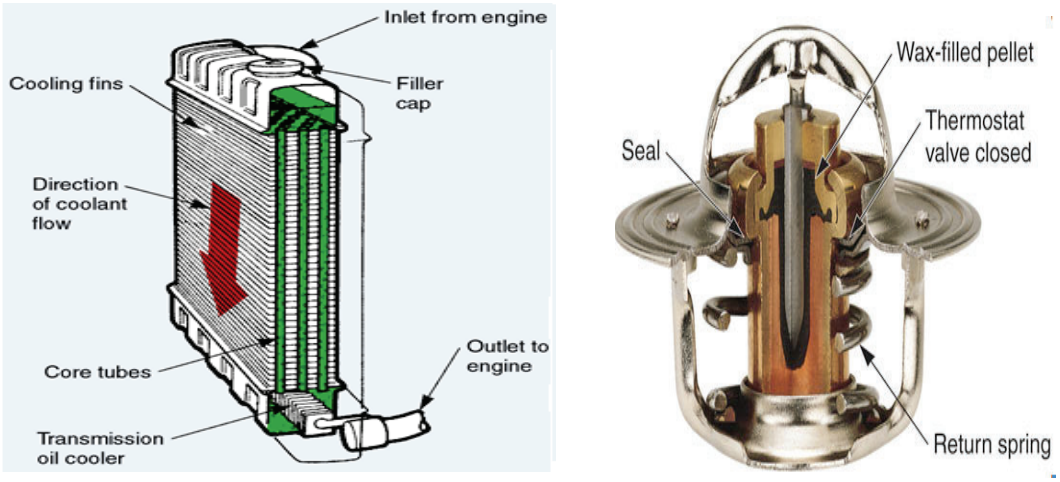
Exercise: -2

Task 1. 5 - Starter motor



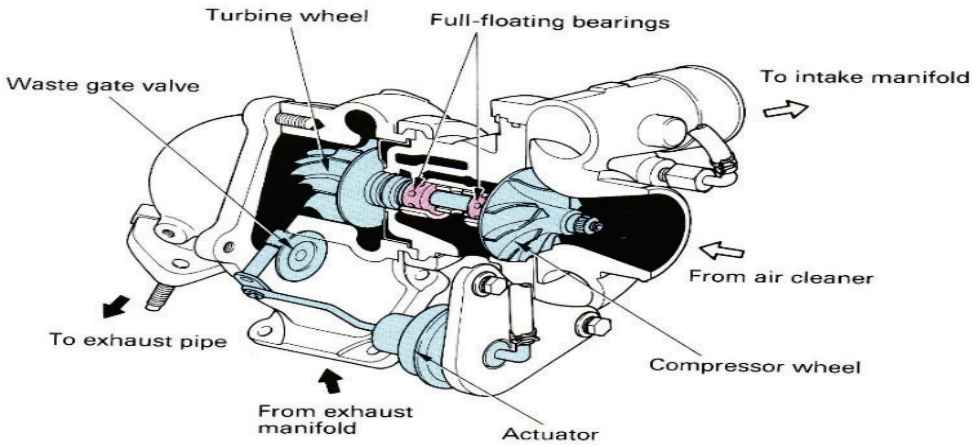
Fig; -1.5 starter motor

Task 1. 6 - Radiator and Thermostat



Fig; -1.6 Radiator and Thermostat

Task 1. 7 - Turbo charger



Fig; -1.7 Turbo charger

Task 2. Testing functionality of supporting/auxiliary systems for the Gen-set

Task: - 2.1 Testing functionality of Air intake and exhaust system

Exercise: -1

Step 1- check Air cleaner is deformed or not and dust protector

Step 2- check Intake manifold gasket to get air in the cylinder

Step 3- check intake valve should open properly

Step 4- check the compression in the Cylinder by using compression gauge

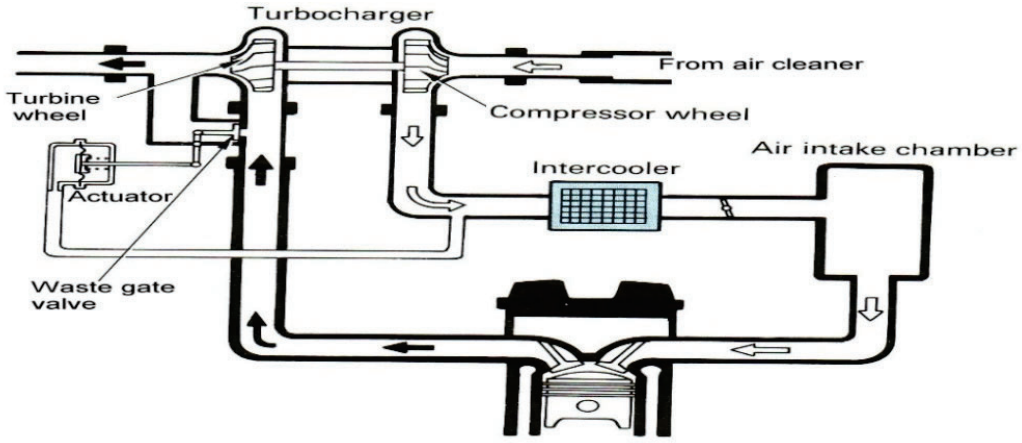
Exercise: -2

Step 5- check exhaust valve should open and release exhaust gas properly

Step 6- check Exhaust manifold gasket is ok

Step 7-check Turbo charger is driven in normal condition

Step 8- check Muffler and tail pipe



Fig; -2.1 Air intake and exhaust

Task: - 2.2 Testing functionality of Fuel system

Exercise: - 1

Step 1- check Fuel tanker gauge is normal or not

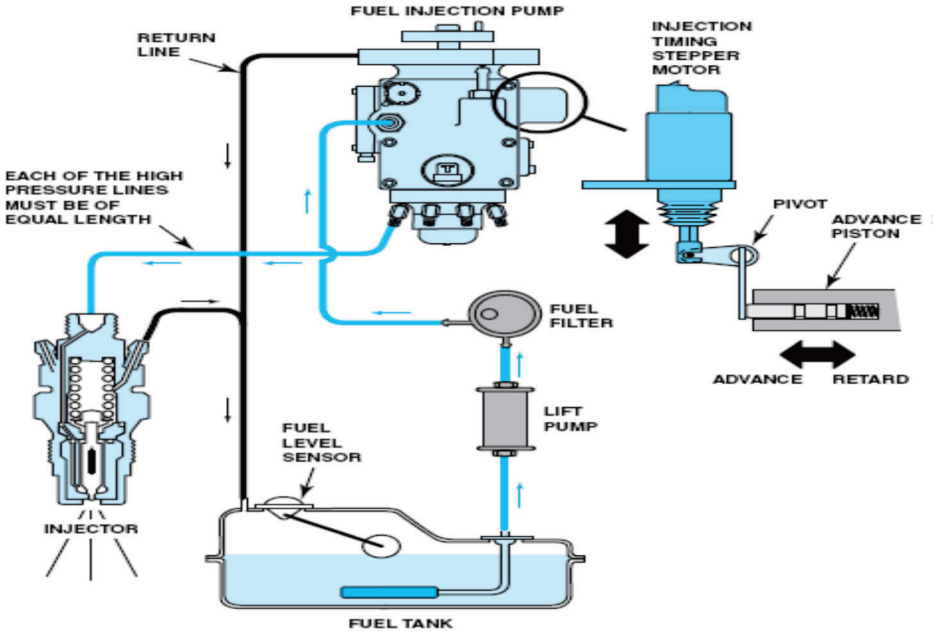
Step 2-check Feed pump states

Step 3- check Fuel filter is deformed or not

Step 4-check Injection pump is feed fuel with high pressure

Step 5- check Injection nozzle is injected in cylinder normal

Step 6- check Return to the fuel tanker through return line is cleaned



Fig; -2.2 Fuel system

Task: - 2.3 Testing functionality of cooling system

Exercise: -1

Step 1-check radiator fin and core is deformed

Step 2- check radiator Lower hose leakage

Step 3- check water pump is normal or not

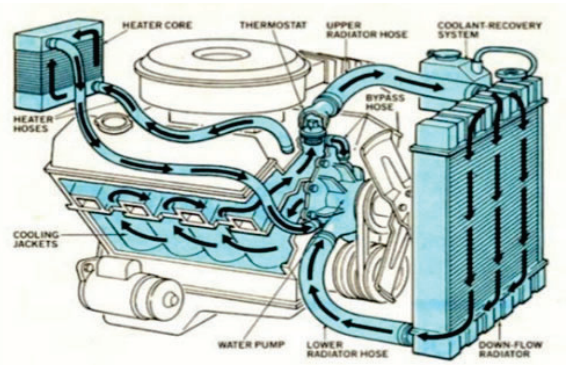
Step 4- check water jacket working properly

Exercise: -2

Step 5- check water return to water pump through bypass (If water temperature is below 80 – 90 °c)

Step 6- check thermostat is open (if the water temperature is above 80 – 90°c)

Step 7- check upper hose is return water to radiator



Fig; -2.3 cooling system

Task: - 2.4 Testing functionality of lubrication system

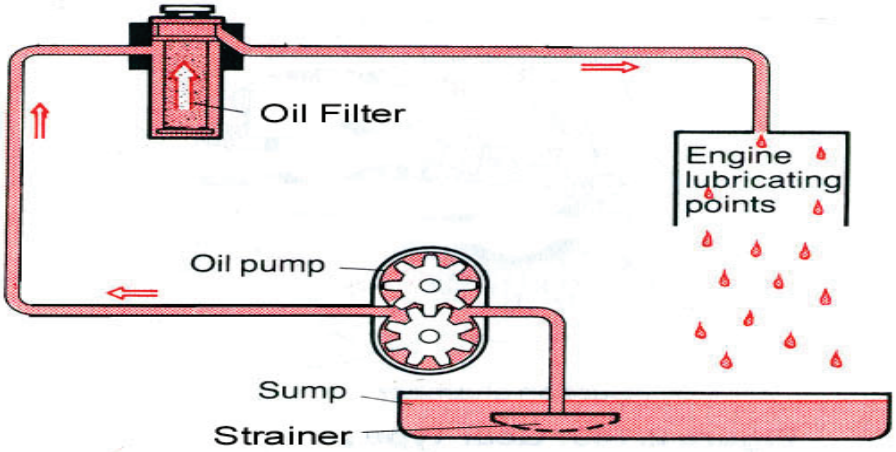
Exercise: -1

Step 1- check oil strainer is screen chips form oil

Step 2- check oil pump is working properly

Step 3- check oil filter is deformed or not

Step 4- check oil viscosity



Fig; -2.4 lubrication system

After we finish, we have to close the opened hood/cover properly, clean the genset area and return the tools.

LAP Test LG 1	Practical Demonstration

Total time allowed for doing the following tasks: *35 min for each trainee*

Preparation

Preparation and setting for the performance assessment

- Prepare or avail the gen-set and cut models related with its components for the assessment
- Ensuring if there is suitable area for the assessment
- Avail the necessary tools, material, instruments
- Avail the rating sheet for demonstration per each trainee

Instructions*:* You are required to perform the following tasks on the diesel gen-set that is provided for your work. Your work progress is being observed by the trainer/technical assistant. Request your trainer/ technical assistant for evaluation and feedback

Task 1 Demonstrate parts of engine assembly and Auxiliary system for the Gen-set

Task: - 1.1 Cylinder head assembly

Task: - 1.2 Cylinder block assembly

Task: - 1.3 Oil sump

Task: - 1.4 Fuel filter, Feed pump, Injection pump and Injection nozzle

Task: - 1.5 starter motor

Task: - 1.6 Radiator and Thermostat

Task: - 1.7 Turbo charger

Task 2. Testing functionality of supporting/auxiliary systems for the Gen-set

Task: - 2.1 Air intake and exhaust system

Task: - 2.2 Fuel system

Task: - 2.3 Cooling system

Task: - 2.4 Lubrication system

List of Reference Materials LG 1

- https://www.autoexpose.org/2017/10/parts-of-diesel-engine-and-function.html
- https://www.engihub.com/diesel-engine-working/
- https://carbiketech.com/diesel-engine/
- http://what-when-how.com/automobile/flywheel-automobile/
- www.cpower.com
- https://medium.com/@dieselgenerator/major-components-of-lube-oil-system-of-diesel-engine-b393c97a98b0
- https://www.engineersedge.com/power_transmission/air_intake.htm
- https://www.thespruce.com/insulated-screwdrivers-and-safety-1152567
- http://www.daviddarling.info/encyclopedia/C/AE_combination_pliers.html
- https://home.howstuffworks.com/allen-wrench.htm
- https://www.google.com/search?ei=1s9KXf6BJsKRsAf8jae4BQ&q=crimper&oq=crimper&gs_l=psy-ab.3..0l2j0i20i263j0l7.1413.8280..11104...1.0..3.1241.11938.4-3j7j2j4.....0....1..gws-wiz.....10..35i39j0i67.R2GFAd0XAkA&ved=&uact=5
- https://www.google.com/search?ei=ftxKXd3zDaqdlwSE2JOQAQ&q=battery+acid+hydrometer&oq=battery+hydrometer&gs_l=psyab.1.1.35i39j0i7i30l4j0l5.10113.12175..16174...0.0..0.345.2502.2-2j6.....0....1..gws-wiz.....0i71j35i304i39.sqFFpFSICnA
- https://www.google.com/search?q=micrometer&oq=micrometer+&aqs=chrome..69i57j0l5.13311j0j8&sourceid=chrome&ie=UTF-8
- https://www.google.com/search?q=generator+battery&oq=generator+battery&aqs=chrome.0.69i59.8975j0j8&sourceid=chrome&ie=UTF-8
- https://en.wikipedia.org/wiki/Oil_filter

