



LABORATORY BIOSAFETY AND BIOSECURITY POLICY GUIDELINES



Ministry of Public Health and Sanitation & Ministry of Medical Services

FOREWORD

Disease diagnosis, human or animal sample analysis, epidemiological studies, scientific research, and pharmaceutical developments: all of these activities are carried out in biomedical laboratories in the private or public sectors. Biosafety and biosecurity in biomedical laboratories is the cornerstone of an effective biorisk management system and practices. The information contained in this guideline is in accordance with the World Health Organization (WHO) guidelines on Biosafety, Occupational Safety and Health Act (OSHA) 2007 regulation, Environmental Management and Coordination Act (EMCA) 1999 and National Infection Prevention and Control Guidelines for Health Care Services in Kenya.

Biological materials are handled worldwide in laboratories for numerous genuine, justifiable and legitimate purposes, where small and large volumes of live microorganisms are replicated, where cellular components are extracted and many other manipulations undertaken for purposes ranging from educational, scientific research, medicinal and health-related to mass commercial and industrial production. Among them, an unknown number of the facilities, large and small, work with dangerous pathogens or their products every day.

The public expects laboratory personnel to act responsibly and not to expose the community to biorisks, to follow safe working guidelines (biosafety) associated with practices that will help keep their work and materials safe and secure (biosecurity), and to follow an ethical code of conduct (bioethics). Laboratory-acquired infections should no longer be considered acceptable, no infection or disease should be as a result of a breach in biosafety or biosecurity resulting from unsafe or insecure laboratory work practices.

This guideline is intended to be used as a template by individual laboratories at all levels in the country to develop their own biosafety and biosecurity manuals.

Dr S K Sharif

Director Public Health and Sanitation

Ministry Of Public Health and Sanitation

Dr Francis Kimani

Director of Medical Services

Ministry of Medical Servic

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Dr. Jane Wasike	National Public Health Laboratory Services
Dr. Margaret Oduor	National Blood Transfusion Centre-NBI
Dr. Jane Mwangi	Center for Disease Control/Kenya
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Dr. Shanna Nesby	Center for Disease Control/Atlanta
Mr. Albert Bunyasi	National Public Health Laboratory Services
Prof. Eucharika Kenya	Kenyatta University
Dr. Angela Amayo	Management Science for Health
Ms. Doris Bota	Management Science for Health
Dr. Caryl Griffins	Griffins Foundation U.S.A
Dr. Daniel Kimani	Center for Disease Control
Dr. Willis Akhwale	Department of Disease Prevention and Control MOPHS
Ms. Mercy Njeru	Center for Disease Control
Ms. Margaret Mburu	Center for Disease Control
Mr. Linus Odawo	Center for Disease Control
Mr. David Muteti	Center for Disease Control
Ms. Josephine Kaburi	Kenya Medical Research Institute
Dr. Bonventure Juma	Walter Reed Project
Ms. Ephy Khaemba	International Livestock Research Institute
Mr. Kevin Omondi	Risk Accreditation Management Systems –Africa
Ms. Rukia Kibaya	Kenya Medical Research Institute /CCR

Mr. Joseph Karinga	National Public Health Laboratory Services
Mr. John Matoke	National Public Health Laboratory Services
Mr. James Mwalloh	National Public Health Laboratory Services
Ms. Nancy Wangari	National Public Health Laboratory Services
Mr. Japheth Otieno	National Public Health Laboratory Services
Mr. Ali Gakweli	Government Chemist-Kenya
Mr. Patrick Olero	Homabay District Hospital
Ms. Gladys Gathoni	Trans Nzoia West District Hospital
Mr. Habakuk Okutoi	Kitale District Hospital
Ms. Pamela Juma	National Public Health Laboratory Services
Ms. Risper Sewe	National Public Health Laboratory Services
Ms. Nancy Njiine	National Public Health Laboratory Services
Ms. George Ogana	National Public Health Laboratory Services
Mr. Jared Okelloh	Siaya District Hospital
Mr. Stanley Otara	Kisii District Hospital
Mr. Francis Gitonga	Nyeri Provincial General Hospital
Mr. Douglas Denje	Coast Provincial General Hospital
Mr. Moses Machimbo	Kwale District Hospital
Mr. Bernard Sande	National Public Health Laboratory Services
Ms. Alice Salamba	Kisumu District Hospital
Mr. Raphael Kalama	Kilifi District Hospital
Mr. Charles Macharia	Karatina District Hospital
Mr. Joel Rotino	Ortum Missionary Hospital
Mr. Charles Wakhungu	Kakamega Provincial General Hospital
Ms. Victoria Nabwire	National Public Health Laboratory Services
Ms. Jane Mwakuwanda	Msambweni District Hospital
Ms. Charity Kiarie	Muranga District Hospital
Ms. Ruth Michuki	Mariakani District Hospital
Mr. Fred Okuku	Program for Appropriate Technology in Health
Ms. Beth Njaramba	National Public Health Laboratory Services

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	1
FOREWORD	2
ACRONYMS AND ABBREVIATIONS	9
OVERVIEW OF BIOSAFETY AND BIOSECURITY	11
General introduction	11
Rationale	12
General objectives.....	12
The biorisk management approach	12
The biorisk management culture.....	13
Biorisk management	13
i. Securing valuable biological materials (VBM).....	13
ii. Distinctions within VBM	14
CHAPTER ONE	15
1.0 INTRODUCTION	15
1.1 MANAGEMENT AND RESPONSIBILITY	16
1.1.2 National Level.....	16
1.1.3 National Laboratory Biosafety and Biosecurity Office	17
1.1.4 National Biosafety and Biosecurity Committee.....	17
1.1.5 County Level.....	18
1.1.6 District Level	18
1.1.7 Health Care Facility (Dispensaries)	19
1.1.8 Responsibilities of the Employer	20
1.1.9 Biosafety and Biosecurity Officer.....	21
1.1.10 The Laboratory Personnel.....	22
CHAPTER TWO	24
2.0 GOOD LABORATORY WORK PRACTICE AND TECHNIQUES.....	24
2.1 Introduction.....	24

2.2 Preparing for Laboratory Work.....	24
2.3 Standard Laboratory Work Practices	25
2.4 Hand Washing.....	26
2.5 Safe Handling of Specimens in the Laboratory	26
2.5.1 Specimen Containers.....	26
2.6 Use of Pipettes and Pipetting Aids.....	27
2.7 Avoiding the Dispersal of Infectious Materials	27
2.8 Avoiding Ingestion of Infectious Materials and Contact with Skin and Eyes	28
2.9 Avoiding Injection of Infectious Materials	28
2.10 Separation of Serum and Plasma	29
2.11 General Guidelines When Using the Common Laboratory Equipments	29
2.11.1 Biological Safety Cabinets.....	29
2.11.2 Use of Centrifuges	31
2.11.3 Use of Homogenizers, Shakers, Blenders and Sonicators	32
2.11.4 Use of Tissue Grinders.....	33
2.11.5 Care and Use of Refrigerators and Freezers	33
2.11.6 Opening of Ampoules Containing Lyophilized Infectious Materials	33
2.11.7 Storage of Ampoules Containing Infectious Materials	34
2.11.8 Special Precautions with Blood and Other Body Fluids, Tissues and Excreta	34
2.12 Procedures for Handling Hazardous Spills	36
2.12.1 Infectious Spills	36
2.12.2 Handling Chemical Spills	37
2.13 Hazardous Waste Disposal.....	38
2.13.1 General policies	38
2.13.2 Sharps Disposal.....	39
2.13.3 Handling of Chemical Waste	39
CHAPTER THREE	41
3.0 PERSONAL PROTECTIVE EQUIPMENTS (PPE).....	41

3.1 Introduction.....	41
3.2 Eye Protection.....	41
3.3 Respiratory Protection	42
3.4 Protective Clothing	42
CHAPTER FOUR.....	46
4.0 CONTAINMENT	46
4.1 Introduction.....	46
4.2 Classification of Microorganism Risk Groups.....	46
4.2.1 Risk Group 1 (low individual and community risk)	46
4.2.2 Risk Group 2 (moderate individual risk, low community risk)	47
4.2.3 Risk Group 3 (high individual risk, low community risk)	47
4.2.4 Risk Group 4 (high individual risk, high community risk).....	47
4.3 Laboratory Biosafety Levels (BSL).....	47
4.3.1 BSL-1	47
4.3.2 BSL-2.....	48
4.3.3 BSL-3	48
4.3.4 BSL-4.....	48
CHAPTER FIVE	50
5.0 OCCUPATIONAL HEALTH PROGRAM.....	50
5.1 Introduction.....	50
5.2 Staff Induction and Training	51
5.2.1 Induction Training	51
5.2.2 Occupational Health Training.....	51
5.3 Fitness to Work Medical Tests and Health Surveillance Program.....	52
5.3.1 Fitness to work medical tests	52
5.3.2 Health surveillance programme	52
5.4 Exposure/Accident Management Plans, and Incident Reporting, Investigation and Mitigation Plans	53
5.4.1 Exposure/Accident Management Plans.....	53

