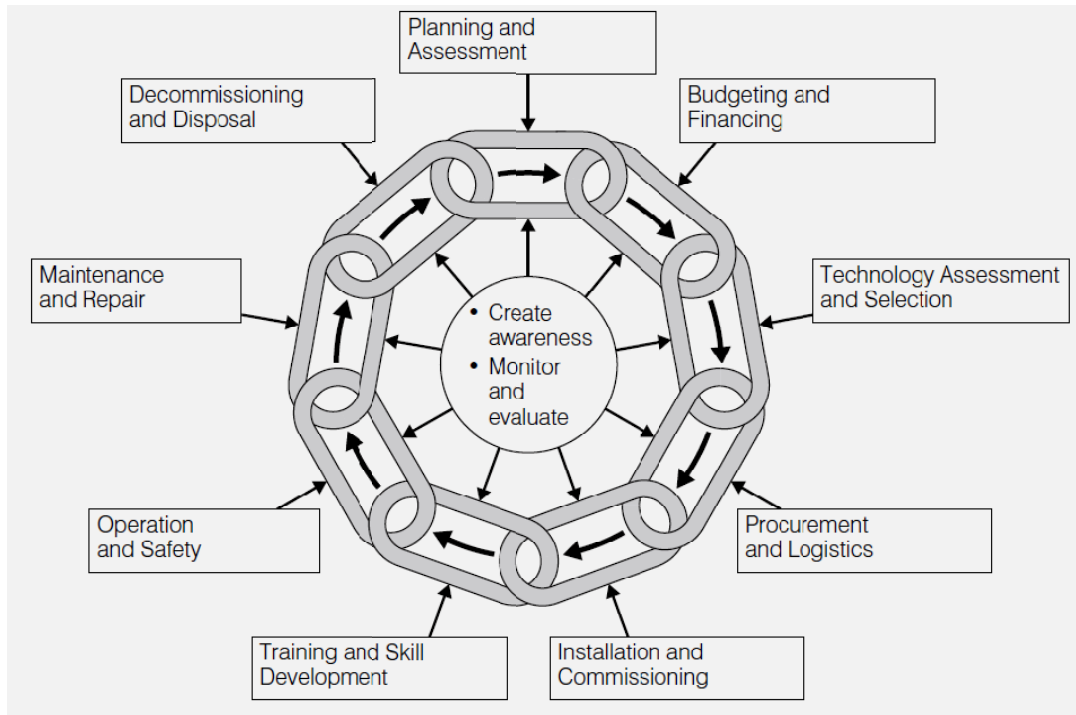


Equipment Maintenance Manual

A first line maintenance guide

for

Students, Faculty, and Staff



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Preface

This document has been prepared for students, faculty, and staff at Dr. Y. S. Parmar University of Horticulture & Forestry, Nauni, Solan (HP) India. The instructions in this document are general in nature and do not apply to specific make and model of equipment(s).

Scientific instruments play a vital role in the field of agricultural and allied research. In research organizations a large proportion of expenditure is incurred on scientific equipments. Universities and colleges have a sizeable pool of modern equipments/instruments, which is likely to increase with time. Therefore these costly equipments are required to be maintained properly for their efficient and effective use.

In order to facilitate research, obtain sustainable benefits and maximize the investments made in equipment, measures must be taken not only by the end users (student, scientist and staff) but also by the maintenance staff and administration /management to ensure that the equipments are maintained in working order..

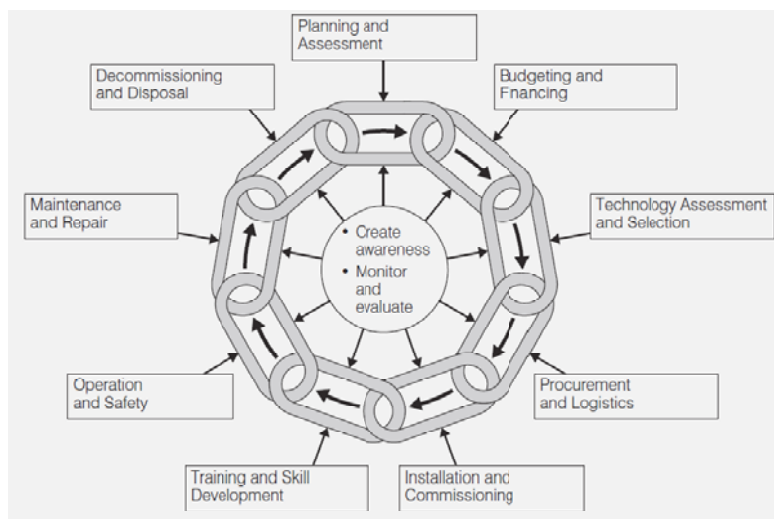
Maintenance and repair is an integral part of managing the whole life cycle of equipment. The approach for corrective and preventive maintenance depends on the complexity of equipment. The majority of problems are relatively simple and can be corrected by end user but for the specialized equipments, vendor provides the maintenance services. This requires proper planning while purchasing equipment such as operational training, maintenance training for staff/user and providing of operational as well service manuals, warranty period clause and maintenance services contract.