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Ethiopian Water Technology Institute (EWTI)

Electromechanical Machineries Maintenance Technology Training

Learning Guide #02

Unit of Competence:	Gen-set Operation & Maintenance
Module Title:	Operating & Maintaining a Gen-set
LG Code:	EMMT/GEN/LM02/0421 V1
TTLM Code:	EMMT/GEN/TTLM 0421 V1

LO2: - Demonstrate and Testing functionality of Electrical parts and main Alternator

Instruction Sheet LG #2	Demonstrate and Testing functionality of Electrical parts and main Alternator

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

2.1 Alternator construction, working principle, types and main parts

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

1. Demonstrate alternator assembly and parts in the main alternator of a gen-set
2. Demonstrate controlling and displaying instruments on control panel
3. Demonstrate parts on controlling device and starting mechanism

Learning Instructions:

1. There are 4 parts of basic knowledge and skills that underpin performance related to the job in this Learning Guide. You are expected to go through all the parts to prepare yourself for starting operation and LAP test at the end of this Learning Guide.
2. Try to answer to “Self-check 1” to confirm your current knowledge. Leave any items blank that you cannot answer now, which is for you to learn in this Guide.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed, and answer all items in “Self-check 1,” including the items you could not answer when you tried for the first time. You may be tested using “Self-check 1” to confirm your understanding of the basics,
4. Demonstrate operation sheet and conduct the LAP test to complete this learning guide.
5. For more information see the reference material listed at the end of the learning guide.

Self-check 2.1	Alternator construction, working principle, types and main parts

Time started:_____ **Time finished:**_____

Directions : Answer all the questions listed below. Use the Answer box provided.

I) Check True/False and make correction if the statement is false

1. An alternator can produce electricity even though the prime mover is not working.
2. Alternator converts mechanical energy into electrical energy and also electrical energy into mechanical energy.
3. A voltage is induced in a coil as a result of either, a coil cutting through a magnetic field, or a magnetic field cutting through a coil.
4. In the production of electricity main field coil and armature winding have the same function
5. Armature part of the main alternator is called rotor.
6. If there is no magnetic field is created means, the produced voltage becomes high.

II) Match parts listed in A with their functions listed in B

Item A	Item B
1. Exciter 2. AVR 3. Rectifier 4. Armature 5. Field winding	A. Output-producing component of an electrical machine B. Magnetic field producing component of electrical machine C. Stationary part of the generator D. Source of electrical power for the field winding of generator E. Electrical regulator designed to automatically maintain a constant voltage level F. Electrical device, consists of diodes that convert AC to DC

Answer Box

PART I									
NO	Your Answer	Correct answer if false							
1									
2									
3									
4									
5									
6									
PART II									
1		2		3		4		5	

Information Sheet 2.1	Alternator construction, working principle, types and main parts

Generator / Alternator

An electric generator is a device that converts mechanical energy obtained from an external prime mover into electrical energy as the output. In fact, a generator does not actually ‘create’ electrical energy. Instead, it uses the mechanical energy supplied to it to force the movement of electric charges present in the wire of its windings through an external electric circuit.

2.1.1 Generator Construction

A generator obviously consists of stator and rotor,

Stator: - stationary part of the generator. It consists of stator frame (the outer cover), stator core (a part in which windings are being wound) and stator windings (conductors which are wound on the stator core).

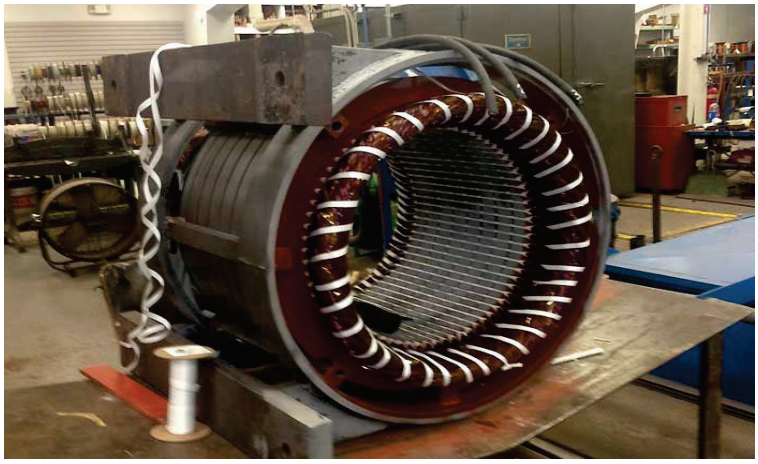


Figure 2.1: Generator stator

For high voltage alternators the stator is used to hold the armature winding. The stator core is made up of lamination of steel alloys or magnetic iron to minimize the eddy current loses. That part of a generator that produces the magnetic field is called the field. That part in which the voltage is induced is called the armature.

Rotor: - rotating part of the generator.

In most of the alternator, field exciters are rotating, and the armature coil is stationary. All generators must have these two mechanicals parts.

Figure 2.2: Generator rotor

2.1.2 Working principle of a generator

A generator works on the principle of electromagnetic induction discovered by Michael Faraday in 1831-32. Faraday discovered that the flow of electric charges could be induced by moving an electrical conductor, such as a wire that contains electric charges, in a magnetic field. This movement creates a voltage difference between the two ends of the wire or electrical conductor, which in turn causes the electric charges to flow, thus generating electric current.

Regardless of size all electrical generators, whether dc or ac, depend upon the principle of electromagnetic induction. A voltage is induced in a coil as a result of either

1. A coil cutting through a magnetic field, or
2. A magnetic field cutting through a coil.

If there is relative motion between a conductor and a magnetic field, a voltage will be induced in the conductor. For relative motion to take place between the conductor and the magnetic field, the generator rotor should be coupled with the prime mover shaft. Most modern, larger generators have a stationary armature (stator) with a rotating current-carrying conductor (rotor or revolving field). So, to produce/ generate electricity, three things which are magnetic field, conductors and rotation should be fulfilled.

Table 2.1 Generator types

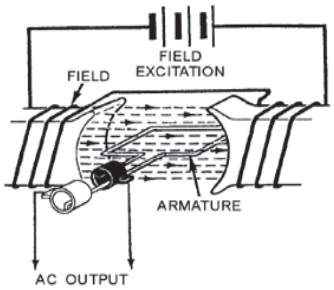
<table>
<tr><th colspan="2">A. Based on the kind of prime mover, or power turning the rotor</th></tr>
<tr><td colspan="2">• Water-turbine generator
• Steam turbine generator
• Motor-generator, Diesel generator, Gasoline generator
• Wind-turbine generator
• Atomic power generator</td></tr>
<tr><th colspan="2">B. Based on construction</th></tr>
<tr><td>1. rotating armature stationary field
The armature rotates in a stationary magnetic field. Is similar in construction to the dc generator.
A rotating armature requires slip rings and brushes to conduct the current from the armature to the load. The armature, brushes, and slip rings are difficult to insulate, and arc-overs and short circuits can result at high voltages.
 

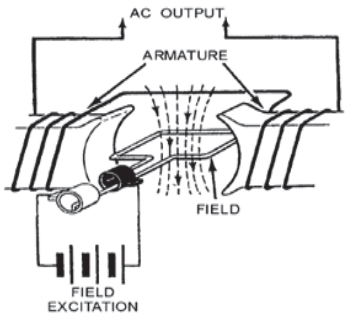
Figure 2.3a</td><td>2. rotating field stationary armature
Have a stationary armature winding and a rotating-field.
 

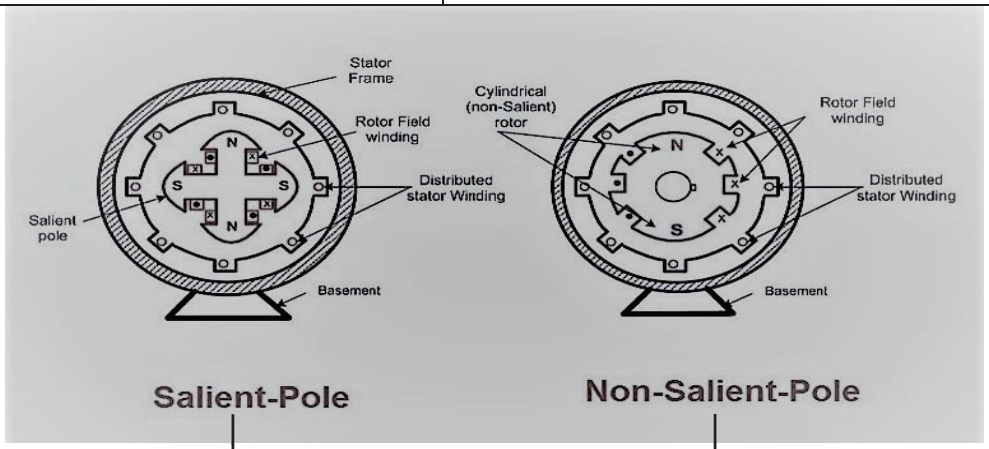
Figure 2.3b</td></tr>
<tr><th colspan="2">C. Depending upon the rotor type</th></tr>
<tr><td>1. Salient pole type
In salient pole type of rotor consist of large number of projected poles (salient poles) mounted on a magnetic wheel. Construction of a salient pole rotor is as shown in the figure below. The projected poles are made up from</td><td>2. Cylindrical type
Non-salient pole rotors are cylindrical in shape having parallel slots on it to place rotor windings. It is made up of solid steel. The construction of non-salient pole rotor (cylindrical rotor) is as shown in figure</td></tr>
</table>

laminations of steel. The rotor winding is provided on these poles and it is supported by pole shoes.

- *These rotors have large diameter and shorter axial length.*
- *They are generally used in lower speed electrical machines, say 100 RPM to 1500 RPM. Number of salient poles is between 4 and 60.*

above. Sometimes, they are also called as drum rotor.

- *They are smaller in diameter but having longer axial length.*
- *They rotors are used in high-speed electrical machines, usually 1500 RPM to 3000 RPM.*
- *Their construction is robust as compared to salient pole rotors. Number of poles is usually 2 or 4.*



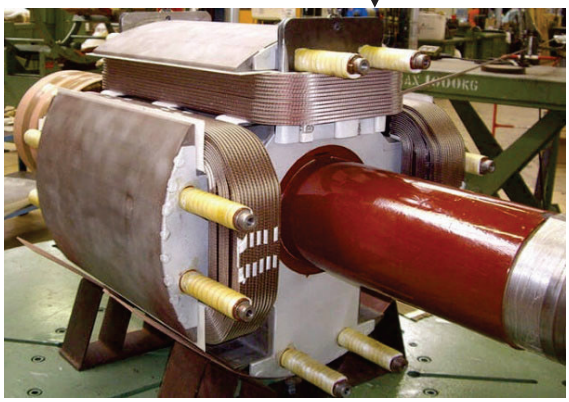


Figure 2.4a

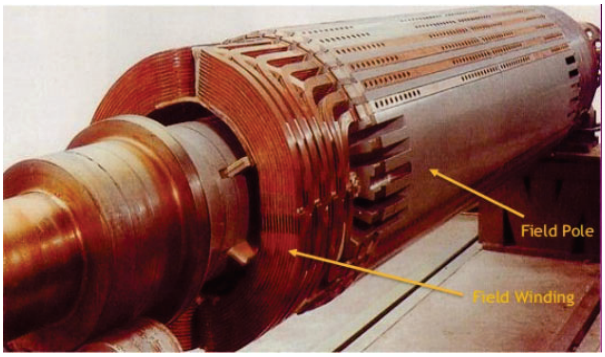


Figure 2.4b

D. Depending upon output Needed

1. Ac Generators
2. DC Generators

*** any generator generates alternating current but according to the user's need this AC is converted to DC.*

Main parts of a generator and their functions

Main parts of a generator are main parts that contribute for the proper output delivery of a generator. These are listed as follows.

A. **AVR (automatic voltage regulator)** – is an electrical regulator designed to automatically maintain a constant voltage level. It processes and amplifies input control signals to a level and form appropriate for control of the exciter.