5.4.2 Incident Reporting, Investigation and Mitigation Plans.....	55
CHAPTER SIX.....	57
6.0 EMERGENCY PREPAREDNESS FOR BIOMEDICAL LABORATORIES	57
6.1 Introduction.....	57
6.2 Emergency Preparedness and Response Plan	57
6.3 Emergency Preparedness and Response Training.....	60
CHAPTER SEVEN	61
7.0 DISINFECTION AND STERILIZATION	61
7.2 Principles of Sterilization and Disinfection	61
7.2.1 Pre-Cleaning and Cleaning Laboratory Materials.....	61
7.2.2 Disinfection.....	62
7.2.3 Decontamination of Used Instruments, Equipment and Surfaces.....	69
7.2.4 Sterilization	70
7.2.5 Prions	71
CHAPTER EIGHT	73
8.0 TRANSPORTATION OF BIOLOGICAL SPECIMENS AND AGENTS	73
8.1 Introduction.....	73
8.2 Packaging for Transportation.....	73
8.3 Labeling Instructions	75
CHAPTER NINE.....	77
9.0 CHEMICAL SAFETY.....	77
9.1 Introduction.....	77
9.2 Routes of Exposure	77
9.3 Chemical Segregation, Storage and Disposal	78
9.4 Chemical Spill Management.....	81
9.5 Chemical Hygiene Plan (CHP)	83
9.6 Employee Training.....	85

CHAPTER TEN.....	87
10.0 FIRE SAFETY.....	87
10.1 The Fire Triangle	87
10.2 Classes of Fire.....	88
10.3 Fire Extinguishers	88
10.4 Preventing Fires	89
10.5 Rules for Fighting Fires	90
CHAPTER ELEVEN.....	93
11.0 ELECTRICAL SAFETY	93
11.1 Electrical Hazards	93
11.2 Preventing Electrical Hazards.....	94
CHAPTER TWELVE.....	98
12.0 ERGONOMICS	98
12.1 Introduction.....	98
12.2 Symptom Recognition	98
12.3 Responsibility	99
12.4 Maintaining Proper Posture in the Laboratory:.....	100
CHAPTER THIRTEEN.....	106
13.0 Laboratory Waste Management	106
13.1 Types of Waste	106
13.2 Waste Minimization.....	107
13.3 Principles of Waste Management	107
CHAPTER FOURTEEN	115
14.0 RISK ASSESSMENT.....	115
14.1 Introduction.....	115
14.2 Biorisk Assessment Process.....	116

14.3 Risk Mitigation Measures	119
CHAPTER FIFTEEN	120
15.0 Biosecurity, Bioethics and Dual use Research.....	120
15.1 Introduction.....	120
15.2 Definitions.....	120
15.3 Laboratory biosecurity as a complement to laboratory biosafety	121
15.3.1 Laboratory biosafety vs. laboratory biosecurity.....	122
15.3.2 Laboratory biosecurity programme.....	123
15.3.3 Elements of a laboratory biosecurity plan.....	124
15.3.4 Laboratory biosecurity risk assessment	124
15.4 Dual use research Potential misuse of bioscience.....	124
15.4.1 Dual-Use Research as Currently Defined	125
15.5 Legitimate research, codes of conduct and codes of practice (Ethics).....	126
Appendix 1 Employee Exposure Report Form.....	127
Appendix 2 Laboratory Ergonomic Workstation Evaluation Checklist.....	128
Appendix 3 Risk Assessment Templates.....	130
Appendix 4 Kenya National biosafety checklist.....	131

ACRONYMS AND ABBREVIATIONS

ABSL	Animal Biosafety Level
BC	Biosafety committee
BSL	Biosafety Level
CDC	Center for Disease Control
CHP	Chemical Hygiene Plan
DHMT	District Health Management Team
EMCA	Environmental Management and Coordination Act
GCLP	Good Clinical Laboratory Practice
GOK	Government of Kenya
HAI's	Hospital Acquired Infections
HAZMAT	Hazardous Materials
HBIg	Hepatitis B Immunoglobulin
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HCW	Health Care Workers
HEPA	High efficiency particulate air
HEPA	High Efficiency Particulate Air
HIV	Human Immunodeficiency Virus
HMT	Health Management Team
IPC	Infection Prevention and Control
IPCC	Infection prevention and control committee
KMLTTB	Kenya Medical Laboratory Technologists and Technicians Board
LAI's	Laboratory Acquired Infections
LIC	Laboratory Information Card
MOMS	Ministry of Medical Services
MOPHS	Ministry of Public Health and Sanitation
MSDS	Material Safety Data Sheets
NBC	National Biosafety Committee
NCST	National Council for Science and Technology
OSH	Occupational Safety and Health

OSHA	Occupational Safety and Health Act
PDMS	Provincial Director of Medical Services
PDPHS	Provincial Director of Public Health and Sanitation
PELs	Permissible exposure limits
PEP	Post Exposure Prophylaxis
PEPFAR	President's Emergency Plan for AIDS Relief
PHMT	Provincial Health Management Team
PHMT	Provincial Health Management Team
PMLSO	Provincial Medical Laboratory Services Officer
PMLT	Provincial Medical Laboratory Technologist
PPE	Personal Protective Equipment
PTFE	Polytetrafluoroethylene
RG	Risk Group
SOP	Standard Operational Protocol/Procedure
TB	Tuberculosis
VBM	Valuable biological materials
WHO	World Health Organization

OVERVIEW OF BIOSAFETY AND BIOSECURITY

General introduction

Laboratory biosafety and biosecurity mitigate different risks, but they share a common goal: protecting the personnel and the environment, keeping Valuable Biological Materials (VBM) safely, securely inside the areas where they are used and stored. Good laboratory biosafety practices reinforce and strengthen laboratory biosecurity systems. A comprehensive biosafety culture translates into the understanding and routine application of a set of safe practices, procedures, actions and habits that protect the people working with biological materials. Appropriate levels of biosafety may be achieved through carefully designed and implemented work practices, even in modestly-equipped facilities.

Definitions

a. Biosafety

Biosafety refers to the application of knowledge, techniques and equipment to prevent personal exposure to potentially infectious agents or biohazards. Biosafety defines the containment conditions under which laboratory workers can safely manipulate infectious agents. The objective of containment is to confine biohazards and to reduce the potential exposure of the laboratory worker to potentially infectious agents. In other words, the community and environmental aspects of the meaning of biosafety seem to have gone elsewhere

Laboratory biosafety describes the containment principles, technologies and practices that are implemented to prevent the unintentional exposure to pathogens and toxins, or their accidental release.

b. Biosecurity

Laboratory biosecurity describes the protection, control and accountability for valuable biological materials (VBM) within laboratories, in order to prevent their unauthorized access, loss, theft, misuse, diversion or intentional release.

c. Biorisk

The probability or chance that a particular adverse event (in the context of this document: accidental infection or unauthorized access, loss, theft, misuse, diversion or intentional release), possibly leading to harm, will occur.

Rationale

The purpose of this Biosafety and Biosecurity Guideline is to provide laboratories in Kenya with safe practices, guidelines, and minimum standards they shall use in developing and improving their own occupational safety and health program, their co-workers, environment and the community. It defines minimum requirements, practices and procedures that will minimize risks to personnel, facilities, and the environment resulting from the handling of biological and chemical agents. The guide acts as a resource to be used in Occupational Safety and health (OSH) orientation of new employees and subsequent trainings. Work practices and guidelines are based on current OSHA 2007 regulatory requirements and accepted good biosafety and biosecurity practices. Implementation of these measures aims to reduce the likelihood that an incident involving a biological and chemical agent will occur, and targets the fulfillment of Kenya Occupational Safety and Health regulations and other relevant standards and guidelines. This guideline also addresses work practices to minimize, the chance of malicious use of valuable biological materials (VBM).

General objectives

This guideline will provide the minimum standards required for biorisk management. These will include but not limited to:

- i. Providing steps taken to perform effective biorisk assessment to identify gaps in the laboratory.
- ii. Initiation of mitigation measures (corrective measures).
- iii. Evaluation of biorisk system performance.

The biorisk management approach

Based on documented agent-based biorisk assessment that includes laboratory biosecurity considerations, laboratories containing valuable biological materials (VBM) should develop systems and controls to provide the required degree of assurance that biosafety and laboratory biosecurity risks are appropriately managed, and that the consequences of release of any VBM from the laboratory are appropriately minimized. Managing these risks represents:

- i. Reducing the risk of unintentional exposure to pathogens and toxins or their accidental release (biosafety), and reducing the risk of unauthorized access, loss, theft, misuse, diversion or intentional release of VBM (laboratory biosecurity);

- ii. Providing assurance, internally and externally (facility, local area, national and global community), that suitable measures have been adopted and effectively implemented;
- iii. Providing a framework for continuous awareness-raising and training for biosafety, laboratory biosecurity and ethical code of conduct within each facility.

The biorisk management approach allows Laboratory and facility managers to define and choose appropriate systems and controls to ensure that the biorisk management goals that have been identified are reached. It allows institutions to adapt their laboratory biosecurity plans to their particular situation.