The very first level of maintenance is related to the end user or technician, who can check power supplies, fuses, clean the filters without opening the unit and without moving it away from the point of use. Electrical equipment if poorly maintained and misused can cause injury and could be fatal. Use of broken sockets, plugs, cables and extension leads should be avoided. The equipment must be installed in the requisite environment to avoid or reduce maintenance problems.

Equipment maintenance is not only the task of maintenance staff, vendor or the supplier but also of the end user. The regular and routine care of equipment by the end users themselves is fundamental. This manual will be helpful to the end user not only to maintain the equipment but also to diagnose some basic problems by using little common sense and simple logic.

Introduction to Equipment Maintenance:

Maintenance and repair is an integral part for managing the whole life cycle of the equipment. To make the whole cycle work properly, a number of different inputs are required. Employees at different levels are required to play significant role in the life cycle of the equipment to enhance its life and get optimum results.. It is also very important that the end-user of the equipment should also be involved / consulted in every stage of its life cycle.



Maintenance of equipment is not just a question of repairing broken things.

The main focus of this manual is for equipment maintenance however the other stages of equipment life cycle are briefly touched.

PLANING & ASSESMENT

Proper planning plays a vital role in deciding the right equipment for the right purpose at competitive price fulfilling the required specifications and objectives. While going in for purchase of new Laboratory equipment or while setting up a new research laboratory thorough planning and assessment needs to be initiated. Planning may occur at institutional, divisional or departmental level. Institutional level planning may be involved with general educational assessment, methods that will be used, timeline for administration and the framework for using the assessment information.

BUDGETING & FINANCING

After the planning and assessment stage is taken care of, budgeting and financing is the next step which needs to be properly looked into. It includes proposed cost of the equipment, its spares/accessories, recurring /running cost of the equipment, manpower and space requirements and other additional expenses. Making arrangement for the required finance for the purpose is yet another herculean task where the budget proposal presentation helps in a big way. Budgeting and financing also foresees the future recurring requirements and plans accordingly.

TECHNOLOGY ASSESMENT & SELECTION

While purchasing the equipment, selection of appropriate technology is an important aspect that needs utmost care. Emphasis should be on purchasing the equipment with the latest available technology. It has been observed that dealers tend to sell off their outdated old stocks and after a certain period of time decline to provide spares or service back-up due to unavailability of spares or component support from the manufacturer

Efforts should be made to procure the quality products from reputed vendor/supplier keeping in mind the cost effectiveness and proper after sales service network.

PROCUREMENT AND LOGISTICS

When the equipment is finalized for purchase the codal formalities needs to be strictly adhered to as per university/ institution guidelines. The specifications of the equipment should be complete with clarity along with terms and conditions for supply, installation, training, equipment warranty, performance warranty,

penalty norms for delayed supply and maintenance contract terms after warranty period etc.

INSTALLATION AND COMMISIONING

Many common problems with equipment can be avoided if it is properly installed. Every scientific equipment requires a specific environment for its optimum function such as proper power supply, adequate space, ambiance (air conditioning, heating, cooling, humidity control, proper exhaust etc.). The pre-requisites as per manufacturer must be strictly adhered to for proper functioning and longevity of the equipment. If the right equipment arrives in working order with the right parts and manuals then a long and useful life is more likely.

Roles and responsibilities

Each person in the chain of equipment supply has a particular role and responsibility to fulfill. This applies right from when the need for new equipment is identified to the time when it is used. The following should be used to remind each of their responsibilities and to check their performance.