When there is a sudden change in load in the generator, there should be a change in the excitation system to provide the same voltage under the new load condition. This can be done by the help of the automatic voltage regulator. The automatic voltage regulator equipment operates in the exciter field and changes the exciter output voltage, and the field current.

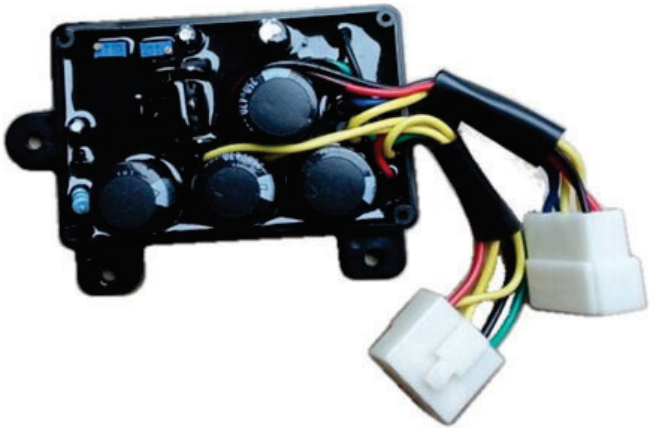


Figure 2.5: AVR

B. **Exciter** – is the source of electrical power for the field winding of generator and is realized as a separate DC or AC generator. The field coils in a generator produce the magnetic flux that is essential to the production of the electric power. The rotor is a rotating electromagnet that requires a DC (Direct Current) electric power source to excite the magnetic field. This power comes from an exciter.

C. **Rectifier -** electrical device, mainly consists of diodes that convert alternating current to direct current or at least to current with only positive value, a process known as rectification. The rectifier in AC generator mainly performs rectification of alternating current coming from the exciter. After it gets rectified by the rectifier circuit, it is supplied to the main field winding of a generator.

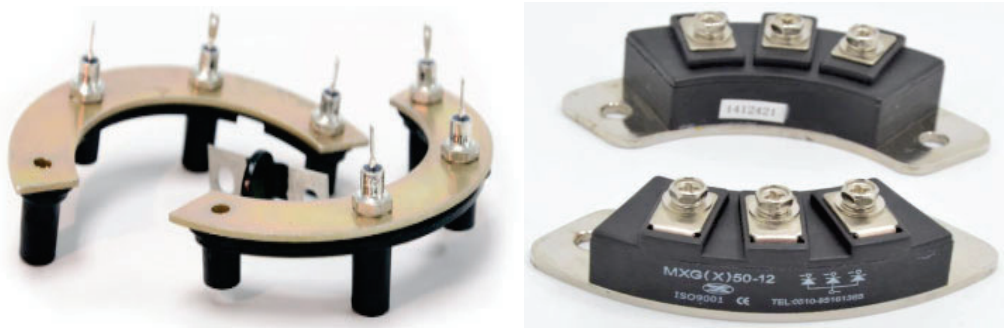


Figure 2.6: rotating rectifiers

D. **Armature and Armature windings** – is output-producing component of an electrical machine. In a generator, the armature windings generate electric current which provides power to an external circuit. It consists of many coils of wire that are large enough to carry the full-load current of the generator those coils are called armature windings. The armature can be on either the rotor or the stator, depending on the design, with the field coil or magnet on the other part.

E. **Field winding/coil or field magnets** – is the magnetic field producing component of electrical machine. The magnetic field in a generator can be provided by either wire windings called field coils (electromagnet) or permanent magnets. Field provided by electromagnet consists of coils of conductors within the generator that receive a voltage from a source (called excitation) and produce a magnetic flux. The magnetic flux in the field cuts the armature to produce a voltage. This voltage is ultimately the output voltage of the generator. Field is stationary in most of the case for a smaller voltage systems & rotating for high voltage systems.

F. **Control panel instruments**

- Display instruments – instruments which are used to display/indicate the operating status of the gen-set (engine, alternator, battery charging, auxiliary systems…).
- Controlling device(s) – devices which are used to control the operation and/or the output of a gen-set (e.g. circuit breaker, start/stop buttons, ……).
- Protective device(s) – devices which are used for the protection of parts of gen-set or the entire gen-set from damage during unexpected situations while it is operating. (e.g., fuses, emergency stop button….)
- Correcting/ adjustment devices - devices which are used to adjust the parameters to a specified or to a required level.

Figure 2.7 Control panel

Operation Sheet LG 2	Demonstrate and Testing functionality of Electrical parts and main Alternator

Summary

This operation sheet contains to demonstrate and Testing functionality of electrical parts and main Alternator. In this we see demonstrate each part on main alternator assembly and by using different measuring instrument test the functionality components and systems.

Preparation

- To perform the tasks the following listed tools & necessary materials, instruments, consumable materials & documents are necessarily to

Personal Protective Equipment (PPE)	Crimping tools
First aid kit	Clamp-ammeter
fire extinguisher	Bench vise
wrenches (open, close)	Genset with battery
Pliers (combination, long nose, cutter)	Alternator cut model
Adjustable wrenches	Insulated & mechanical screw drivers (flat & Philips)
Multi-meter	Allen keys (hexagonal & star)
Socker wrenches	cleaning rag
Insulation resistance tester (megger)	Rectifier

Instruction

Before we start our tasks, we have to use personal protective equipment. Then the necessary tools, consumable materials, documents and equipment are provided by the technical assistant, and we will take a look on them and Demonstrate and Testing functionality of Electrical parts and main Alternator for operation and maintenance work.

- Then to start Demonstrate and Testing functionality of Electrical parts and main Alternator we have to get the appropriate tools to open the gen-set hood(cover), service(user) manual for reference, related cut models. then open the hood/cover follow the steps listed below.

- During the time of opening and closing the gen-set hood/cover we should take care of cables & sensitive components/devices from damage and be careful not to make short between battery terminals.

Task 1: - Demonstrate each part on main alternator assembly

Task 1.1: - Demonstrate Excitor coil and main field coil

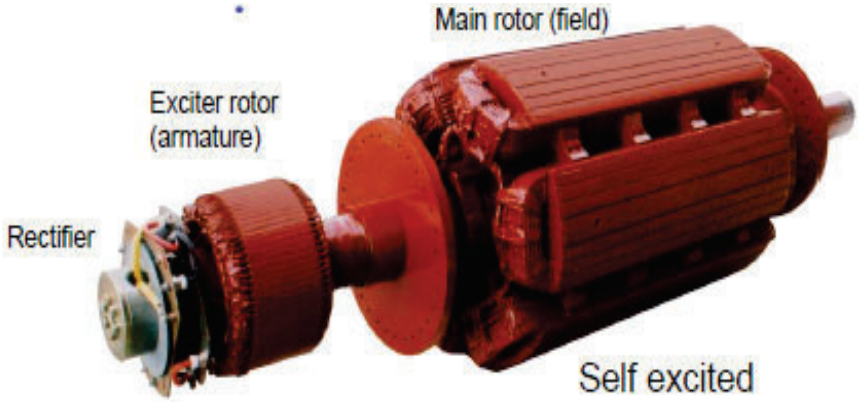


Fig.1.1 Rotor part of Exciter and main alternator

Task 1.2: - Demonstrate Armature core and main alternator

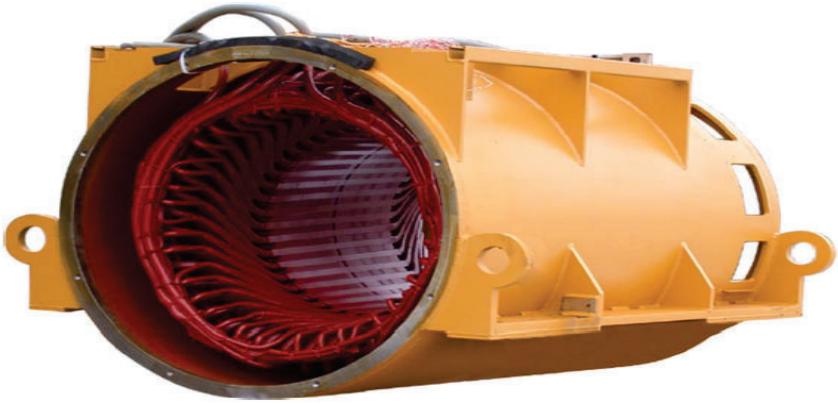


Fig.1.2 Stator part of main alternator

Task 1.3: - Demonstrate each part on this AVR

Fig.1.3 AVR assembly

Task 1.4: - Demonstrate displaying instruments on control panel

Fig.1.4 control panel

Task 2: - Test the functionality components and systems

Task 2.1: - Rectifier in the main alternator

Fig.2.1 Rectifier

1. Method 1

Step 1 set the voltmeter to diode test direction.
Step 2 touch the positive terminal point of the diode with positive cable of voltmeter
Step 3 touch the negative terminal point of the diode with negative cable of voltmeter
Step 4 observe the reading on the display of voltmeter
- If it read 0.7 V or 0.3 V Its OK otherwise the diode fails

Step 5 repeat the same step for the rest of 5 diodes

2. Method 2

Step 1 set the multi meter on continuity mode.
Step 2 touch the positive terminal of the diode with positive cable of voltmeter
Step 3 touch the negative terminal of the diode with negative cable of voltmeter

Step 4 observe the reading on the display of voltmeter /It should be reads continuity

Step 5 Reverse the cable of the meter (positive to negative and negative to positive)

Step 6 observe the reading again on the display of the meter /It should be reads infinity

Task: - 2.2 Starting system

(Use red cable for positive line and Black cable for negative line)

Step 1 connect the negative cable to ground point of the starter

Step 2 connect the positive cable to starter solenoid (terminal point x)

Step 3 connect the x terminal point of the starter to x point of starter relay

Step 4 connect the y terminal point of the starter relay to x point of ignition switch

Step 5 connect the y terminal point of the ignition switch to positive terminal of the battery through fuse

Step 6 Turn ON the ignition switch and observe the rotation of starter

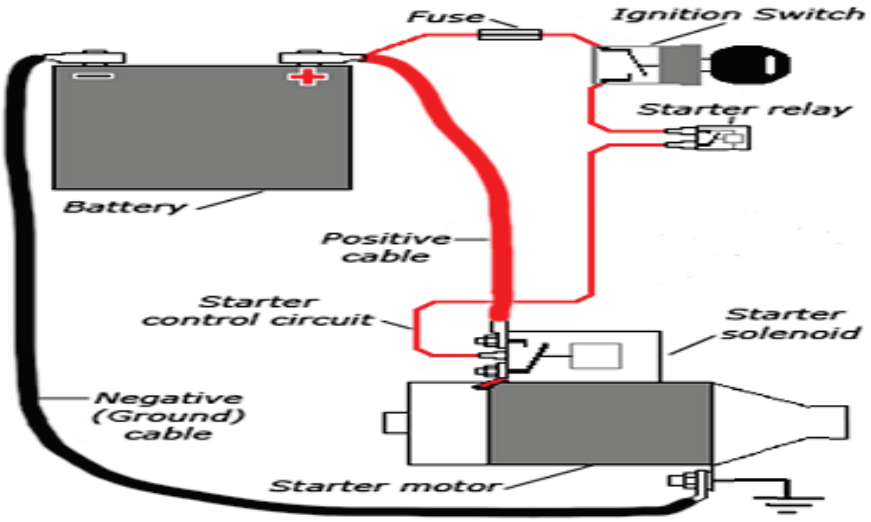


Fig.2.2 starting system

Task: - 2.3 Charging system

The flow of current in the system as follow

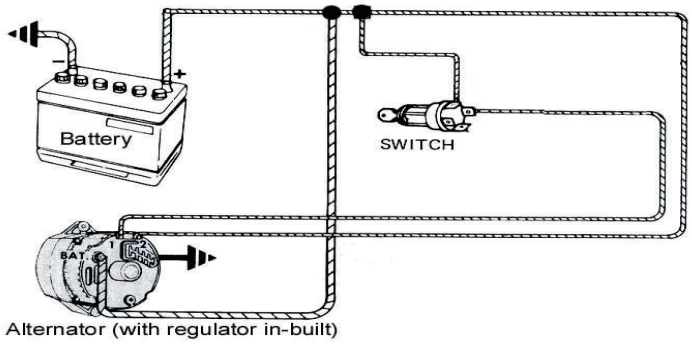


Fig.2.3 charging system

Step 1 connect the negative terminal of battery to any metal part of the gen-set part

Step 2 connect the positive terminal of battery to one termina of key switch

Step 3 connect the output terminal from switch to alternator terminal

Step 4 connect the ground terminal of the alternator to any metal part of the gen-set part

Step 5 Turn ON the key and observe the alternator and the voltage across battery

Task 2.4: - Switches (Temperature, oil pressure)

Fig. 2.4 A. Temperature switch

Fig. 2.4 B pressure switch

A. For Temperature switch

Step 1 Touch the body of the Temperature switch close to heat

Step 2 Set the voltmeter to continuity mode

Step 3 connect the two terminals of the voltmeter across the two terminals of the switch

Step 4 Observe the display on the multi-meter

Step 5 After the device enough heated the normally closed point becomes open

B. For Pressure switch

Step 1 give pressurized air to the inlet of the device

Step 2 Set the voltmeter to continuity mode

Step 3 Connect the two terminals of the voltmeter across the two terminals of the switch

Step 4 Observe the display on the multi-meter

Step 5 After the device enough take the air the normally closed point becomes open

Task 2.5: - Relay, Fuel solenoid, Temperature senser, pressure senser

Fig.2.5 A. solenoid

Fig.2.5 B. relay coil

LAP Test LG 2	Practical Demonstration

Step 1 give the recommended voltage to the coil terminals of the relay

Step 2 Set the voltmeter to continuity mode

Step 3 Connect the two terminals of the voltmeter across the terminal point of the switch

Step 4 Observe the display on the multi-meter

Step 5 The Normally closed point become open and normally open point become closed

Task 2.6: - Exciter coil

Fig.2.6 Exciter coil

Step 1 Set the voltmeter to resistance selection mode

Step 2 Connect the two terminals of the voltmeter across the terminal point of the coil

Step 3 Observe the display on the multi-meter/we read some resistance value around 15ohm/

After we finish, we have to close the opened hood/cover properly, clean the genset area and return the tools & cut models to their position.