The biorisk management culture

One of the goals of the biorisk management approach is to develop a comprehensive laboratory biosafety and biosecurity culture, allowing biosafety and biosecurity to become part of the daily routine of a laboratory, improving the overall level of working conditions, and pushing for expected good laboratory management. Laboratories and institutions should have moral responsibility to ensure that the materials they handle are accounted for and secured, and consequently in the protection of global public health. Indeed, biological laboratories in which biorisks are inappropriately managed and the staff and environment exposed to biosafety and biosecurity risks represent a threat to the international community and global public health.

Some facilities may be in a position to know which VBM they handle, work with or store, other facilities receiving for example samples for disease diagnosis or other analyses may not have complete oversight of materials handled. These latter facilities should establish a mechanism to enable either the storage of samples under appropriate conditions, or the destruction of samples once analysis is performed.

Biorisk management

i. Securing valuable biological materials (VBM)

Laboratory biosecurity is more than just the safeguarding of dangerous pathogens and toxins from individuals or organizations who would use them for harm but also materials with historical, medical, epidemiological, commercial or scientific value. Some VBM have intrinsic value and they need to be preserved for study by future generations of scientists. Their transfer

and sharing should be encouraged or maintained as long as appropriate documentation allowing tracking them is available and enforced.

Thus scientists have a duty to maintain VBM according to current best practice. If a decision is taken to destroy unwanted or unnecessary materials, protocols must be followed to ensure their full and complete destruction and documentation. The protection of VBM includes appropriate storage conditions, documentation of their storage, use, transfer to more appropriate laboratories, or proof of complete destruction.

ii. Distinctions within VBM

All microorganisms, natural or laboratory-modified, may be included in the broad definition of VBM. Some agents have heightened capacities to cause harm if intentionally misused. All materials of a biological nature may fall within the definition of VBM, however not all VBM warrant exceptional protective measures or strict accounting. Indeed, the value of VBM themselves may be based on subjective assessments resulting in biorisk management measures that may differ between sites holding the same agents.

CHAPTER ONE

1.0 INTRODUCTION

The Ministries of Public Health and Sanitation and Ministry of Medical services (MOPHS and MOMS) recognized that safety and, in particular, biological safety are important national issues. These two Ministries published and implemented the Infection, Prevention and Control (IPC) in health care facilities in Kenya. This program has greatly influenced safety when dealing with biological hazards, however the laboratory biosafety and biosecurity was not adequately addressed. It is for this reason that the National biosafety and biosecurity office was established to address issues pertaining to the same and hence the birth of this guideline. The intention of this document is to encourage laboratory personnel to accept and implement basic concepts in biological safety and to develop codes of practice for the safe handling of pathogenic microorganisms in laboratories within their respective facilities.

It is the policy of MOPHS and MOMS to provide employees with a safe and healthy working environment, promote safe and healthy work conditions and practices, establish and maintain an effective safety and health program. The responsibility for the development, implementation, and monitoring the Biosafety and Biosecurity program lies within the National Biosafety and Biosecurity Office.

SCOPE

This guideline applies to all laboratories in research and health facilities in Kenya. The guideline applies to all activities involving biological and chemical agents and all personnel working with these agents. It also includes occupational safety and health, biosecurity, bioethics and dual use research among others. The document is intended for the use of relevant national regulatory authorities, laboratory directors (laboratory managers) and laboratory workers, all of whom play key roles in the field of biosciences and in public health in general. This document addresses all the fourteen core elements of Biosafety and Biosecurity as recommended by the World health Organization (WHO) and these are as follows:-

- i. Management's Responsibility
- ii. Safety Business & Administrative Programs
- iii. Review Laboratory Biosafety Programs (Risk Assessment)

- iv. Equipment evaluation (PPE & Lab Equipment)
- v. Review Building & Facility Systems
- vi. Occupational Health Program
- vii. Chemical Management & Industrial Hygiene Programs
- viii. Waste Management & Environmental Safety Programs
- ix. Emergency Preparedness & Response Programs
- x. Agents of Biosecurity
- xi. Transport of Biological Agents
- xii. Field Activities (Clinical & Research)
- xiii. Training & Outreach Activities
- xiv. Radiation Safety Programs

1.1 MANAGEMENT AND RESPONSIBILITY

Effective implementations of this guideline shall require proper coordination from the National level all the way to the lowest health facilities (Dispensaries). At each level, a Biosafety and Biosecurity committee will be formed to strengthen coordination in the implementation of the guidelines. Additionally, the committees will be involved in planning, advocacy, and resource mobilization, coordination of trainings, capacity building, provide oversight in implementation and support in biorisk assessment. There are various levels of responsibility and authority for Biosafety and Biosecurity lead persons as indicated below.

Coordination

1.1.2 National Level

At the national level, Ministry of Medical Services (MOMS) and Ministry of Public Health and Sanitation (MOPHS) have the ultimate responsibility and authority for ensuring the availability, implementation and monitoring of use of the laboratory Biosafety and Biosecurity policy guideline.

1.1.3 National Laboratory Biosafety and Biosecurity Office

The National laboratory Biosafety and Biosecurity office within the two ministries of health shall be responsible for monitoring, reviewing, and updating of this laboratory Biosafety and Biosecurity guideline.

1.1.4 National Biosafety and Biosecurity Committee

The committee composition:

- i. Head of department (chairman)- plenary for discussion
- ii. Head of division
- iii. Biosafety and biosecurity office (secretariat)
- iv. Laboratory Quality Assurance Office
- v. Biosafety officer for each reference laboratories
- vi. Chief medical laboratory technologist
- vii. Biomedical engineer
- viii. Department of Occupational health and safety representative
- ix. Implementing partners
- x. Kenya Medical Laboratory Technicians and Technologists Board (KMLTTB) representative
- xi. Others can be co-opted as specialty need arises.

The National biosafety and biosecurity committee shall be responsible for:-

- i. Formulation and updating of policies on implementation of biosafety and biosecurity guideline.
- ii. Establishing, promoting, enforcing and implementation of biosafety and biosecurity policy regulations and procedures.
- iii. Advising the Ministries of Health on all matters relating to biosafety and biosecurity.
- iv. Advice the policy makers to ensure that respective pre-service and in-service training curriculum reflects adequate and appropriate content on biosafety and biosecurity.
- v. Spearhead laboratory Biosafety and Biosecurity concerns within the Ministry
- vi. Coordinate biosafety risk assessment in medical facilities

- vii. Coordination with international and national organizations on laboratory Biosafety and Biosecurity capacity building.
- viii. Coordinate laboratory Biosafety and Biosecurity training and technical advice
- ix. Provide bi-annual reports on the committee's activities to the Ministry of Health authorities

1.1.5 County Level

The County health management team (CHMT) shall form the County biosafety and biosecurity committee. The committee shall comprise of:

- i. County/regional Provincial Director of Medical Services (PDMS) / Provincial Director of Public Health and Sanitation (PDPHS) (chairs)
- ii. Provincial Medical Laboratory Technologist (PMLT)/Provincial Medical Laboratory Services Officer (PMLSO)
- iii. Provincial Biosafety/Biosecurity office (secretariat)
- iv. Provincial laboratory quality assurance office
- v. Partners where applicable
- vi. Medical engineer

The County biosafety and biosecurity committee shall be responsible for:-

- i. Implementing and commissioning risk assessment of the facilities under its control for compliance with laboratory biosafety and biosecurity guidelines.
- ii. Ensuring that adequate and appropriate resources are available to support laboratory biosafety and biosecurity guidelines implementation within these facilities.
- iii. Overseeing biosafety and biosecurity implementation at the regions.
- iv. Identifying existing gaps and developing strategies on how to resolve the issues identified through the annual operation plan.
- v. Identifying training needs
- vi. Identify existing stakeholders to leverage on GOK support.

1.1.6 District Level

The District Health Management Team (DHMT) shall form the District biosafety and biosecurity Committee. The committee shall comprise of:

- i. District Medical Officer of Health (DMOH) Chair
- ii. District Medical Laboratory Technologist (DMLT) office (Secretariat)
- iii. District Public Health Officer (DPHO), District Public Health Nurse (DPHN) office.
- iv. DPF office
- v. District Health Administration Officer (DHAO) office
- vi. District Health Records Information Officer (DHRIO) office
- vii. Infection Prevention and Control (IPC) representative
- viii. District Medical Laboratory Scientific Officer (DMLSO)
- ix. Implementing partners

NB: The secretariat will be coordinated by the District Laboratory Biosafety Officer.

Responsibilities:

- i. Monitor the healthcare facilities within the district for use and compliance with outlined laboratory biosafety and biosecurity guidelines.
- ii. Ensure that adequate and appropriate resources are available to support biosafety and biosecurity guideline implementation within the facilities.
- iii. Liaise with the County Biosafety Committee in planning and coordinate risk assessments within the healthcare facilities in the district.
- iv. Enforce implementation and monitor the biosafety and biosecurity improvement projects at the facility level
- v. Report to the county biosafety and biosecurity committee on quarterly basis on the programs and activities undertaken.

1.1.7 Health Care Facility (Dispensaries)

The health management team (HMT) shall form the Facility biosafety and biosecurity Committee.