Specifier - Make sure the specification is clear and thorough.

Purchaser - Select order and pay correctly, inform receiver of dates and details.

Supplier - Check supply against specification, install on time and provide training.

Carrier - Inform receiver before delivery, deliver safely and completely.

Receiver - Prepare site for installation, check delivery against specification.

Local technical staff - Ensure equipment is correctly installed, learn maintenance checks required.

Stores - Ensure equipment is complete, report to purchaser, enter into inventory / stock register.

User – Ensure that the equipment is installed at the right place, check its functioning and get properly acquainted with the user manual.

Checklist

When equipment arrives, it will be necessary to record the fact and to check that everything has been supplied that was ordered. It will also be necessary to check that the equipment is supplied in the right way.

General Guidelines

- Install the equipment close to an electrical outlet. The outlet must have proper earthing in order to guarantee the protection and safety of the operator and of the equipment.
- Verify that the location selected is leveled and has the necessary resistance to safely support the weight of the equipment.
- Ensure that the location has a suitable amount of space for putting the samples and other accessories required for the normal operation of the equipment.
- Ensure that equipment has sufficient space around for maintenance purpose.
- Do not install the equipment in front of window or under the air conditioners.

TRAINING AND SKILL DEVELOPMENT

Training and skill development is necessary for each and every piece of equipment so as to get optimum results and for the long life of the equipment. While purchasing the sophisticated equipment, terms relating to user / operational training must be clearly mentioned and persued. The training can be at the manufacturer's site or at the place of installation.

OPERATION AND SAFETY

Operation and Maintenance Manual is an important aid for smooth operation and safety of the equipment as well as of the user. Utmost care needs to be taken for handling sophisticated equipment as prescribed in the operational manual. In no case the equipment in running condition should be moved from one place to another. Pre-requisites for installation of equipments must be strictly adhered to. The various settings and controls of the equipment should not be disturbed or altered unless you are fully conversant with the operation of the equipment. If any undesired sound, smoke or

electrical sparking is observed from any equipment, it should be immediately switched off/stopped and should be reported to the trained service personnel.

MAINTENANCE AND REPAIR

The main focus of this manual is on first line upkeep and maintenance of the equipments, since repair is a specialized job to be under taken by the concerned specialist for each equipment. The rest of the manual discusses about different resources for maintenance, types of maintenance, effective maintenance strategy, types and approaches to maintenance of equipment, levels of maintenance and planned maintenance of Equipment. General maintenance tips and troubleshooting methods for the end user related to some of the most popular scientific equipments used in research institution in the fields of Agriculture, Horticulture, Forestry and allied disciplines have been elaborated.

DECOMISSIONING AND DISPOSAL

Every equipment has a specific life-cycle, due to normal wear and tear and degradation / erosion, the equipment becomes inaccurate and hence un-usable. Valid reasons for condemnation / replacement of equipments are:

- Worn out beyond repair (has reached the end of its natural life)
- Damaged beyond repair
- Unreliable – faulty, old, unsafe
- Technically obsolete
- Spare parts no longer available
- Un- economical to repair.

Equipment should not be replaced simply because:

- It is old
- Staff does not like it
- Newer model has arrived in the market.

It is also important to follow the procedure for condemnation of equipment as per the guidelines of the university/ institution. After condemnation the equipment disposal norms must be strictly adhered to as per the manufacturer and government guidelines to avoid environmental hazards. The obsolete model of equipment can be replaced with the new model under manufacturer / company buy back policy to reduce the cost of new equipment and unnecessary built up of useless inventory/store.

MAINTENANCE AND REPAIR

Once equipment is installed, commissioned and accepted and the users have been fully trained in its operation. The following resources are needed to use and maintain the equipment:

- **Manuals in a fluent language**

Operator manuals are essential and should be specified at the time of purchase. If possible service or technical manuals should also be procured which could be useful for the maintenance staff / department.

- **Scheduled Maintenance**

A schedule of regular visits by qualified maintenance personnel will be needed. Whether the maintenance is in-house or outsourced, a system of reminders to prompt the work will be needed.

- **Repair Services**

The repair team should be immediately called on when the equipment breaks-down. Most of the equipments can be serviced by the local maintenance team, whereas sophisticated equipments such as HPLC, GC and Complex Microscopes etc. will require specialized service personnel from the vendor/ supplier of the equipment.