Total time allowed for doing the following tasks: *35 min for each trainee*

Preparation

Preparation and setting for the performance assessment

- Prepare or avail the gen-set and cut models related with its components for the assessment
- Ensuring if there is suitable area for the assessment
- Avail the necessary tools, material, instruments
- Avail the rating sheet for demonstration per each trainee

Instructions: You are required to perform the following tasks on the diesel gen-set that is provided for your work. Your work progress is being observed by the trainer/technical assistant. Request your trainer/ technical assistant for evaluation and feedback.

Task 1: - Demonstrate each part on main alternator assembly

Task 1.1 Demonstrate Excitor coil and main field coil

Task 1.2 Demonstrate Armature core and main alternator

Task 1.3 Demonstrate each part on this AVR

Task 1.4 Demonstrate displaying instruments on control panel

Task 2: - Test the functionality components and systems

Task 2.1 Rectifier in the main alternator

Task 2.2 Starting system

Task 2.3 Charging system

Task 2.4 Switches (Temperature, oil pressure)

Task 2.5 Relay, Fuel solenoid, Temperature senser, pressure senser

Task 2.6. Exciter coil

List of Reference Materials LG 2

- www.cpower.com
- https://www.slideshare.net/ManmeetSingh163/engine-type-and-classification?from_action=save
- https://www.electricaleasy.com/2014/03/salient-pole-rotor-vs-non-salient-pole.html
- https://www.google.com/search?q=generator+battery&oq=generator+battery&aqs=chrome.0.69i59.8975j0j8&sourceid=chrome&ie=UTF-8

Ethiopian Water Technology Institute (EWTI)

Electromechanical Machineries Maintenance Technology Training

Learning Guide #03

Unit of Competence:	Gen-set Operation & Maintenance
Module Title:	Operating & Maintaining a Gen-set
LG Code:	EMMT/GEN/LM03/0421 V1
TTLM Code:	EMMT/GEN/TTLM 0421 V1

LO3: - Operate a Gen-set

Instruction Sheet LG 3	Operate a Gen-set

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

3.1 Operation of a gen-set and checklists

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

1. Perform visual inspection, pre operational tests and field preparation for operation in accordance with manufacturer and enterprise/site procedures
2. Operate the generator within limits of its design, regulators requirements, and enterprise or site requirements
3. Adjust the generator output to achieve its required operating requirements and demand by observing operational requirements
4. Evaluate generator operation to detect deviations from required operating conditions.
5. Correct operational abnormalities in accordance with manufacturer and enterprise/site procedures
6. Record the operation data on the generator operation log sheet

Learning Instructions:

1. There are 4 parts of basic knowledge and skills that underpin performance related to the job in the learning Guide. You are expected to go through all the parts to prepare yourself for starting operation and LAP test at the end of this Learning Guide.
2. Try to answer to “Self-check 1” to confirm your current knowledge. Leave any items blank that you cannot answer now, which is for you to learn in this Guide.
3. Read the information written in the “Information Sheet”. Try to understand what are being discussed, and answer all items in “Self-check 1,” including the items you could not answer when you tried for the first time. You may be tested using “Self-check 1” to confirm your understanding of the basics.
4. Demonstrate operation sheet and conduct the LAP test to complete this learning guide.
5. For more information see the reference material listed at the end of the learning guide.

Self-check 3.1	Operation of a gen-set and checklists

Time started:_____ **Time finished:**_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) Check True/False and make correction if the statement is false

1. Pre operation checks or inspections are not performed before operating a generator.
2. Output or correction of deviations needed after starting the generator.
3. We measure Specific Gravity of the electrolyte to check the concentration of the acid in a battery.
4. During idling time, the current on the control panel reads maximum.
5. During pre-operation checking activity the key Switch is in STOP/OFF position.
6. Inspection of operation status during engine warming time (IDLE operation) is not needed.
7. Operation checklist contains checklist items which are used as a guide to perform an operation safely.

II) Choose the best answers for the questions listed below

1. The current will increase as far as connected loads increased and this change should be recorded on
   A. Pre-operation checks
   B. Maintenance log sheet
   C. Generator operation log
   D. Inspection checklist

2. When is the performance tests done?
   A. Before starting the generator
   B. After the generator is started
   C. After the generator is stopped/shutdown
   D. When the generator is under maintenance

Answers Box

Part I		
NO	Your Answer	Correct answer if false
1		
2		
3		
4		
5		
6		
7		

Part II			
NO	Your Answer	NO	Your Answer
1		2	

Information Sheet 3.1	Operation of a gen-set and checklists

1. Introduction

Operation of the generator is to mean that permitting or allowing a generator to give the task/service it is intended for. That is giving an electrical output which is needed for different applications. An operator who operates the gen-set should get operator training and understand operation of the Gen-set satisfactorily.

Manufacturing companies provide manuals for generator operation at standard/normal conditions and the operation will be affected if there are variations from listed normal conditions. So, to avoid those problems related with the operation there should be pre starting inspections & tests, post starting observations & checks and correction/adjustment of outputs from given limits of operation. These can be seen under the following categories.

2. Inspections and checklists

Inspection and pre-operational checks - All checks/inspections required for system components prior to/before energizing or operating the major system component (in this case generator). Visual inspection should take only a few minutes and can prevent costly repairs and accidents. For maximum generator set life and to protect it from damage due to careless starting, visually inspect and perform pre-operation checks on the generator set before starting.

Post starting tests/check or performance test –tests/checks that should be conducted to evaluate the compliance of a system or component (in this case generator) with specified performance. This is to mean that checking or observing the operation and delivered output is as per the specified performance.

Post starting adjustment and correction of deviations– adjustments that are needed to be set after starting of the generator within the limits of its design and enterprise or site requirements. And it refers also to correct deviations of the operation from manufacturer and enterprise/site procedures.

Operation checklist– contains checklist items which are used as a guide to perform an operation safely.

Specific gravity (SG) of battery electrolyte -The SG is a measure of the concentration of the acid in a battery electrolyte. Hydrometer is used to measure the Specific Gravity (SG) of a battery.

Generator operation log – while an operator is operating the gen-set, it is expected to feed the necessary information using the following log sheet by the time of before starting, during running & shutdown. This is helpful to get the working condition of the generator set, and it is a recorded operation/ working history of the generator set.

Table: -3.1 generator operation log

Generator Operation Log Sheet											
Model of Gen-set_____KVA _____ 3phase ☐ single phase ☐ ***Location_____ Tag No. _____***											
Date	**Operator's Name**	**Reason for Running** (for office supply, Test, Maintenance, etc…)	**Fuel level**		**RPM**	**Output Voltage reading** (after it is started)	**Current** (after giving load) **	**Time**		**Hour Meter Reading**	
			start	**stop**				**Start**	**Stop**	**Start**	**Stop**
						P-P P-N					
						P-P P-N					

*** the current will increase as far as connected loads increased and this change should be recorded on the log.*

Table: -3.2 Safety kits checklist

Item	Yes	No	Remarks
Is first aid kit available?	☐	☐	
Is fire extinguisher available?	☐	☐	
Is the fire extinguisher working?	☐	☐	

Table: -3.3 Documents checklists

Item	Yes	No	Remarks
Are operation/user manuals provided by the manufacturer available?	☐	☐	
Is generator operation log available?	☐	☐	

Pre-operation checks and Inspection checklist – contains checklist items to be conducted before starting the gen-set.

Table: -3.4 Pre-operation checks and Inspection checklist

Item	Yes	No	Remarks
Existence of foreign material near the surface of generator set/ its surrounding, which may affect the generator set's operation.	☐	☐	
Air ventilation in the generator set room	☐	☐	
Protection from rain and dust in the generator set room	☐	☐	
Is the coolant level within the specified range?	☐	☐	
Is the fuel tank filled with fuel within the specified range?	☐	☐	
Is the oil sump is filled with oil within the specified range and oil quality?	☐	☐	
If the fuel valve is open?	☐	☐	
Loose fastenings / fixings, worn belts or loose connections.	☐	☐	
fan and exhaust guards at the correct positions and securely fixed	☐	☐	
Is there any fluid leak (oil, fuel, cooling water, battery electrolyte)?	☐	☐	
Is the key Switch STOP/OFF?	☐	☐	
Is the battery cable connected in a correct way?	☐	☐	
Are the load connection/ output terminals and other electrical connections properly fixed?	☐	☐	
Is the alternator output circuit breaker properly fixed and in the "OFF" position?	☐	☐	

Starting and operation checklist – checklist which contains checks and observations during starting and operation.

Table: -3.5 Starting and operation checklist

Item	Yes	No	Remarks
Is preheating works (is the glow plug get electricity to glow)?	☐	☐	
Are the indicating lights on the generator control panel OFF?	☐	☐	
Leakage of fluids (oil, fuel, water) during startup and operation	☐	☐	
Is the exhaust system working normally?	☐	☐	
Unusual/abnormal noise, vibration, smell, light	☐	☐	
Is there any electric spark?	☐	☐	
Is the reading of meters and gages displaying outputs on the control panel normal?	☐	☐	

Operating Module/Electronic Controlled Generators

The operation sheet in this learning guide does not include module-controlled generators so we will cover some important points will be presented as follows. Module/Electronic controlled type generators may not have manual starting keys, instead starting is done from the by selecting modes from operator's panel. The following is general information for operation of module-controlled generator after doing pre start checks and which has human-machine interface/panel *(sample operator panel is displayed as follows – which belongs to CUMMINS gen-set C125D6C type)*. You should go through the operation manual provided by the manufacturer for your specific gen-set.

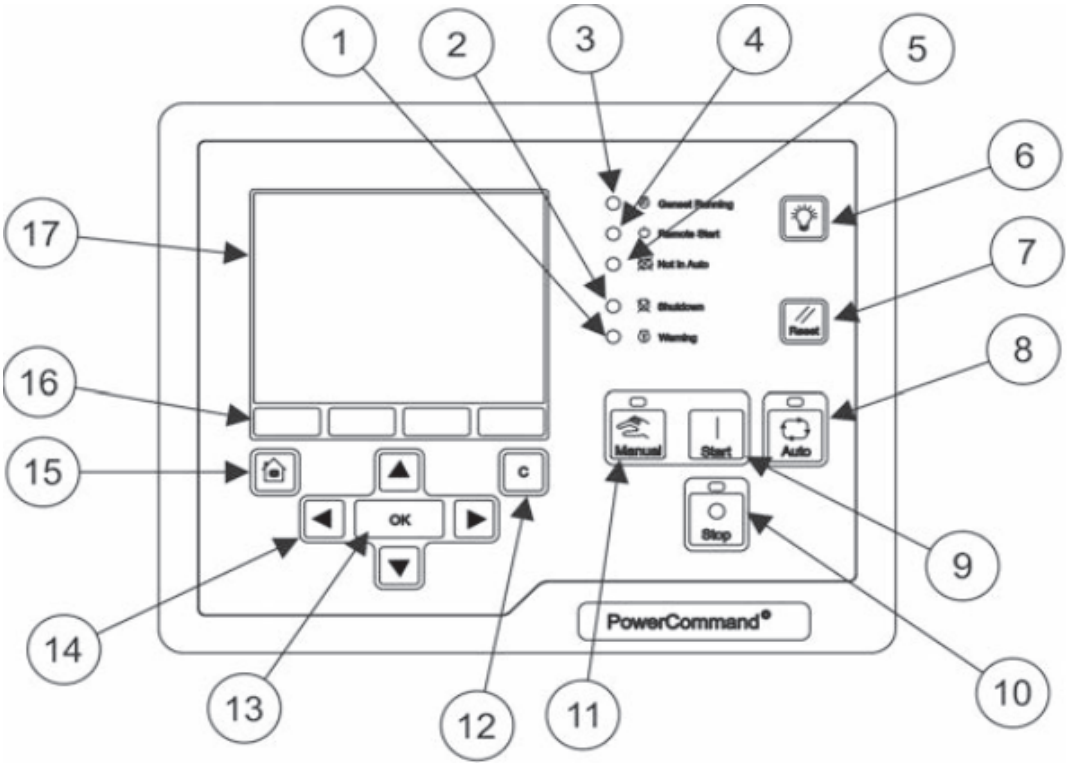


Figure 4.1 Electronics control panel

Table: -7 panel is displayed

1-indicator lamp-warning	6-Lamp test button	11-Manual button	15-Home button
2-indicator lamp-shutdown	7- Reset button	12-Previous menu button (or clear)	16-Menu select button for graphical display
3-indicator lamp-genset running	8-Auto mode button	13-Item Select button (OK)	17-Graphical display
4-indicator lamp-remote start	9-Start button	14- Menu Navigation buttons (up, down, left, right)	
5-indicator lamp-not in auto	10- Stop button		

Starting a generator using module/electronic control

while starting these generators checklists described in the previous section of this information sheet can be used. And pre start checks, checks during starting and post start adjustments which are listed in the operation sheet in this learning guide can be used. Finally starting in manual and auto modes *(which belongs to CUMMINS gen-set C125D6C type)* are stated as follows.