The committee shall comprise of:

- i. Facility in-charge - chair
- ii. Biosafety officer - Secretariat
- iii. All HMT members,
- iv. Implementing partners- where applicable

Responsibilities

At the individual health care facility level, the implementation of biosafety and biosecurity measures is intimately linked to the laboratory quality assurance and quality improvement initiatives. All laboratories at the national, regional, county, district and sub-district levels shall establish respective laboratory biosafety and biosecurity committees. Each health facility should have a biosafety officer who in consultation with the district Biosafety Committee shall plan and conduct risk assessments and develop action plan to minimize risks. The Biosafety committee at this level shall monitor, coordinate, and evaluate the implementation of biosafety and biosecurity Guidelines. DHMT shall ensure that there is a health care facility laboratory biosafety and biosecurity committee.

1.1.8 Responsibilities of the Employer

The employing authority, through the laboratory Biosafety committee, is responsible for ensuring that the health of laboratory personnel (all technical and support staff) is adequately monitored. The objective is to monitor for occupational accidents and acquired diseases.

The employer shall:-

- i. Provide a safe and healthy work Environment
- ii. Ensure Material Safety Data Sheets (MSDS) are available at the point of use
- iii. Facilitate provision of active or passive immunization where applicable
- iv. Provide OSH training for all healthcare workers.
- v. Ensure all work hazards are identified with adequate mitigation measures and healthcare workers made aware of hazards and mitigation measures.
- vi. Fit the work environment to the worker and not the worker to the work environment.
- vii. Provide effective protection of the worker to hazard exposure including: Engineering control, personal protective equipment (PPE) and train all workers on the use of Protection equipment provided.
- viii. Put a system in place for accident and incident reporting that shall include management and post exposure monitoring of occupational-acquired infections and accidents.

- ix. Train staff on all aspects of biosafety and biosecurity to keep abreast with the current practices.

1.1.9 Biosafety and Biosecurity Officer

Each Health care facility in the country shall have a laboratory biosafety officer. The biosafety officer shall be appointed by (identified and recommended by the committee according to set criteria) the head of the laboratory. The biosafety officer shall represent the laboratory in the hospital infection control and prevention (IPC) committee. The officer must have appropriate technical background and be well versed in safety issues.

The biosafety officer will be appointed to ensure that safety policies and programmes are followed consistently throughout the Health facility laboratory. The biosafety officer will execute these duties on behalf of the head of the laboratory and the national biosafety officer. Whatever the degree of involvement in safety work, the person designated should have a sound Laboratory biosafety background, be actively involved in the work of the laboratory, and have experience and training in the broader aspects of biosafety.

The activities of the biosafety officer include the following:

- i. Perform internal biorisk assessments and audits, these audits will also include comprehensive workplace surveys to ensure compliance with appropriate local and national safety and health policies and standards.
- ii. Review and ensure implementation of customized biorisk Standard Operational Procedures (SOPs).
- iii. Ensure documentation of all biosafety procedures and activities
- iv. Discussions of the safety policy with the appropriate/responsible persons
- v. Verification that all members of the staff have received appropriate instruction and that they are aware of all hazards, and that members of the medical, scientific and technical staff are competent to handle infectious materials.
- vi. Provision of continuing instruction in safety for all personnel.
- vii. Provision of up-to-date safety literature and information to staff about changes in procedures, technical methods, requirements, and the introduction of new equipment.

- viii. Investigation of all accidents and incidents involving the possible escape of potentially infectious or toxic material, even if there has been no personal injury or exposure, and reporting of the findings and recommendations to the head of the institution and to the biosafety committee.
- ix. Review the absenteeism and advice where these absences may be associated with the work.
- x. Ensure that decontamination procedures are followed in the event of a spill or other incident involving infectious material, a detailed, written record of such accidents and incidents should be kept in case they may be related at a later date to a laboratory-acquired infection or other condition.
- xi. Provide regular reports on safety status of the laboratory to the laboratory in-charge
- xii. Archiving all documentation related to biosafety and biosecurity (for example, accident report forms, the accident record book, and all biosafety and biosecurity guidelines)
- xiii. Put in measures to ensure all materials are decontaminated and that infectious wastes are safely disposed of after treatment.
- xiv. Ensuring the disinfection of any apparatus requiring repair or servicing before it is handled by non-laboratory personnel.
- xv. Establishment of procedures for recording the receipt, movements and disposal of pathogenic material and for notification by any research worker or laboratory staff of the introduction of infectious materials that is new to the laboratory.
- xvi. Advising the director or laboratory in charge of the presence of any agents that should be notified to the appropriate local or national authorities and regulatory bodies (annex of the reportable list of agents to be meet)
- xvii. Reviewing the safety aspects of all plans, protocols and operating procedures for clinical diagnostic work prior to the implementation of these procedures or studies.
- xviii. Develop a system (plan) to deal with any emergencies (as per the risk assessment) that arise in the laboratory.
- xix. Coordinate orientation to new staff, researchers and students to ensure compliance.

1.1.10 The Laboratory Personnel

Laboratory worker policy statement

Each laboratory worker shares the responsibility towards safety in the laboratory by:

- i. Adhering to Good Clinical Laboratory Practice (GCLP)
- ii. Reporting and recording all accidents and bio hazardous exposures, work related illnesses to the appointed biosafety and biosecurity officer and/or the supervisor.
- iii. Following all work protocols and operating procedures applicable to their activities.
- iv. Informing the supervisor and/or biosafety and biosecurity officer of any personal conditions such as an illness, use of medication, pregnancy, or reduced immunity which could make their work more hazardous to themselves or others.
- v. Understand the risks of the project, procedures and activities he or she is undertaking.
- vi. Take appropriate safety measures to protect themselves, co-workers and the environment.
- vii. Use personal protective equipment as prescribed at all time when on duty.
- viii.** Undergo all relevant training requirements for the allocated duties and responsibilities

CHAPTER TWO

2.0 GOOD LABORATORY WORK PRACTICE AND TECHNIQUES

2.1 Introduction

The majority of laboratory accidents, injuries and work-related infections are caused by human error, poor laboratory techniques and misuse of equipment. This chapter provides a guide of technical methods that are designed to avoid or minimize the most commonly reported problems of this nature.

A major proportion of the work in the laboratory involves handling infectious biological materials. It is therefore, important for laboratories to establish standard policies and procedures necessary for safe laboratory conduct, handling laboratory hazards, and contingency planning for safety issues as part of a safety program. Laboratory personnel must have knowledge of safe laboratory procedures and an awareness of potential hazards. The adherence to appropriate safety practices will prevent serious laboratory accidents. The safety standards should apply to all the staff that are attached to the laboratory. Each person contributes to the adequacy of the safety program, therefore, each person has an obligation to him/herself and to his/her co-workers to protect the health and safety of all by strict observance of the safety regulations identified in this guideline

2.2 Preparing for Laboratory Work

"Universal Precautions" is the term used to describe a prevention strategy in which all specimens and potentially infectious materials are treated as if they are, in fact, infectious, regardless of the perceived status of the source individual. This approach is used in all situations where exposure to blood or potentially infectious materials is possible. This also means that certain engineering and work practice controls shall always be utilized in situations where exposure may occur.

Before starting to work in a laboratory, familiarize yourself with the following:

- i. The hazards of the materials in the laboratory, as well as appropriate safe handling, storage and emergency protocols. Read labels and material safety data sheets (MSDSs)

before moving, handling or opening chemicals. Never use a product from an unlabeled container, and report missing labels to your supervisor.

- ii. The agents, processes and equipment in the laboratory. If you are unsure of any aspect of a procedure, check with the in-charge before proceeding.
- iii. The location and operation of safety and emergency equipment such as fire extinguishers, eye wash and emergency shower, first aid and spill response kits, fire alarm pull stations, telephone and emergency exits
- iv. Emergency spill response procedures for the materials you will handle
- v. Emergency reporting procedures and telephone numbers

2.3 Standard Laboratory Work Practices

- i. Restrict laboratory access to authorized persons only
- ii. Follow all outlined safety instructions/policies.
- iii. Smoking, eating, drinking, applying cosmetics or lip balm and handling contact lenses are not permitted in laboratories
- iv. Storing food, beverages or tobacco in laboratories is not permitted.
- v. Wear laboratory coats (knee length) and safety glasses in laboratories when working with chemicals, biohazards or radioisotopes.
- vi. Open shoes, such as sandals, should never be worn in the laboratory.
- vii. Tie back or otherwise restrain long hair when working with chemicals, biohazards, radioisotopes, or moving machinery.
- viii. Keep work places clean and free of unwanted chemicals, biological specimens, and idle equipment. Avoid leaving reagent bottles, empty or with content, on the floor.
- ix. Work only with materials once you know their flammability, reactivity, toxicity, safe handling, storage and emergency procedures.
- x. Consult material safety data sheets (MSDS) before working with hazardous chemicals or infectious material. Read all labels carefully.
- xi. Post appropriate warning signs within the laboratory
- xii. Read all posted signs
- xiii. Label reagents, materials, and storage containers legibly and according to regulations
- xiv. Inform co-workers of any potential health hazard associated with the work performed

- xv. Prepare and maintain a chemical inventory for the laboratory.
- xvi. Never pipette by mouth; use mechanical transfer devices.
- xvii. Do not run in the laboratory.
- xviii. Keep exits and passage ways clear at all times.
- xix. Ensure that access to emergency equipment (eyewashes, emergency showers and fire extinguishers) is not blocked.
- xx. Report accidents and incidents ("near-misses") promptly to your supervisor.
- xxi. Wash your hands before leaving the laboratory.
- xxii. Leave your laboratory coats in the laboratory.
- xxiii. Procedures involving release of volatile toxic or flammable materials should be conducted in a chemical fume hood or in a well aerated room
- xxiv. Perform procedures that liberate infectious aerosols in a biological safety cabinet or ventilated work stations or good laboratory techniques.
- xxv. Handle all human specimen as if potentially infectious

2.4 Hand Washing

Wash hands after laboratory procedures and before leaving the laboratory, this is essential to avoid becoming exposed to chemical irritants and infectious agents. Hand washing is one of the most important (and easiest) practices used to prevent transmission of blood borne pathogens. Hands or other exposed skin should be washed as soon as possible following an exposure incident. Use soft, antibacterial soap, if possible. Avoid harsh, abrasive soaps, as these may open fragile scabs or other sores.