- **Contract Management**

The purchase contract should have details of what warranty services are available and contact details to call in these services. User or

administration should monitor performance against these contracts and plan for cover on expiry of any agreement.

- **Consumables supply**

The needs for consumables should have been specified during the procurement process, so that necessary supplies are available from the start of equipment use. A schedule of restocking will need to be developed, so that there is never a gap in services.

- **Spares supply**

Technical advice would be required to decide which spares should be stocked on site and which should only be purchased when needed. As a general rule, it is recommended to keep spares likely to be needed for two years operation on site and to have these supplied with new equipment.

TYPES OF EQUIPMENT MAINTENANCE

Maintenance plays a vital role in the life cycle of the equipment. Lack of a maintenance policy can result in no advance planning for maintenance budgets and thus no availability of spares and accessories. Many laboratories suffer because the installation and maintenance requirements are not planned in advance. This results in equipment becoming idle because of lack of spares or funds.

EFFECTIVE MAINTENANCE STRATEGY

It is essential that we plan the resources required for maintenance. Planning will need to be made for both repair work and also for planned preventive maintenance. The following will also promote effective maintenance:

- **Training, user and service manuals**

In procurement it should be made mandatory for the vendors to provide the following:

- Training to technicians and operators.

- Providing user / operating manuals.
- Providing service / maintenance manuals

- **Receipt and Incoming Inspection**

Incoming equipment should be carefully checked for possible shipment damages; compliance with specifications in the purchase order; and delivery of accessories, spare parts and operating and service manuals etc.

- **Inventory and Documentation**

A proper entry needs to be made in the inventory/ stock register. The inventory record must contain the bill number, bill date, amount, equipment's serial number, date of receipt, date of installation and inspection, warranty details, future expenses incurred in terms of spares, consumables and maintenance contracts etc.

- **Installation and Final Acceptance**

Installation should be done by the vendor and training should be provided at this stage to the user as well as to the maintenance technicians.

- **Equipment History Record**

There should be an equipment history record register/ log book to track the operation and performance of the equipment. This register should contain the date of installation and commissioning, sample analysis record and record of preventive and corrective maintenance..

- **Maintenance**

Proper maintenance of equipment is essential to obtain sustained benefits and to preserve capital investment. Equipment must be maintained in working order and periodically calibrated for effectiveness and accuracy.

- **Condemnation of old and obsolete equipment**

Every piece of equipment has its own life cycle. If the equipment is declared obsolete by the vendor it may not be possible to get spare parts. Even if the parts are available it can become too expensive to obtain them and the equipment is no longer economical to repair. Condemnation of equipment should be well planned and the necessary steps should be taken in advance to arrange replacement.

TYPES AND APPROACHES TO MAINTENANCE OF EQUIPMENT:

There are two types of maintenance:

- **Corrective Maintenance (or Repair)**

This is done to take corrective action in the event of a breakdown of the equipment. The equipment is returned repaired and calibrated.

- **Planned (or Scheduled) Preventive Maintenance**

This work is done in a planned way before repair is required and the scheduled time for the work circulated well in advance. It involves cleaning, regular function / safety tests and assuring that problems are diagnosed at an early stage and corrective measures are accordingly taken. The choice of approach for Preventive and Corrective Maintenance depends on the complexity of the equipment.

- **Maintenance by in-house trained technicians**

The majority of the problems are relatively simple and can be corrected by trained technician. Simple repairs and inspections are less costly.

Vendors should provide trainings to in-house technicians at the time of installation and commissioning.

- **Maintenance by manufacturer or third party**

For specialized and advanced equipment, the vendor should provide maintenance services through a combination of on-call services and a maintenance contract negotiated at the time of the purchase. It will rarely be economical to provide this level of service in-house.

LEVELS OF MAINTENANCE

There are three levels of maintenance commonly identified:

- **Level 1, User (or first-line)**

The user or technician will clean the filters, check fuses and check power supplies etc. without opening the unit and without moving it away from the point of use.

- **Level 2, Technician**

It is recommended to call the local technician when first-line maintenance cannot rectify the fault.