A- Starting in MANUAL RUN mode

- Make sure that the main circuit breaker is in the open position.
- Press Manual Button on the operator panel 

- Manual Run LED will display.
- Press Start Button on the operator panel within ten seconds. 

The power command will initiate a starter cranking signal & will perform automatically sequenced manual start, under a complete engine protection system combined with full monitoring capability. This will activate the engine control system and the starting procedure. The starter will begin cranking and after few seconds, the engine will start, and the starter will disconnect. If the engine fails to start, the starter will disengage after a specified period of time and the control will indicate a fail 

to start shutdown.

To clear a fail to shutdown first press a stop button on the operator panel then press a reset button on the operator 

panel.

Before attempting to re-start, wait a minimum of two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt, refer to the operator manual.

- To disable Manual Run mode change to Auto or Off mode.

B- Starting in AUTO RUN mode

- Select Auto Run mode on the operator panel - 

Auto Run LED will display. Once the power command control receives a remote-control signal, and after a time delay to start, the control will initiate the starting sequence as above.

  Refer also to the selecting Auto mode section of the manufacturer's manual.
- To disable Auto Run mode change to Manual or Off mode.

C- Shutdown: -

- To shut down the generator set, turn off the load by switching the Alternator Output Circuit Breaker to "OFF".
- Press a stop button on the operator panel. 

The generator set shuts down safely.
- In case of an emergency where immediate shutdown is necessary, stop using emergency stop (if the generator has an emergency stop)

Operation sheet LG 3	Generator set operation

Summary

This operation sheet contains methods of operating a gen -set. An operator who operates the gen-set should be perform pre operation checks to start the genset and record the operation activity before starting, starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist, Shutdown the gen-set and use the operation log sheet to record the operation data or readings after shutdown.

Preparation

- To perform the tasks the following listed tools & necessary materials, instruments, consumable materials & documents are necessarily.
- Prepare or avail functional gen-set with its starting key.

Personal Protective Equipment (PPE)	screw drivers
First aid kit	engine oil
fire extinguisher	fuel
Power/power factor meter	hydrometer
Multi-meter	cleaning rag
clamp-meter	cable lug
Megger (insulation resistance tester)	insulation tape
wrenches (open, close & adjustable)	Genset with battery
Pliers (combination, long nose, cutter)	Operation checklists
wire striper	Operation log sheet

Instruction

Before we start our tasks, we have to use personal protective equipment. Then the necessary tools, consumable materials, documents and equipment are provided by the technical assistant, and we will take a look on operation and maintenance work.

- During the time of opening and closing the gen-set hood/cover we should take care of cables & sensitive components/devices from damage and be careful not to make short between battery terminals.

-Then we have to ensure that the generator can deliver an output that is needed, and we have to shut down the generator properly finally we have to clean the genset area and return the tools to their position.

Task: -1. Perform pre operation checks to start the genset and record the operation activity before starting

Exercise: -1

Step: -1. Check for unnecessary materials near the surface of generator set/ its surrounding, air ventilation, protection of rain and dust in the generator set working room

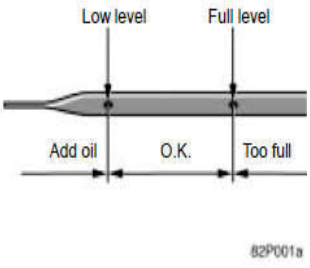
Step: -2. Check for the coolant level within the specified range

- Do not open the radiator cap when the engine gets hot

Step: -3. Check for the fuel tank filled with proper type of fuel & within the specified range, the fuel valves open

Step: -4. Check for the oil sump is filled with oil within the specified range and oil quality Engine oil checking

- Engine is OFF and on level ground
- Open the engine hood/cover and locate the engine oil dipstick.
- Pull out the dipstick and wipe the end clean with a rag.



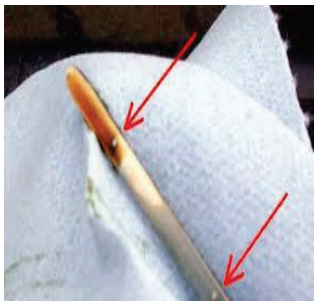


Figure 3.4

I. Reinsert dipstick into the engine until it fully seats
II. Pull out the dipstick again
III. Observe the status of viscosity & level of oil on the dipstick and get a correct oil level reading& viscosity status. Once you see the status do one of the following;

➢ Leave it (return the dipstick to its position) if it is within specification

Figure 3.5

➢ Top up if it is below the minimum level

Figure 3.6a)

Top up

Figure 3.6b)

➢ Drain some amount if it is above the maximum level until you get the correct oil level by opening the oil drain valve or nut.

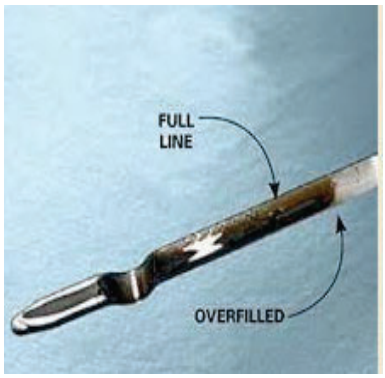


Figure 3.7a)

Figure 3.7b)

➢ Change if the oil changing time is reached [1] or if the oil becomes dirty & loses its expected viscosity Note: This task should be done after the engine gets warm/ after the engine is started. So, first finish all other pre start checks and you can do oil change activity immediately after you finish engine starting and shutdown activities.  Figure 3.8a) [1] refer the manufacturer service/ user manual and maintenance log sheet of the generator	➢ Steps to change engine oil • Properly start the engine & keep it working at 'idling' for 5 minutes and then after change the 'idling' position to 'run'& allow it to work for additional 5 minutes. • Properly shut down the engine, use draining container to hold dirty oil & carefully open the oil drain valve or nut (because the oil gets hot) and allow it to drain. • After the dirty oil is drained properly, close the oil drain valve or nut and fill with new oil that is compatible for the generator. Here if the time to change the oil filter is reached [2] change the oil filter before adding the new oil.  Figure 3.8b) [2] refer the manufacturer service/ user manual and maintenance log sheet of the generator

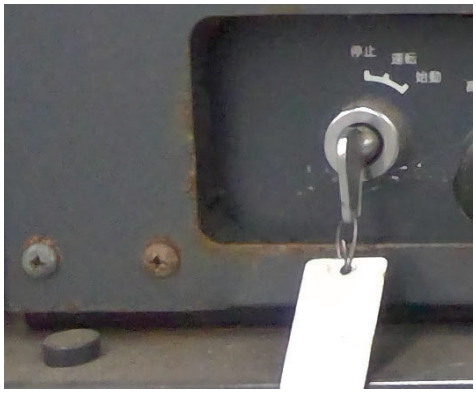
Step: -5. Check for Loose fastenings / fixings, worn belts or loose connections

Step: -6. Check for fan and exhaust guards at the correct positions and securely fixed

Exercise: -2

Step: -7. Check for any fluid leak (oil, fuel, cooling water, battery electrolyte)

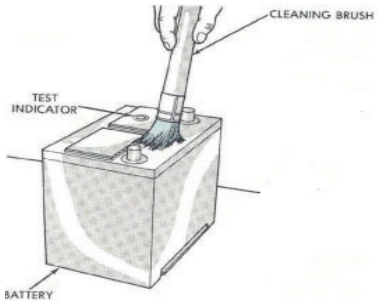
Step: -8. Check for the Key Switch is OFF/STOP and control lever is at 'IDLING'



Step: -9. Check the battery cable is connected in a correct way

- Check the battery terminals for corrosion – if corrosion occurs disconnect the battery terminals with a correct procedure (negative terminal should be disconnected first and positive terminal next) and clean using baking soda and water solution by keeping the solution not to enter into the battery cells.

– While using tools to disconnect the battery, be sure that you do not touch both terminals at the same time with a tool
– Never touch both battery terminals with your bare hands at the same time!
– Never connect the battery terminals together!
– Check the status of battery electrolyte level visually and the terminals



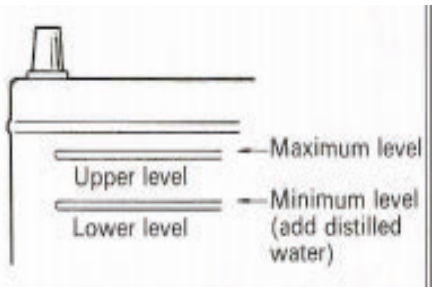
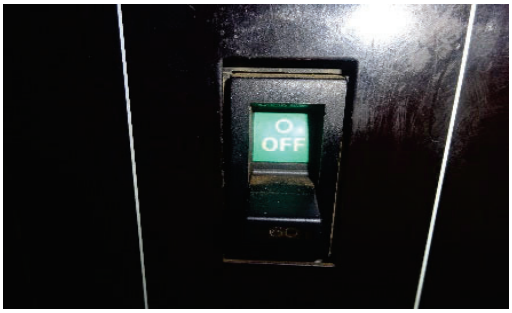


Figure 3.9 a) b) c)

Step: -10. Check the load connection / output terminals and other electrical connections are securely fixed?

Step: -11. Check the alternator output circuit breaker is properly fixed and in the"OFF" position?



Step: -12. Use the operation log sheet to record the Gen set status before starting

Task: -2. Starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist

Exercise: -3

Task: -2.1 Starting the gen set

Step: -1. Turn the starter switch to 'PREHEAT' or 'GLOW' position to preheat the machine.

Step: -2. Turn the starter switch (starter key) to 'START' position

- After the glowing the glow plug heater, turn the starter switch fully to 'START' position to crank/start up the engine. Release the key immediately after cranking, it turns to RUN position automatically. When the starter switch is turned to START the starter, motor become functional, and it drives the flywheel gear via the pinion gear.

Step: -3. Keep the engine control lever at ‘IDLING’ for 3-5 minutes

- Once the engine has started up, leave the engine running to warm up it under unload for 3 to5 minutes which is necessary for smooth operation of the engine.

Task: -2.2 Use the operation checklist and check items during engine warm up (IDLING)

Exercise: -4

Step: -1. Check for the indicating lights on the generator control panel are OFF

Step: -2. Check for leakage of fluids (oil, fuel, water) during start-up and operation

Step: -3. Check the exhaust system working normally

Step: -4. Check for Unusual/abnormal noise or vibration

Step: -5. Check for Unusual smell

Exercise: -5

Step: -6. Check if there is any electric spark

Step: -7. After Engine warm up turn the engine control lever to ‘RUN’

Step: -8. Check the reading of meters and displaying instruments are giving outputs on the control panel are normal

- By watching the voltmeter, turn the voltage regulator controlling knob to set the voltage output to the rated value.

- Be sure to operate the generator at a rated frequency, irrespective of the load capacity
- Keep the door shut and locked whenever the machine is running
- Check displaying instruments (like meters, gauges, status indicator lights….) found in the control/display panel of the generator are working properly.

Step: -9. Make circuit breaker 'ON' and measure & adjust the electrical output (ensure the phase-to-phase voltage is 380V and phase to neutral is 220V)

- Carefully re-check the electrical output on the output terminals using a multimeter and do voltage adjustment by voltage adjustment knob if there is a considerable variation on the expected output value. And then turn the output terminal cover shut and locked whenever the generator is running.