2.5 Safe Handling of Specimens in the Laboratory

Improper collection, internal transport and receipt of specimens in the laboratory carry a risk of infection to the personnel involved.

2.5.1 Specimen Containers

Plastic specimen containers are preferable to glass due to biosafety reasons and should not leak when the cap or stopper is correctly applied. No material should remain on the outside of the container. Containers should be correctly labeled to facilitate identification. Specimen request or

specification forms should not be wrapped around the containers but placed in separate, preferably waterproof envelopes.

2.6 Use of Pipettes and Pipetting Aids

- i. A pipetting aid should always be used. Pipetting by mouth must be prohibited.
- ii. All pipettes should have cotton plugs to reduce contamination of pipetting devices.
- iii. Air should never be blown through liquid containing infectious agents
- iv. Infectious materials should not be mixed by alternate suction and expulsion through a pipette.
- v. Liquids should not be forcibly expelled from pipettes.
- vi. Mark-to-mark pipettes are preferable to other types as they do not require expulsion of the last drop.
- vii. Contaminated pipettes should be completely submerged in a suitable disinfectant contained in an unbreakable container. They should be left in the disinfectant for 18-24 h before disposal.
- viii. A discard container for pipettes should be placed close to the work area.
- ix. Syringes fitted with hypodermic needles must not be used for pipetting. Blunt cannulas should be used instead of needles. There are devices for opening septum-capped bottles that allow pipettes to be used and avoid the use of hypodermic needles and syringes.
- x. To avoid dispersion of infectious material accidentally dropped from a pipette, a disinfectant-soaked cloth or absorbent paper should be placed on the working surface; this should be autoclaved or discarded as infectious waste after use.

2.7 Avoiding the Dispersal of Infectious Materials

- i. In order to avoid the premature shedding of their loads, microbiological transfer loops should have a diameter of 2–3 mm and be completely closed. The shanks should not be more than 6 cm in length to minimize vibration.
- ii. The risk of spatter of infectious material in an open Bunsen burner flame should be avoided by using an enclosed electric micro incinerator to sterilize transfer loops. Disposable transfer loops, which do not need to be re-sterilized, are preferable.

- iii. Catalase tests should not be performed on slides to avoid bubbling and dispersal of aerosols. The tube, capillary tube or cover-glass methods should be used instead.
- iv. Discarded specimens and cultures for autoclaving and/or disposal should be placed in leak proof containers, e.g. laboratory discard bags.
- v. Working areas must be decontaminated with a suitable disinfectant, at the beginning of shift, after every procedure and at the end of shift.

2.8 Avoiding Ingestion of Infectious Materials and Contact with Skin and Eyes

Large particles and droplets ($> 5\mu\text{m}$ in diameter) released during microbiological manipulations settle rapidly on bench surfaces and on the hands of the operator.

- i. Disposable gloves should be worn.
- ii. Laboratory workers should avoid touching their mouth, eyes and face.
- iii. Food and drink must not be consumed or stored in the laboratory.
- iv. There should be no gum-chewing in the laboratory.
- v. Cosmetics should not be applied in the laboratory.
- vi. The face, eyes and mouth should be shielded or otherwise protected during any operation that may result in the splashing of potentially infectious materials.

2.9 Avoiding Injection of Infectious Materials

- i. Accidental inoculation with broken or chipped glassware can be avoided through careful practices and procedures. Glassware should be replaced with plastic ware whenever possible.
- ii. Injections may result from accidents with hypodermic needles (needle-sticks), glass Pasteur pipettes and broken glass.
- iii. Needle-stick accidents can be reduced by (a) taking particular care, and (b) minimizing the use of syringes and needles; for many techniques, syringes with blunt cannulas may be used instead.
- iv. Simple devices are available for opening septum-stoppered bottles so that pipettes can be used.

- v. Needles should never be recapped. Without disconnecting them from the syringe (if available), disposable articles should be discarded into puncture-proof containers fitted with covers.
- vi. Plastic Pasteur pipettes should replace those made of glass.

2.10 Separation of Serum and Plasma

- i. Only properly trained staff should be employed for this work.
- ii. Gloves and eye and mucous membrane protection should be worn.
- iii. Splashes and aerosols can only be avoided or minimized by good laboratory technique. Blood and serum should be pipetted carefully, not poured. Pipetting by mouth must be forbidden.
- iv. After use, pipettes should be completely submerged in hypochlorite or other suitable disinfectant. They should remain in the disinfectant for at least 18 h before disposal, or washing and sterilization for reuse.
- v. Discarded specimen tubes containing blood clots, etc. (with caps replaced) should be placed in suitable leak proof containers for autoclaving and/or incineration.
- vi. A solution of hypochlorite, freshly prepared daily, should be available for clean-up of splashes and spillages.

2.11 General Guidelines When Using the Common Laboratory Equipments

2.11.1 Biological Safety Cabinets

General considerations

- i. Determine the biological safety level of the laboratory, type of infectious agents or biochemical hazard that may be present, and the nature of the work performed.
- ii. Use total exhaust safety cabinets for operations that utilize hazardous chemicals and volatile toxins.
- iii. Use a biological safety cabinet when performing procedures that may create an inhalation or aerosol hazard.
- iv. Use the correct classification of a biological safety cabinet (BSC) when working with infectious agent depending on its risk classification. Classification of infectious agents is according to Risk Groups 1-4 and the BSC are 1-4 too).

- v. Biological Safety Cabinets must be inspected and certified when installed or relocated and certified annually thereafter. Documentation of certification consists of a sticker with the certification date affixed to each BSC. Also the next due date for certification
- vi. Containment
 - a. Diagnostic work may be done in a basic laboratory - Biosafety Level 2, preferably one dedicated for this purpose.
 - b. Research and development work involving propagation of large volumes or high concentrations of infectious microorganisms may require a containment laboratory - Biosafety Level 3 or higher containment level.

Use of Biological Safety Cabinets

- i. The use and limitations of biological safety cabinets should be explained to all potential users with reference to national standards and relevant literature. Written protocols or safety or operations manuals should be issued to staff. In particular, it must be made clear that the cabinet will not protect the operator from spillage, breakage or poor technique.
- ii. The cabinet must not be used unless it is working properly.
- iii. The glass viewing panel must not be opened when the cabinet is in use.
- iv. Apparatus and materials in the cabinet must be kept to a minimum. Air circulation at the rear plenum must not be blocked. Materials should be surface-decontaminated before placing them inside the working area of the cabinet.
- v. Bunsen burners must not be used in the cabinet. The heat produced will distort the air flow and may damage the filters. An electric micro-incinerator is permissible but sterile disposable transfer loops are better.
- vi. All work must be carried out in the middle or rear part of the working surface and be visible through the viewing panel.
- vii. Traffic behind the operator should be minimized.
- viii. The operator should not disturb the air flow by repeated removal and reintroduction of his or her arms.
- ix. The front air grill must not be blocked with notes, pipettes or other materials, as this will disrupt the air flow causing potential contamination of the material and exposure of the operator.

- x. The surface of the biological safety cabinet shall be wiped using an appropriate disinfectant at the beginning of a shift, after work is completed and at the end of the shift.
- xi. The cabinet fan should be run for at least 5 min before beginning work and after completion of work in the cabinet.