- **Level 3, Specialized**

Equipment such as HPLC, Electronic Microscopes and sophisticated micro processor based systems etc. will need specialized engineers and technicians trained in these specific equipment. They are normally employed by third party or vendor companies. As the spares of these equipments are not available in the open market and hence are required to be serviced by the supplier/vendor.

PLANNED MAINTENANCE OF EQUIPMENT

Planned preventive maintenance is regular, repetitive work done at scheduled intervals to keep equipment in good working condition. The activities under preventive maintenance involve routine cleaning, calibrating and adjusting, checking for wear and tear and lubricating to optimize working efficiency and to avoid breakdown. Also consumables replacement like the fitting of new filters etc. is done as part of this work.

Effective planning for preventive maintenance involves proper selection of the equipment to be included in the plan. Decisions must be made on what to include in order to reduce cost. Inexpensive units can be replaced or repaired if they break down, so need not always be included. The overriding consideration is cost effectiveness.

Setting up a complete system

When many items of equipment are under the care of a single department, it is better to keep the planned preventive maintenance with a programmed schedule. This will require:

- **An equipment inventory**

All equipment in the department should be recorded on inventory/stock register. All relevant information about the equipment must be entered, including its location, records of repair and maintenance and manufacturer details. A reference number is written on each item

- **Definition of maintenance tasks**

These tasks can normally be established by consulting the manufacturer's literature

- **Establishing intervals of maintenance**

The frequency of these tasks must be decided. A heavily used item must be cleaned and checked more frequently than one which is used less often; however, minimum standards must be set. The frequency suggested in the manufacturer's manual can be used as a guide, but the amount of actual usage should determine the maintenance procedure required.

- **Personnel**

The department team will normally monitor the Preventive Maintenance Program.

- **Reminder system**

It will be necessary to develop a reminder system, so that staff is prompted to carry out tasks when they are due. A card index / calendar system can be used.

- **Special test equipment**

A department team should have a range of test equipment to check the correct functioning of equipment and its compliance with electrical and other safety standards.

- **Technical library**

A full technical library should be available.

- **Surveillance**

After the programme has been set up, periodic surveillance must be carried out to ensure that records are legible and that all entries are being made.

Planning User Maintenance Tasks

The tasks outlined in this manual are designed for the equipment user to carry out at the point of equipment use. No special equipment will be needed for these tasks.

GENERAL GUIDELINES, VISUAL CHECKS AND PRECAUTIONS

A stitch in time saves nine is a famous proverb which also holds good for effective care and maintenance of laboratory equipment. To get optimum results from these costly equipments one needs to check the finer details so that the equipment functions

satisfactorily. Given below are few of the general guidelines that not only provide the desired results but also avoid heavy maintenance costs.

- An electric supply source should comply with the norms and standards used in the country. In India the mains voltage is 220 Volts AC,50 Hz.
- A clean, dust free, environment.
- A stable work table away from equipment that generate vibrations (centrifuges, agitators).

Installation Area Check

- Check that there is free space around the equipment
- Verify that there is no equipment installed that can transmit vibrations in proximity. (e.g. centrifuges, shakers etc.).
- Verify that the equipment is not affected by excessively humid conditions, dust or high temperatures.
- Avoid installing the equipment where it receives direct solar radiation.
- Do not install the equipment where there are magnetic fields or intense electromagnetic radiation.
- Ensure installation area is free from the influence of gases and corrosive substances.

Visual inspection of the equipment Frequency: Every six months

- Check that the structure of the work table supporting equipment is in good condition.
- Test the general structure of the equipment. Verify that buttons or control switches and mechanical closures are mounted firmly and that their identification labels are clear.
- Ensure that accessories are clean, not showing cracks and that their functional state is optimal.
- Confirm that mechanical adjustment parts (nuts, screws, bolts, etc.) are adjusted and are in good condition.
- Check that electrical connectors do not have cracks or ruptures, that they are joined correctly to the line.

- Verify that cables are not showing signs of splicing, that they are not frayed and that they do not have worn-out insulation.
- Check that cables securing devices and terminals are free of dust, filth or corrosion. These same cables must not be worn out or show signs of deterioration.
- Check that the grounding system (internal and external) is standardized of approved type, functional and correctly installed
- Ensure that circuit switches or interrupters, the fuse box and indicators are free from dust, filth and corrosion.
- Check the external electrical components for signs of overheating.