Task: -3. Shutdown the gen-set by following the correct shutdown steps and use the operation log sheet to record the operation data or readings after shutdown

Exercise: -1

Step: -1. To shut down the generator set, turn off the load by switching the Alternator Output Circuit Breaker to "OFF".

Step: -2. Allow the generator set to keep on 'IDLING' by setting the control lever ''IDLING'' position run without load for 1-2 minutes to cool.

Step: -3. Then turn the key switch to 'STOP' position. The generator set shuts down safely.in case of an emergency where immediate shutdown is necessary, stop using emergency stop (if the generator has an emergency stop) or use the key switch should be turned to 'STOP' position immediately without disconnecting the load (if the generator has no emergency stop)

Step: -4. Use the operation log sheet to record the operation data or readings after shutdown

❖ After you confirm that the generator starts its operation safely & after you properly shutdown it, keep clean the surrounding of a gen-set and return the tools used for operating the gen-set.

LAP Test LG 3	Practical Demonstration

Total time allowed for doing the following tasks: *40 min for each trainee*

Preparation

Preparation and setting for the performance assessment

- Prepare or avail functional gen-set with its starting key
- Ensure if there is suitable operation area for the assessment
- Avail the necessary tools, material and instruments.
- Prepare operation log-sheets &operation check list per each trainee

Instructions*:* Receive the instruments, tools, operation checklists and operation log sheet are provided by the technical assistant. After this you are required to perform the following tasks in order to operate the gen-set by using the correct procedure. Your work progress is being observed by the trainer/technical assistant. Request your trainer/ technical assistant for evaluation and feedback.

Task1: Perform pre operation checks to start the genset and record the operation activity before starting

Task2: Starting the gen set, measure & adjust the electrical output using the correct starting procedure and operation checklist

Task 2: 1 Starting the gen set

Task 2.2: measure & adjust the output parameters

Task 3: -Shutdown the gen-set and record the operation data.

List of Reference Materials LG 3

- http://www.dtic.mil/dtic/tr/fulltext/u2/a043170.pdf
- https://www.dieselserviceandsupply.com/pdf/Operations-Manual-Operating-Procedures-Emergency-Diesel-Generator.pdf
- Generator set operator & maintenance instruction manual, FG WILSON 356-5901(GB) V9 06/ 14
- CUMMINS generator set operator, service, and installation manuals *(provided by Cummins Power Generation)*
- Cummins_Power_Generation_Standby_Gen_Operator_Manual_C80D6C_C100D6C. Pdf 6233_rs125_install_1_2018.pdf

Ethiopian Water Technology Institute (EWTI)

Electromechanical Machineries Maintenance Technology Training

Learning Guide #04

Unit of Competence:	Gen-set Operation & Maintenance
Module Title:	Operating & Maintaining a Gen-set
LG Code:	EMMT/GEN/LM04/0421 V1
TTLM Code:	EMMT/GEN/TTLM 0421 V1

LO4: - Perform Generator Maintenance

Instruction Sheet LG #4	Perform generator maintenance

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

4.1 Plan and prepare for generator maintenance
4.2 Troubleshooting technique on generator maintenance

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

1. Identify and categorize maintenance activities based on complexity of internal and external capacities.
2. Examine and identify Malfunctioning of the generator.
3. Select and perform proper maintenance techniques from simple to complex by following standard procedures.
4. Perform post maintenance check/evaluation of functionality of the generator is within limits of its design, regulators requirements, and enterprise or site requirements.
5. Record the maintenance activity on the generator maintenance log sheet.

Learning Instructions:

1. There are 2 parts of basic knowledge and skills that underpin performance related to the job in this Learning Guide. You are expected to go through all the parts to prepare yourself for starting operation and LAP test at the end of this Learning Guide.
2. Try to answer to “Self-check 1” to confirm your current knowledge. Leave any items blank that you cannot answer now, which is for you to learn in this Guide.
3. Read the information written in the “Information Sheet 1”. Try to understand what are being discussed, and answer all items in “Self-check 1,” including the items you could not answer when you try for the first time. You may be tested using “Self-check 1” to confirm your understanding of the basics, repeat 2 and 3 above for the rest parts of the Guide until just before goes to “Operation Sheet.
4. Demonstrate operation sheet and conduct the LAP test to complete this learning guide.
5. For more information see the reference material listed at the end of the learning guide.

Self-check 4.1	Plan and prepare for generator maintenance

Time started:_____ **Time finished:**_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) Check True/False and make correction if the statement is false

1. Maintenance is the process of determining future decisions and actions necessary to accomplish intended maintenance work and targets.
2. Maintenance log shows necessary status information of the generator set maintained and it has no purpose for next maintenance.
3. Breakdown maintenance implies that repairs are made before the equipment is failed.
4. failure or symptoms of failure should occur to conduct preventive maintenance.
5. Maintenance is done for the purpose of keeping a machine for its proper functioning in the process of operation.

Answer Box

Part I		
NO	Your Answer	Correct answer if false
1		
2		
3		
4		
5		

Information Sheet 4.1	Plan and prepare for generator maintenance

Introduction

Maintenance– an activity carried out on an equipment or physical plant in order to ensure that an equipment or physical plant continues to perform its intended functions, or to repair the equipment. Maintenance and repair should be made by the authorized staffs. Note that modifications are not maintenance, even though they may be carried out by maintenance personnel.

Purpose of Maintenance

- to maximize performance of production equipment efficiently and regularly
- to prevent breakdown or failures
- to minimize production loss from failures
- to increase reliability of the operating system

Types of Maintenance

Maintenance may be classified into three categories:

1. Corrective or Breakdown maintenance – implies that repairs are made after the equipment is failed and cannot perform its normal function anymore.
2. Predictive (Condition-based) maintenance – In predictive maintenance, machinery conditions are periodically monitored, and this enables the maintenance crews to take timely actions, such as machine adjustment, repair or overhaul. It makes use of human sense and other sensitive instruments, such as audio gauge, vibration, pressure, temperature and resistance strain gauges etc.
3. Preventive maintenance – provides periodic/scheduled inspections, lubrication, repair and overhaul of equipment's to reduce the danger of unexpected failures

   Advantage of Preventive maintenance

   - Reduces failures and thereby down time
   - Greater safety of workers
   - Lower maintenance and repair costs

- Better product quality
- Increases machines life.
- It used to maximize the productivity of the equipment

Maintenance Planning

It is the process of determining future decisions and actions necessary to accomplish intended maintenance work and targets. It is the process by which the elements required to perform a task are determined in advance of the job start. Planning for future actions helps in achieving job in the most efficient and effective manner. It minimizes costs and reduces risks and missing opportunities. It can also increase the competitive edge of the organization. The planning process can be divided into three basic levels depending on the planning horizon: -

1 Long range planning
2 Medium range planning
3 Short range planning

Planning the maintenance of an equipment in advance is useful to prevent breakdowns from happening. Here you will look at your company's maintenance procedures and investigate the benefits of planned maintenance to the company. You will produce a report to your team leader on the time and money that could be saved on preventive maintenance.

All machines (in our case alternator and engine) should be maintained in accordance with the manufacturers' specifications. Manufacturers provide inspection, maintenance, and service schedules that should be strictly followed. Because the manufacturer-specified intervals are intended primarily to protect the equipment rather than optimize system efficiency. Good planning is a prerequisite for sound scheduling.

Planning Procedures

- Determine the job content.
- Develop work plan. This entails the sequence of the activities in the job and establishing the best methods and procedures to accomplish the job.
- Establish crew size for the job.
- Plan and order parts and material.
- Check if special tools and equipment are needed and obtain them.

- Assign workers with appropriate skills.
- Review safety procedures.
- Set priorities for all maintenance work.
- Assign cost accounts.
- Complete the work order.
- Review the backlog and develop plans for controlling it.
- Predict the maintenance load using effective forecasting technique

Resources for maintenance plan may include;

- The equipment itself to be maintained
- Instruments and tools
- Consumable materials and spare parts (from stock or new purchase)
- Manuals, parts catalogue & necessary drawings
- Skilled personnel and Labor
- Past Maintenance record
- Time &Budget for maintenance

Maintenance scheduling

It is the process by which jobs are matched with resources and sequenced to be executed at a certain point in time. It refers to timing and sequences of operations. It deals with the specific time and phasing of planned jobs together with the orders to perform the work, monitoring the work, controlling it, and reporting on job progress. scheduled maintenance activities will be provided by the manufacturer's operation and service manuals. Each manufacturer and model have a unit specific maintenance schedule which is normally provided by working hours or daily, weekly, monthly etc.…

Maintenance Log sheet

It shows necessary status information of the generator set before& after it is being maintained and this log is a recorded maintenance history of the generator set. So, during any maintenance activity information has to be logged/recorded. This information is useful to decide for & perform the next maintenance activity.

Table 4.1 Genset Maintenance Log sheet

Maintenance Log sheet						
Model of Gen-set_____ KVA_____ **Type: - 3 phase ☐ single phase ☐ Tag No._____** **Location_____**						
Date	***(1)* Problem found/occurred**	***(2)* Identified failure**	**Maintenance Activity**	**Hour Meter Reading during maintenance**	**Maintenance done by**	**Remark**

(1) & (2) problem or symptoms of problems & identified failure are not expected to happen for the case of preventive maintenance.

Maintenance Reporting

Maintenance work report should be done after maintenance work is performed and consist of the amount of work done & the locations of work /machinery as well as the resources used. Normally, these are completed at the end of each day or at the end of each maintenance work.

The daily work reports should be reviewed by the supervisors promptly to ensure that activities were completed properly and to determine if the performance standards were substantially followed. Significant variations should be followed up quickly to determine the cause and, if necessary, take corrective action

Preparation of tools, instruments and necessary materials

To perform Maintenance activities; skilled person, proper testing instruments, tools, spare parts and consumables are necessary in addition to availability of manuals & specifications provided by the manufacturer. In any of maintenance activities it is necessary to use the right replacement spare parts, other consumables, tools &

instruments for the right application to avoid damages on the equipment as well as on the personnel.

These necessary spare parts, consumables, tools & instruments should be provided and made available in a suitable place for maintenance work. If those are not available in stock, it is necessary to do purchase order for tools/instruments and for the same/closer specification of the part in failure/to be changed.

Self-check 4.2	Troubleshooting technique on generator maintenance

Time started:_____ **Time finished:**_____

_____

Directions*:* Answer all the questions listed below. Use the Answer box provided

I) Match failures listed in A with possible causes listed in B

Item A	Item B
1. Engine Stops After it starts 2. Generator has no electrical output 3. Starter motor does not stop running 4. Batteries are not charging 5. Engine fails to start	A. Faulty/dead battery B. Faulty alternator (*small alternator*) C. Faulty lines coming to the AVR D. Replace starter or ring gear E. Over-running clutch sticks to shaft F. Air exists in fuel system G.

Answers Box

Part I		
NO	Your Answer	Correct answer if false
1		
2		
3		
4		
5		

Information Sheet 4.2	Troubleshooting technique on generator maintenance

Introduction

Troubleshooting a generator is investigating or dealing with the cause of partial or complete failure of it and this in turn leads to do the appropriate measures to return to its design purpose in which it is designed for. It includes any breakdown that may be occurred during operation, due to long service age, due to lack of prevention and follow-ups and so on.

To do troubleshooting basically;

1.1 There should be manual which is provided by the manufacturer and understanding of it

1.2 Availability of testing tools & materials.

1.3 Understanding of the operation, construction and function of unit.

Doing a troubleshooting & finding the root cause of malfunctioning takes great part of a maintenance activity and it helps/tells to decide what should be the proper maintenance activity. It starts from identifying existence of unusual operational noises or noisy operation, investigating the root causes for partial or total failure by following provided troubleshooting techniques and by starting from the working principle.

Before breakdown occurs, the equipment/machine should be prevented & protected from the causes of failure to sustain and secure the service that is needed from it. If failure occurs maintenance activity is performed starting from simple to complex after doing troubleshooting is done.

The following tables show troubleshooting techniques of problems that will occur on generator sets.