2.11.2 Use of Centrifuges

- i. Satisfactory mechanical performance is a prerequisite of microbiological safety in the use of laboratory centrifuges.
- ii. Centrifuges should be operated according to the manufacturer's instructions.
- iii. Centrifuges shall be placed on flat and firm surface to reduce vibrations and shall not share a bench with other laboratory equipment.
- iv. Centrifuges should be placed at such a level that workers of less than average height can see into the bowl to place trunnions and buckets correctly. Buckets and trunnions should be paired by weight and, with tubes in place, correctly balanced
- v. Centrifuge tubes and specimen containers for use in the centrifuge should be made of thick-walled glass or preferably of plastic and should be inspected for defects before use.
- vi. Tubes and specimen containers should always be securely capped (screw-capped if possible) for centrifugation.
- vii. The buckets must be loaded, equilibrated, sealed and opened in a biological safety cabinet or let stand for 30 minutes before opening
- viii. The amount of space that should be left between the level of the fluid and the rim of the centrifuge tube should be given in manufacturer's instructions.
- ix. Distilled water or alcohol (Iso-propanol, 70%) shall be used for balancing empty buckets. Saline or hypochlorite solutions should not be used as they corrode metals.
- x. Sealable centrifuge buckets (safety cups) shall be used for microorganisms of Risk Groups 3 and 4.
- xi. When using angle head centrifuge rotors, care shall be taken to ensure that the tube is not overloaded as it might leak.
- xii. The interior of the centrifuge bowl shall be inspected daily for staining or soiling at the level of the rotor. If staining or soiling is evident then the centrifugation protocols should be re-evaluated.

- xiii. Centrifuge rotors and buckets shall be inspected daily for signs of corrosion and for hair-line cracks.
- xiv. Buckets, rotors and centrifuge bowls shall be decontaminated after each use.
- xv. After use, buckets should be stored in an inverted position to drain the balancing fluid.
- xvi. Infectious airborne particles may be ejected when centrifuges are used. These particles travel at speeds too high to be retained by the cabinet air flow if the centrifuge is placed in a traditional open fronted Class I or Class II biological safety cabinet. However, good centrifuge technique and securely capped tubes offer adequate protection against infectious aerosols and dispersed particles.

Note: It is good practice to involve the biomedical engineers when installing centrifuges.

2.11.3 Use of Homogenizers, Shakers, Blenders and Sonicators

- i. Domestic (kitchen) homogenizers should not be used in laboratories as they may leak or release aerosols. Laboratory blenders and stomachers are safer.
- ii. Caps and cups or bottles should be in good condition and free from flaws or distortion. Caps should be well-fitting and gaskets should be in good condition.
- iii. Pressure builds up in the vessel during the operation of homogenizers, shakers and sonicators.
- iv. Aerosols containing infectious materials may escape from between the cap and the vessel. Plastic, in particular, Polytetrafluoroethylene (PTFE) vessels are recommended because glass may break, releasing infectious material and possibly wounding the operator.
- v. When in use, homogenizers, shakers and sonicators shall be covered by a strong transparent plastic casing. This shall be disinfected after use. Where possible, these machines should be operated, under their plastic covers, in a biological safety cabinet.
- vi. At the end of the operation the containers should be opened in a biological safety cabinet or let to stand for 30 minutes before opening.
- vii. Hearing protection should be provided for people using sonicators.

2.11.4 Use of Tissue Grinders

- i. Glass grinders should be held in a wad of absorbent material in a gloved hand. Plastic (PTFE) Grinders are safer.
- ii. Tissue grinders should be operated and opened in a biological safety cabinet.

2.11.5 Care and Use of Refrigerators and Freezers

- i. Refrigerators, deep-freezers and solid carbon dioxide (dry ice) chests should be defrosted and cleaned periodically, and any ampoules, tubes, etc. that have broken during storage removed. Face protection and heavy duty rubber gloves should be worn during cleaning. After cleaning, the inner surfaces of the cabinet should be disinfected as per manufacturer's instructions.
- ii. All containers stored in refrigerators, etc. should be clearly labeled with the scientific name of the contents, the date stored and the name of the individual who stored them. Unlabeled and obsolete materials should be autoclaved and discarded.
- iii. An inventory must be maintained of the freezer's contents.
- iv. Flammable solutions must not be stored in a refrigerator unless it is explosion-proof. Notices to this effect should be placed on refrigerator doors.

2.11.6 Opening of Ampoules Containing Lyophilized Infectious Materials

Care should be taken when ampoules of freeze-dried materials are opened, as the contents may be under reduced pressure and the sudden inrush of air may disperse some of the materials into the atmosphere. Ampoules should always be opened in a biological safety cabinet.

The following procedures are recommended for opening ampoules.

- i. First decontaminate the outer surface of the ampoule.
- ii. Make a file mark on the tube near to the middle of the cotton or cellulose plug, if present
- iii. Hold the ampoule in a wad of alcohol-soaked cotton to protect hands before breaking it at a file scratch.
- iv. Remove the top gently and treat as contaminated material.
- v. If the plug is still above the contents of the ampoule, remove it with sterile forceps.

- vi. Add liquid for re-suspension slowly to the ampoule to avoid frothing.

2.11.7 Storage of Ampoules Containing Infectious Materials

- i. Ampoules containing infectious materials should never be immersed in liquid nitrogen because cracked or imperfectly sealed ampoules may break or explode on removal.
- ii. If very low temperatures are required, ampoules should be stored only in the gaseous phase above the liquid nitrogen.
- iii. Infectious materials should be stored in mechanical deep-freeze cabinets or on dry ice
- iv. Laboratory workers should wear eye and hand protection when removing ampoules from cold storage.
- v. The outer surfaces of ampoules stored in these ways should be disinfected when the ampoules are removed from storage.

2.11.8 Special Precautions with Blood and Other Body Fluids, Tissues and Excreta

The precautions outlined below are designed to protect laboratory workers against infection by blood borne pathogens and infectious agents.

2.11.8.1 Collection, labeling and transport of specimens

- i. Universal precautions shall always be followed; gloves should be worn for all procedures.
- ii. Samples shall be collected from patients and animals in accordance with SOPs.
- iii. For blood collection, conventional needle and syringe systems should be replaced by single-use safety vacuum devices that allow the collection of blood directly into stoppered transport and/or culture tubes, automatically disabling the needle after use.
- iv. The tubes shall be placed in adequate containers for transport to the laboratory within the hospital facility. For further guidelines for packaging and transport of specimens refer to Chapter 8.
- v. Request forms should be placed in separate water-proof bags or envelopes.
- vi. Reception staff shall not open these bags.

2.11.8.2 Opening Specimen Tubes and Sampling Contents

- i. Specimen tubes shall be opened in a Class I or Class II biological safety cabinet.
- ii. Gloves must be worn. Eye and mucous membrane protection is also recommended (goggles or shield (visor)).
- iii. Protective clothing should be supplemented with a plastic apron.
- iv. The stopper should be grasped through a piece of paper or gauze to prevent splashing.

2.11.8.3 Glass and “Sharps”

- i. Plastics shall replace glass wherever possible. Only laboratory grade (borosilicate) glass should be used, and any article that is chipped or cracked should be discarded.
- ii. Hypodermic needles must not be used as pipettes. Blunt cannulas are permitted.

2.11.8.4 Films and Smears for Microscopy

Fixing and staining of blood, sputum and fecal samples for microscopy does not necessarily kill all organisms or viruses on the smears. These items should be handled with forceps, stored appropriately, and decontaminated and/or autoclaved before disposal.

2.11.8.5 Automated Equipment (Sonicators, Vortex mixers)

- i. Equipment should be of the closed type to avoid dispersion of droplets and aerosols.
- ii. Effluents should be collected in closed vessels for further autoclaving and/or disposal.
- iii. Equipment should be disinfected at the end of each session, following the manufacturer's instructions.

2.11.8.6 Tissues

- i. Formalin fixatives shall be used. Small specimens, e.g. from needle biopsies, can be fixed and decontaminated within a few hours, but larger specimens may take several days.
- ii. Frozen sectioning shall be avoided. Should it be essential, the cryostat shall be shielded and the operator shall wear a safety shield (visor)
- iii. For decontamination, the temperature of the instrument shall be raised to 20 °C.

2.11.8.7 Decontamination

- i. Hypochlorite and high-level disinfectants are recommended for decontamination.
- ii. Freshly prepared hypochlorite solutions shall contain available chlorine at 1 g/l for general use and 10 g/l for blood spillages.
- iii. Glutaraldehyde or 70% alcohol may be used for decontaminating surfaces.

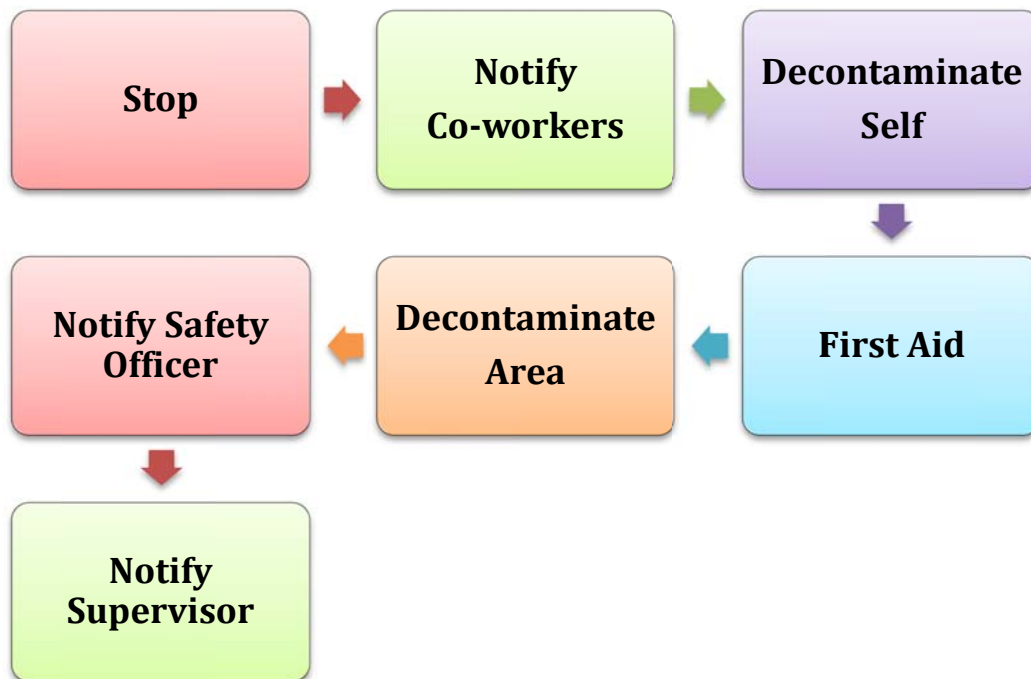
Note: For further guidelines of the above calculation refer to Chapter 7 of these guidelines.