Table 4.2 Generator problems and remedies

No.	Failure	Possible causes	Corrective action (Remedy)
1	Engine fails to start	Faulty starter key/ switch	Check Operation of starter key/ Switch & replace as necessary.
		Faulty connections	Clean and tighten connections
		No fuel	Add fuel
		Faulty starter motor assembly	Check contact points from battery and to the motor field tighten/ change cable Check starter relay and replace Check starter solenoid contacts and hold-in & pull-in coils and replace Check springs Check motor brushes and replace Check pushing rod/arm & plunger Check motor armature & field windings rewind/ replace the motor
		Faulty/dead battery	Check battery status and change
2	Starter motor spins, but engine does not crank	Faulty over-running clutch	Check over-running clutch, replace starter if necessary
		Damaged or worn starter pinion gear or engine ring gear.	Check gears for damage or wear. Replace starter or ring gear
3	Starter motor does not engage / disengage properly	Damaged or worn starter pinion gear or engine ring gear	Check gears for damage or wear. Replace starter or ring gear
		Faulty starter solenoid,	Test & replace if necessary
4	Starter motor does not stop running	Key switch or starter relay contacts keep closing or stick. Over-running clutch sticks to shaft	Check and replace faulty component
5	Starter motor does not rotate or rotates slowly	Motor field coil failure	Check and replace
		Armature winding failure	Check and replace
		Carbon brushes failure	Check and replace
		Commutator damage	Check and replace
		Faulty/dead battery	Check and replace
		Contact terminals failure	Check and replace
6	Engine Stops After it starts	Lubrication oil problem	Check Oil Level/quality - top up/ change
		Run out of fuel or clogged fuel line	Top up/fill the fuel

No.	Failure	Possible causes	Corrective action (Remedy)
			Check and clean if dirt is accumulated in the fuel line
		Fuel shutoff solenoid related problems *Loose electrical connections* *Oil pressure switch defective* *Water temperature switch defective* *Fuel solenoid defective*	Check and tight loose connections Check and/ adjust the correct placement of the solenoid, Check and replace switches otherwise replace the solenoid by referring the manual
		Obstruction in fuel pipe or air cleaner	Check and clean.
		Air exists in fuel system	Remove the air.
		Sudden increase of load	Lighten the load.
		Coolant problem	Check coolant level and *(Be sure to allow the generator set to cool first as hot water/steam can be present when you remove the radiator cap)* and top up as necessary
		Engine over speed	Check if the speed governing system is flexible and verify the actual engine speed
7	generator has no electrical output	Circuit breaker failure	Check and replace
		Main rectifier failure	Check and replace
		Loss of residual magnetism *Residual magnetism in the generator exciter field allows the generator to build up voltage during start-up.* *The residual magnetism can be lost naturally when the genset is placed too long without use However, for the new genset, the residual magnetism can be lost due to a long-distance transportation vibration.*	‘Flashing’ the Exciter field: -
		Loose, broken or corroded connections.	Check all auxiliary and main terminals. Tighten connections /terminals or repair/ renew where necessary
		Faulty/wear out of brushes and/or slip rings *(if the*	Check and replace

No.	Failure	Possible causes	Corrective action (Remedy)
		generator has brushes and slip rings)	
		Fault in AVR	Check and replace
		Stator and/ rotor windings failure	Check winding resistances and rewind/replace
8	generator has low electrical output	Low engine speed	Check and adjust the engine speed
		Faulty lines coming to the AVR	Check inputs of AVR, fix or replace faulty lines. If the voltage remains, the armature winding should be checked
		Faulty AVR	Check and replace AVR
9	generator has high electrical output	Faulty AVR	Check and replace AVR
		Faulty lines coming to the AVR	Check inputs of AVR, fix or replace faulty lines. If the voltage remains, the armature winding should be checked
		Too high engine speed	Check and adjust the engine speed
10	Charge Indicator lamp does not light when key switch ON	Blown fuse	Check charge, Ignition and Engine fuses, replace as needed.
		Indicator lamp burned out	Replace lamp
		Wiring/ connections loose	Tighten loose connections
11	Charge Indicator lamp stays ON after the engine started (if it does not go OFF after engine started)	Defective relay	Check relays, if used, for continuity and proper operation
		Worn out brushes	Check and replace
		Worn out belt	Check and replace
		Defective alternator	Check and Replace alternator *(charging generator)*
		Defective regulator	Check and Replace regulator
12	Batteries are not charging	Insufficient belt tension	Tighten or replace
		Defective battery(s) or battery connections	Check battery and replace Check Battery terminal & other wirings and fix them
		Blown fuse or fusible link	Check fuse and fusible link, replace as needed
		Defective wiring	Check for voltage drop and fix the wiring
		Faulty alternator	Check and Replace alternator
		Excessive electrical load	Reduce load by turning off unnecessary accessories
13		Defective battery	Faulty battery; maintain or replace

No.	Failure	Possible causes	Corrective action (Remedy)
	Constantly overcharging (battery electrolyte is depleted in a short time)	Poor contact at voltage detection points of alternator	Clean contact area
		Faulty voltage regulator	Check and Replace regulator
14	Abnormal Noise – in alternator *(charging generator)* operation	Insufficient belt tension	Tighten or replace
		Faulty bearing	Replace alternator *(charging generator)* bearing

For the case of module controlled (which may not use starting key) generator sets, faults/errors and warnings are displayed on the operator panel (display) with error codes which are described in the operation and maintenance manuals provided by the manufacturers.

Operation Sheet LG 4	Troubleshooting technique on generator maintenance

Summary

This operation sheet contains methods of troubleshooting technique's how to solve the fault on generator. In this we see two basic faults Engine fails to start and A generator is not delivering electricity /No output

Preparation

To perform the tasks the following listed tools & necessary materials, instruments, consumable materials & documents are necessarily to We are going to perform the following troubleshooting and maintenance activities. Before doing the activities, we have to avail tools, service/user manual, maintenance log & instruments that are necessary for this operation. While we are doing the activities, we have to see and record related data on the maintenance log. After we finish our work, we have to test the proper functionality of the generator.

Personal Protective Equipment (PPE)	Cleaning rag
First Aid Kit	Filler gauge
Fire Extinguisher	Cables
Multi-Meter and Clamp-Meter	Cable lug
Power/Power Factor Meter	Insulation tape
Electrician Knife	Maintenance log sheet
Megger (Insulation Resistance Taster)	Faulty/dead battery and functional battery
Wrenches (Open, Closed, Adjustable, Socket)	Faulty gen-set (not working properly) with its starting key
Pliers	Air compressor
Wire Striper	Cleaning rag
Hydrometer	filler gauge
Screw Drivers	Fuel
Engine Oil	Filters (Oil, Fuel)
Fuel	Air cleaner
Filters (Oil, Fuel)	

Instruction

Before we start our tasks, we have to use personal protective equipment. Then the necessary tools, consumable materials, documents and equipment are provided by the technical assistant, and we will take a look on them and generator maintenance.

- Then to start maintenance of generator we have to get the appropriate tools to open the gen-set hood(cover), service(user) manual for reference, related cut models. then open the hood/cover follow the steps listed below.

- During the time of identifying problem and perform a maintenance we should take care of cables & sensitive components/devices from damage and be careful not to make short between battery terminals.

Task 1 – we are given to solve the problem for “Engine fails to start

The possible causes for this fault include faulty connections, faulty starter key/ switch, No fuel/path or disconnection in fuel system, faulty starter motor assembly and /or flywheel gear, faulty/dead battery.

Task 1.1: -Faulty connections

Use a multimeter to test the continuity and use your hand to check tightness of lines from the key to the starter relay and then to a starter motor.

- Tighten loose connections and replace damaged cables.

Task 1.2: -Faulty starter key/ switch

Check if there is disconnection visually & using a multimeter and check/tighten the contact points out from the key.

Task 1.3: -Disconnected path between the fuel lines (**No fuel or no fuel path)**

- Check the fuel tanker level

Check the fuel lines starting from the fuel tank to the final destination to find the lost or disconnected part & make a correction

Task 1.4: -Relays failure

First identify its operation, coil terminals & contact points. Then check the relay contact points with coil terminals using continuity test – should read no continuity or read infinity. Check the coil terminals using multimeter – should read some coil resistance.

Figure 5.1a) starter relay/starter solenoid

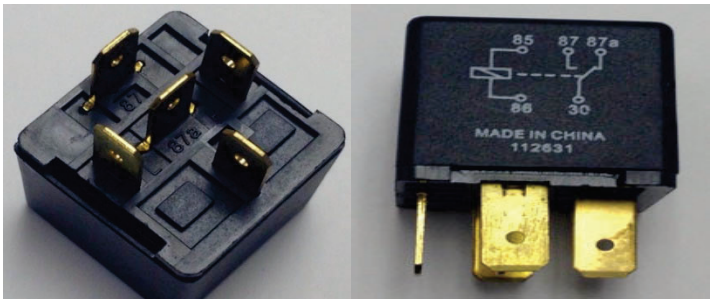


Figure 5.1b) Five pin relays

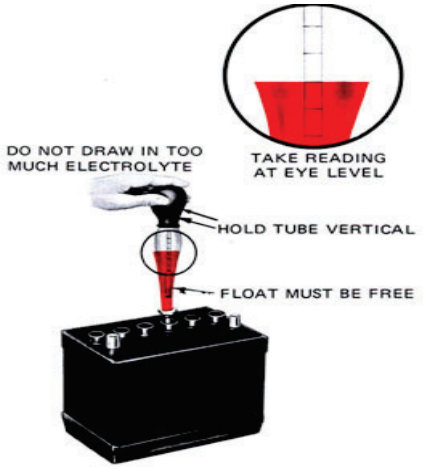
Apply a specified coil voltage via coil terminals and check the normally open and closed contact points' status- click sound and change of state of contact points should be observed when battery voltage is supplied. If there is no change on the relay status it should be replaced.

Task 1.5: -faulty/dead battery

Visual checks for rusted connections clean & tighten connections and check for the cracked container. If there is a crack it will cause leakage of electrolyte& it has to be replaced.

Figure 5.2

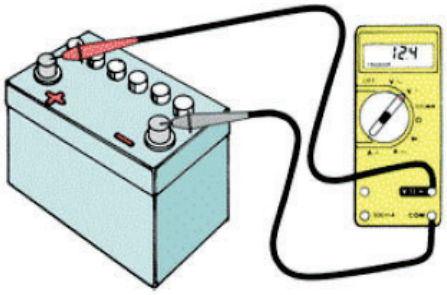
Observe the level of electrolyte is at a correct level and check specific gravity of battery electrolyte with a hydrometer. If the level is not at a specified level, fill with distilled water to a correct level.



State of Charge Level	Specific Gravity
100%	1.265 or Greater
75%	1.225 - 1.230
50%	1.185 - 1.190
25%	1.140 - 1.175
Discharged	1.125 or Less

Figure 5.3

- Check open circuit voltage



% of charge

12.6v = 100%

12.4v = 75%

12.2v = 50%

12.0v = 25%

11.9v = 0%

Check the status of battery electrolyte level visually and specific gravity using a hydrometer

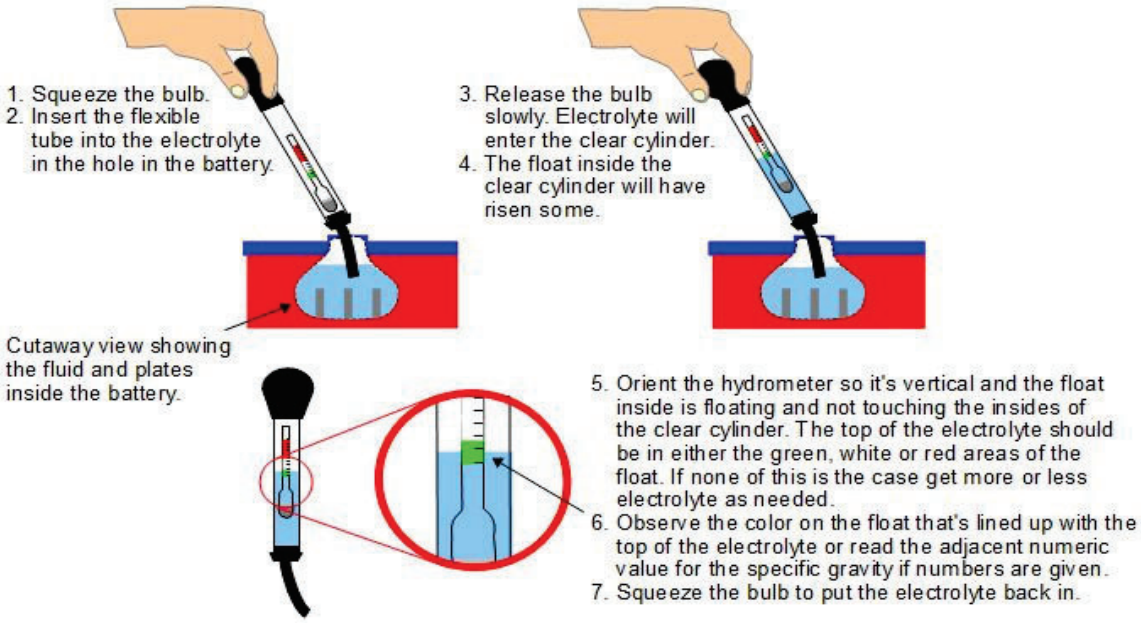


Figure 5.4

Task 1.6: -faulty starter motor assembly and /or flywheel gear

Before dismantling - Using a multimeter check whether the battery voltage reaches on the starter motor terminals and test the continuity of controlling and starting circuits and check for terminals.