2.12 Procedures for Handling Hazardous Spills

2.12.1 Infectious Spills

In case of a spill the plan to use is:

a) Self Decontamination



- i. Stop work immediately and assess the extent of the danger.
- ii. Alert other personnel in the immediate area.
- iii. Remove latex gloves, discard, and replace with clean gloves.

- iv. Immediately decontaminate all body areas that may have been exposed to infectious material. Ask for the help of a co-worker if necessary.
- v. Initially soak clothing or exposed body areas with 70% alcohol.
- vi. Wash thoroughly with soap and warm water - a minimum of three minutes. Do not abrade skin during the washing process.
- vii. Use the eyewash if eyes were exposed.
- viii. Notify emergency personnel and follow available PEP guidelines
- ix. Notify supervisor

b) Work Surface Decontamination

- i. Change gloves again and take any first aid measures necessary.
- ii. Do not pick up any containers until they have been decontaminated.
- iii. Restrict access to the area, cover the spill with absorbent material and thoroughly soak with freshly prepared 10% household bleach.
- iv. Allow the spilled material to stay in contact with the disinfectant for 30 minutes and then clean up the area.
- v. Remove protective clothing and discard.
- vi. Notify the Safety officer and supervisor as soon as possible. Do not leave the area until this is done.
- vii. Prepare a Report of Incident or Accident with the help of the supervisor.

2.12.2 Handling Chemical Spills

- i. Immediately flush any exposed body areas and clothing with large volumes of water. Request the help of a co-worker, if necessary. Use emergency shower or eye showers if available.
- ii. Notify the emergency personnel.
- iii. Put on protective clothing (PPE).
 - a. Laboratory coat "Sleeve guards" if the coat is not disposable
 - b. Latex gloves.
 - c. Safety goggles, glasses, or face shield.
- iv. Retrieve the Chemical Spill clean-up materials if available

- v. Place absorbent neutralizing material over the spill area. Use enough material to absorb the entire spill.
- vi. Place the used absorbent material in the clear plastic bags provided and close securely with the fastener.
- vii. Dispose of plastic bags in a Biohazard Waste container or bag.
- viii. Contact the Safety officer or refer to the MSDS for proper disposal.
- ix. Prepare a Report of Incident or Accident with the help of the supervisor.
- x. Notify the Department Safety Officer or Laboratory supervisor of the incident within one hour.

The procedure listed above is for small spills, for larger spills refer to Chapter 7

2.13 Hazardous Waste Disposal

2.13.1 General policies

- i. The goal is to reduce the volume of hazardous waste as much as possible. A Hazardous Waste Minimization Program is highly recommended for every facility.
- ii. Address coordination of hazardous waste disposal or questions on policies and procedures to the Safety Officer or designee
- iii. Hazardous waste includes infectious or pathological waste, sharps (needles, pipette tips), chemical waste, and radioactive waste
- iv. Infectious or Pathological Waste (Soft Waste)
 - a. Includes any solid or liquid biological material that may contain or be contaminated with potentially communicable disease agents.
 - b. Locate red infectious/biohazard waste disposal containers in each area of the laboratory where infectious waste may accumulate.
 - c. Line containers with disposable bright orange/red biohazard bags before placing infectious waste into them to prevent leakage.
- v. Fill infectious waste containers no more than three-quarters full.
- vi. Remove biohazard bags from the work area after each day's use.
- vii. Transport bags and containers to the biohazard holding room as per the facility procedures.

2.13.2 Sharps Disposal

- i. Sharps are pipette tips, pipettes, needles, syringes, broken glassware, blood collection tubes, microwell plates or any object that can puncture the skin.
- ii. All sharps must be prepackaged in puncture resistant containers.
- iii. Dispose of sharps in appropriate biohazard sharps containers provided for this purpose. Do not dispose of any other trash into these containers. Several sizes are available in the laboratory.
- iv. Do not overfill sharps disposal containers. Fill to 3/4 capacity. Needles shall not be recapped, bent, or broken prior to disposal. Do not remove needles from disposable syringes.
- v. Expel excess liquid from syringes or pipettes. Dispense infectious liquid into a 10% bleach solution prior to disposal.
- vi. Dispose of serological pipettes into special boxes if available or dispose in biohazard bags. Place containers at point of use in the laboratory.
- vii. Lock filled containers and dispose by incineration.

2.13.3 Handling of Chemical Waste

- i. All chemical containers shall be labeled with the name of the chemical, name and address of the manufacturer, and specific hazard warnings.
- ii. Material Safety Data Sheets (MSDS) shall be readily available for each chemical or reagent used in the laboratory.
- iii. Non-hazardous chemical waste can be disposed of by pouring down the sink:
- iv. Hazardous chemical waste includes toxic, corrosive, ignitable, reactive, and explosive materials.
- v. Store corrosive chemicals in an approved corrosive container.
- vi. Store flammables in a flammable cabinet separate from corrosives and oxidizers.
- vii. Store oxidizers separately.
- viii. Store organic acids separate from mineral acids.
- ix. Store concentrated acids and bases in use in a fume hood with a barrier between them.
- x. Do not store hazardous chemicals on shelves above eye level (approx. five feet).

- xi. Label chemical storage areas according to National Fire Protection Association (NFPA) standards.
- xii. Handle any material that is not infectious or radioactive and whose risk to public safety is in doubt, as hazardous chemical waste until clarification can be obtained.
- xiii. Dispose of chemical waste according to Chemical safety and storage, Chapter 9. Also refer to MSDSs.
- xiv. Do not dispose of hazardous chemicals by pouring them down the sink.
- xv. If in doubt as to how to dispose of hazardous chemicals consult with the Safety Officer, laboratory supervisors and/or MSDS.

CHAPTER THREE

3.0 PERSONAL PROTECTIVE EQUIPMENTS (PPE)

3.1 Introduction

The major routes by which the laboratory staff acquire infection is through the skin penetration, contact between mucus membranes and contaminated materials, accidental ingestion and inhalation.

To reduce the risk of these occurrences, it is imperative that staff have access to PPE that are appropriate for the level of care, according to Kenya Essential Package of Health (KEPH), and the activity being performed. The members of staff also need to be trained on how to use them properly and habitually while working in the laboratory. Approved goggles, face shields, splatter guards, masks, or other eye and face protection should be worn when handling infectious or other hazardous materials outside the biosafety cabinet.

PPE includes gloves, respiratory protection, eye protection and protective clothing. The need for PPE is dependent upon the type of operations and the nature and quantity of the materials in use, and must be assessed on a case by case basis. Workers who rely on PPE must understand the functioning, proper use, and limitations of the PPE used.

3.2 Eye Protection

a. Safety Glasses

Safety glasses look very much like normal glasses but have lenses that are impact resistant and frames that are far stronger than standard street wear glasses. Safety glasses must have side shields and should be worn whenever there is the possibility of objects striking the eye, such as splashes, particles, glass, or metal shards. Many potential eye injuries have been avoided by wearing safety glasses. Safety glasses may be adequate when the potential splash is minimal, such as when opening eppendorf tubes.

b. Face Shields

Face shields are in order when working with large volumes of hazardous materials, either for protection from splash to the face or flying particles. Face shields must be used in conjunction with safety glasses or goggles.

3.3 Respiratory Protection

Respirators

Respiratory protection may be used when carrying out high-hazard procedures (e.g. cleaning up a spill of infectious material). The choice between mask and respirator will depend on the type of hazard. Respirators are available with interchangeable filters for protection against gases, vapors, particulates and microorganisms. Note that no filter other than a HEPA filter will provide protection against microorganisms, and it is imperative that the filter be fitted in the correct type of respirator. To achieve optimal protection, respirators should be individually fitted to the operator's face and then tested. Fully self-contained respirators with an integral air supply provide full protection. Advice should be sought from a suitably qualified person, e.g. an occupational hygienist, for selection of the correct respirator

3.4 Protective Clothing

a. Laboratory coats, gowns, coveralls, aprons

These are required in areas depending on procedures/policies of the area.

Laboratory coveralls, gowns or uniforms must be worn at all times for work in the laboratory.