Dismantle the motor and observe if there is damage on starter motor pinion gears.

1. Check the functionality of starter solenoid – before checking, identify the solenoid terminals

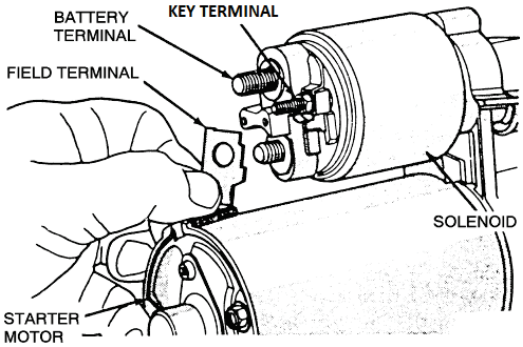
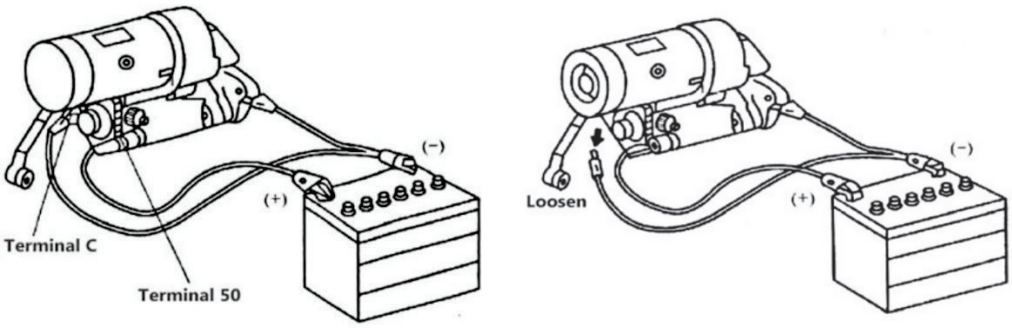


Figure 5.7

1.1 Fix the starter motor on a bench vice and connect the battery with the solenoid (magnetic switch) terminals as shown below to check its hold in & pull in ability and observe forward & backward movement of the pinion gear – the solenoid plunger should allow the pinion gear to move forward and back, if not go through the next step



Pull in coil test Hold in coil test

Figure 5.6

1.2 Solenoid spring test - based on the above test, disengage the wire connected to the battery terminal negative, as shown in figure below. Normally, when the battery negative terminal is disengaged, the drive gear should reverse rapidly. If the drive gear cannot reverse, it indicates that the solenoid return spring is damaged and the solenoid should be replaced.

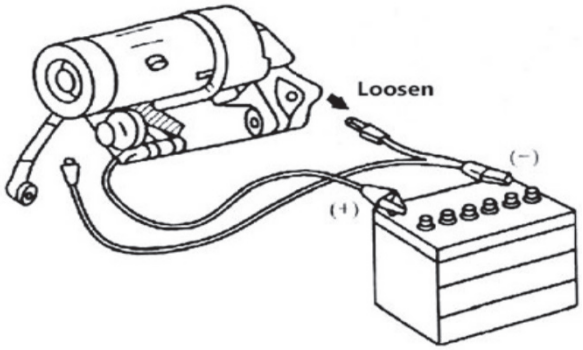


Figure 5.7

using a multimeter on continuity mode check the continuity between terminal 50(key terminal) and terminal and body shown as below – there should be continuity. If yes go to the next step and if there is no continuity here the solenoid has to be replaced

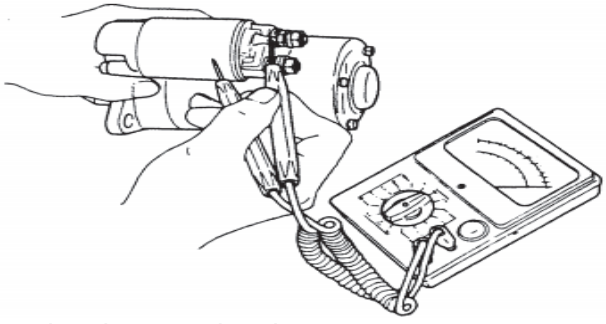


Figure 5.8

If the solenoid is functional proceed to the next test

2. Rotation of pinion/ motor shaft

2.1 Fix the starter motor on a bench vice and connect the battery with the solenoid (magnetic switch) terminals as shown below to check whether the motor is rotating or not. If it is not rotating during this check, go to the next step.

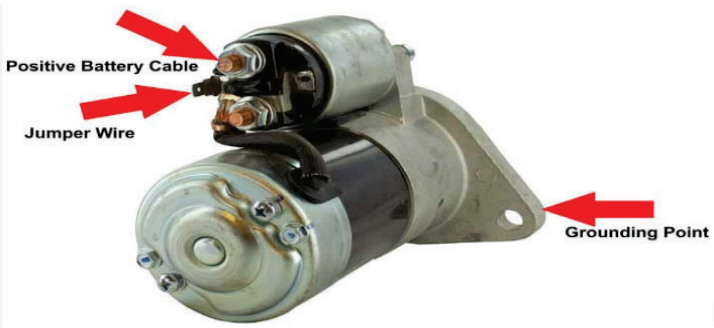
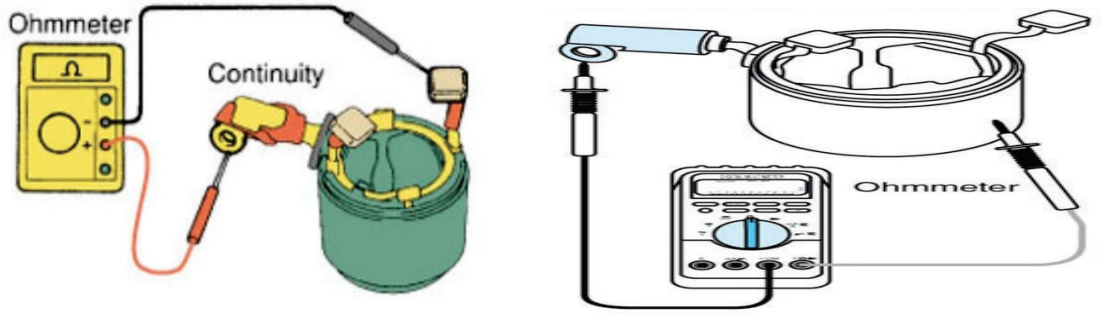


Figure 5.9

2.2 using a multimeter on continuity mode check the continuity between terminal C (field terminal) and terminal 30 (battery terminal) shown as figure below – there should be no continuity then open and clean/replace the terminals if the internal side of these terminals gets worn out. If this is okay go to the next activity.

Figure 5.10

2.3 check the Starter motor field coil for opens and shorts between terminals using a multimeter field coil end terminals continuity – should read continuity, test continuity of field coil end terminal with frame/yoke – should read **no** continuity. If one of the two happens it should be replaced or if both are ok go to the next check



Field coil end terminals test Field coil with frame test

Figure 5.11

2.4 Inspect the commutator status if it is cracked or covered with remains of carbon brushes and inspect the brushes length and their alignment with commutator. Replace the worn-out brushes. Then check

A) the continuity between armature core & commutator *(to check the armature windings for a short to ground)* and also between commutator and shaft – should read **no** continuity it should be replaced if it reads continuity,

B) check the continuity between positive & negative brush holders – **no** continuity between opposite brush holders and this should be replaced if it reads continuity. If both of the above checks are ok added lubrication at the shaft end.

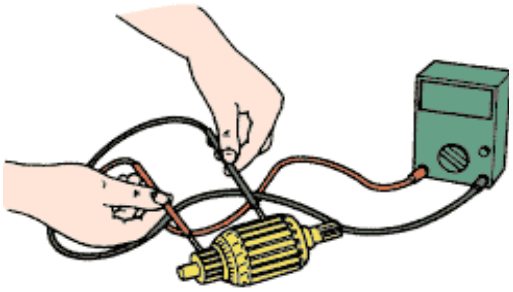


Figure 5.12 a)

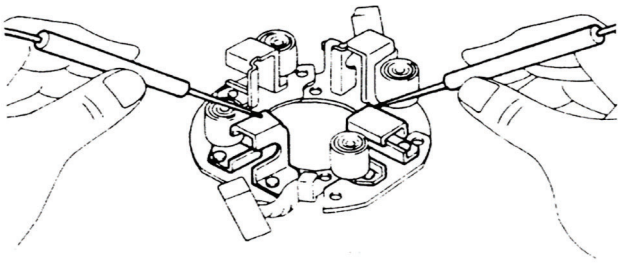


Figure 5.12 b)

Task 2: we are given to solve the problem A generator is not delivering electricity /No output.

Possible causes include - Voltmeter connected incorrectly or faulty multimeter, loose broken or corroded connections, circuit breaker failure, main rectifier failure, faulty/wear out of brushes and/or slip rings *(if the generator has brushes and slip rings),* fault in AVR, loss of residual magnetism, stator and/ rotor windings failure.

Task 2.1: Voltmeter connected incorrectly or faulty multimeter

Ensure the correct connection of the voltmeter, calibrate the multimeter and measure other parameters, if there is still incorrect reading, change/ replace the multimeter.

Task 2.2: Circuit breaker failure

- Check if the handle is positioned at a middle position and reset to its normal position.
- Check the functionality of the breaker

Task 2.3: Loose or broken or corroded connections

By using the manuals and diagrams provided by the manufacturer and by the help of a multimeter, test the continuity and check tightness of lines coming out from the armature windings, output from the main circuit breaker, inputs, and outputs from the AVR.

- Make tighten loose connections and replace damaged cables.

Task 2.4: Main rectifier failure

- Check lost connections and tighten if there.

Check the forward and backward current flow of rectifier diodes and for the normal working the reading should tell that the diode passes the current only in the forward direction.

Task 2.5: Fault in AVR

- Check lost connections /disconnected lines and fix if there.

Using and referring the provided manual by the manufacturer, check and compare values of the inputs and outputs of the AVR and replace the AVR if there are variations.

Task 2.6: stator and/ rotor windings failure

Measure the insulation resistances of armature and field windings by an insulation tester/megger by setting measurement range from lower and increasing the range. Insulation resistance should be infinity, means no shorting throughout the circuit to be tested. If the pointer shows ‘zero’, which means ‘NO’ resistance there is short circuit.

Connect clip to body ground/ measure

Connect plug to output terminal/

Push measure button, and

Figure 5.13

Task 3: Use the maintenance log sheet to record the maintenance activity

Table 4.3 generator maintenance log sheet

Genset Maintenance Log sheet						
Model of Gen-set: - __SDG-35S____ **KVA: -_____30_____** **Type: - 3 phase ☒ single phase ☐ Tag No.: - _____** **Location: -_____EWTI compound near workshop_____**						
Date	*(1)* **Problem found/ occurred**	*(2)***Identified failure**	**Maintenance Activity**	**Hour Meter Reading during maintenance**	**Maintenance done by**	**Remark**
xx/xx/xxxx	Engine does not start	Battery failure	- Tightening - correct level of electrolyte	3242165	MR. XXX	- for future replace electrolyte,

LAP Test LG 4	Practical Demonstration

Total time allowed for doing the following tasks: *45 min for each trainee*

Preparation

Preparation and setting for the performance assessment

Prepare or avail the gen-set and cut models related with its components for the assessment

- Ensuring if there is suitable area for the assessment
- Avail the necessary tools, material, instruments
- Avail the rating sheet for demonstration per each trainee

Instructions

Receive the materials and maintenance log sheet to record the maintenance activity provided by the technical assistant. You are required to perform the following tasks in order to solve the above failures occurred on the gen-set that is provided for your work. Your work progress is being observed by the trainer/technical assistant. Request your trainer/ technical assistant for evaluation and feedback.

Task 1: Make a list of possible causes using a blank paper for the problem occurred

Task 2: Use the maintenance log sheet to record the maintenance activity

Task 3: Uses the proper tools & measuring instruments, perform troubleshooting

Task 4: Solve the identified failure and evaluate the functionality of the generator

List of Reference Materials　LG 4

- http://www.dtic.mil/dtic/tr/fulltext/u2/a043170.pdf
- https://www.dieselserviceandsupply.com/pdf/Operations-Manual-Operating-Procedures-Emergency-Diesel-Generator.pdf
- https://www.dieselgeneratortech.com/generators/why-generator-wont-produce-electricity.html
- http://www.dieselduck.info/machine/03%20electricity/flashing_generator.html
- https://axleaddict.com/auto-repair/Alternator-Problems-Troubleshooting
- Generator set operator & maintenance instruction manual, FG WILSON 356-5901(GB) V9 06/14
- Unified Facilities Criteria (UFC), Operation and maintenance of Generators, Department of Defense USA.
- DENYO CATALOG -Beginner's Class Serviceman Course
- AIRMAN – instruction manual for Engine Generator SDG35S-3A2