Laboratory coats should preferably be fully buttoned. However, long-sleeved, back-opening gowns or coveralls give better protection than laboratory coats and are preferred in microbiology laboratories and when working in the biological safety cabinet. Aprons should be worn over laboratory coats or gowns where necessary to give further protection against spillage of chemicals or biological materials such as blood or culture fluids.

When the possibility of chemical contamination exists, protective clothing that resists physical and chemical hazards should be worn over street clothes. Laboratory coats are appropriate for minor chemical splashes and solids contamination, while plastic or rubber aprons are best for

protection from corrosive or irritating liquids. Disposable outer garments (i.e., Tyvek suits) may be useful when cleaning and decontamination of reusable clothing is difficult.

Note: Protective clothing including laboratory coats should never be worn outside the laboratory; always leave them in the laboratory. Disinfection and cleaning of the protective clothing shall be done within a designated area.

b. Gloves

Appropriate gloves must be worn for all procedures that may involve direct or accidental contact with blood, infectious materials or infected animals. If glove material is thin or flimsy, double gloving can provide an additional layer of protection.

- i. Wear gloves all the time when working in the laboratory.
- ii. If you know you have cuts or sores on your hands, you should cover these with a bandage or similar protection as an additional precaution before donning your gloves.
- iii. Make sure you don't touch the outside of the gloves with any bare skin, and be sure to dispose of them in a proper container so that no one else will come in contact with them, either
- iv. Ensure integrity of gloves before use.



Always check your gloves for damage before using them and if damaged, don't use it!

- v. Change gloves between jobs and wash hands every time gloves are changed and when leaving the laboratory.
- vi. Do not re-use gloves.
- vii. Use aseptic technique to don and remove gloves.
- viii. Do not walk out of the laboratory wearing used gloves.
- ix. Protective gloves should be worn when handling hazardous materials, chemicals of unknown toxicity, corrosive materials, rough or sharp-edged objects, and very hot or very cold materials. When handling chemicals in a laboratory, disposable latex, vinyl or nitrile

examination gloves are usually appropriate for most circumstances. These gloves will offer protection from incidental splashes or contact. When working with chemicals with high acute toxicity, working with corrosives in high concentrations, handling chemicals for extended periods of time or immersing all or part of a hand into a chemical, the appropriate glove material should be selected, based on chemical compatibility.

Selecting the Appropriate Glove Material

Gloves should be made of latex, nitrile, rubber, or other water impervious materials. When selecting the appropriate glove, the following characteristics should be considered:

- i. Degradation rating
- ii. Breakthrough time
- iii. Permeation rate
- iv. Proper sizes
- v. Expiry date

c. Footwear

- i. Closed-toed shoes should be worn at all times in buildings where chemicals are stored or used.
- ii. Perforated shoes, sandals or cloth sneakers should not be worn in laboratories or where mechanical work is conducted. Such shoes offer no barrier between the laboratory worker and chemicals or broken glass.
- iii. Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup). Leather shoes tend to absorb chemicals and may have to be discarded if contaminated with a hazardous material.
- iv. Although generally not required in most laboratories, steel-toed safety shoes may be necessary when there is a risk of heavy objects falling or rolling onto the feet, such as in bottle-washing operations or animal care facilities.

Table 1. Personal Protective Equipment		
Equipment	Hazard corrected	Safety features
Goggles or safety Spectacles	Impact and splash	Impact-resistant lenses (must be optically correct or worn over corrective eye glasses) Side shields
Face shields	Impact and splash	Shield entire face Easily removable in case of accident
Respirators	Inhalation of aerosols	Designs available include hoods, full-face or half face masks.
Laboratory coats, gowns, coveralls	Contamination of clothing	Back opening Cover street clothing
Plastic aprons	Contamination of clothing	Waterproof
Gloves	Accidental direct contact	Disposable latex or vinyl
	Accidental punctures or cuts	Hand protection mesh
Footwear	Impact and splash	Closed toe

CHAPTER FOUR

4.0 CONTAINMENT

4.1 Introduction

Containment is used to describe safe methods for managing infectious agents in the laboratory. Primary containment is the protection of the personnel and the immediate laboratory environment from exposure to the agents. This is achieved through good laboratory techniques and the use of safety equipment. Secondary containment is the protection of the environment external to the laboratory. It is achieved through the combination of facility design and operational practices. The three elements of containment include laboratory practice and technique, safety equipment, and facility designs. Work is assigned a biosafety level based on the pathogens and operations to be performed, the documented or suspected routes of transmission for the agent, and the laboratory functions and activities.

4.2 Classification of Microorganism Risk Groups

Classification of organisms according to risk group has traditionally been used to categorize the relative hazards of infective organisms. The factors used to determine which risk group an organism falls into is based upon the particular characteristics of the organism, such as

- i. Pathogenicity
- ii. Infectious dose
- iii. Mode of transmission
- iv. Host range
- v. Availability of effective preventive measures
- vi. Availability of effective treatment.

These classifications presume ordinary circumstances in the research laboratory or growth in small volumes for diagnostic and experimental purposes. Four levels of pathogenic risks have been defined as follows

4.2.1 Risk Group 1 (low individual and community risk)

This is any biological agent that is unlikely to cause disease in healthy workers or animals.

4.2.2 Risk Group 2 (moderate individual risk, low community risk)

This is any pathogen that can cause human disease but, under normal circumstances, is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures rarely cause infection leading to serious disease; effective treatment and preventive measures are available, and the risk of spread is limited.

4.2.3 Risk Group 3 (high individual risk, low community risk)

This is any pathogen that usually causes serious human disease or can result in serious economic consequences but does not ordinarily spread by casual contact from one individual to another, or that causes diseases treatable by antimicrobial or anti parasitic agents.

4.2.4 Risk Group 4 (high individual risk, high community risk)

This is any pathogen that usually produces very serious human disease, often untreatable, and may be readily transmitted from one individual to another or from animal to human or vice-versa, directly or indirectly, or by casual contact.

4.3 Laboratory Biosafety Levels (BSL)

Laboratory Biosafety level designations are based on a combination of the design features, construction, containment facilities, equipment, practices and operational procedures required for working with agents for various working groups. There are 4 levels of Laboratory facilities designated as BSL 1-4.

4.3.1 BSL-1

BSL-1 is the basic level of protection and is appropriate when working with agents that are not known to cause disease in normal healthy humans. BSL-1 requires the lowest level of containment and safety guidelines, which are entirely based on standard laboratory practices, e.g. laboratories that do not work with disease-causing agents or specimens from humans such as school laboratory. Organisms handled in this level are in risk group 1.

4.3.2 BSL-2

BSL-2 is appropriate when working with moderate-risk agents that cause human disease of varying severity where transmission is by ingestion, percutaneous or mucous membrane exposure. Most clinical diagnostic laboratories are in this level. Agents may be handled on open benches, especially if primary barriers, such as facemasks, gowns, and examination gloves are used appropriately. Some procedures may require enhanced containment which includes unidirectional air flow (Air flows from low hazard to higher hazard areas no recirculation of air to other areas of the building the building is permitted), the use of biological safety cabinets (BSCs) and safety centrifuges. Laboratory personnel must be trained in the use of equipment, personal protective gear and related SOPs. Organisms handled in this level are in risk group 2

4.3.3 BSL-3

BSL-3 is appropriate for work with indigenous or unusual agents that have a known potential for aerosol transmission and that can cause serious and potentially fatal infections such as TB or varicella (chicken pox). BSL-3 is an enhanced level 2 with additional features to prevent transmission of infectious organisms which include unidirectional airflow, appropriate respiratory protection, HEPA filtration of exhausted laboratory air and strictly controlled laboratory access. Laboratory personnel must be trained in the use of equipments, personal protective gear and related SOPs. Organisms handled in this level are in risk group 3

4.3.4 BSL-4

BSL-4 is designed for use with exotic agents that have the potential for aerosol transmission, often having a low infectious dose and produce very serious and often life threatening disease; there is generally no treatment or vaccine available, such as hemorrhagic fever viruses. Workers who perform procedures in these laboratories require special training and they must use BSCs or wear full-body, air-supported, positive-pressure suits. In addition, the facility itself must be totally isolated from other laboratories and have specialized ventilation and waste-management systems. Laboratory personnel must be trained in the use of equipment, personal protective gear and related SOPs Organisms handled in this level are in risk group 4

Caution: When selecting BSC always select A2 circulating within the room for facilities that already built. Only go for ducted BSC for new facilities where concentrated large amounts of chemicals are used, special approval must be sort to purchase this type of BSC from Biomedical Engineering department.

CHAPTER FIVE

5.0 OCCUPATIONAL HEALTH PROGRAM

5.1 Introduction

An occupational health program promotes physical, mental and social well-being of workers and provides a safe work environment. The basic objectives of a good occupational health program are:

- i. To promote health and protect employee's against health hazards in their work environment
- ii. To match the work environment with the individual, and not the individual to the work environment.
- iii. To ensure fitness to work medical assessments ascertain the physical capability of the employee to perform the duties assigned.
- iv. To implement a health surveillance programme that ensures periodic evaluation of medical status with an emphasis on prevention of exposure to occupational hazards and early detection of occupational exposures.
- v. To ensure occupational risk assessment is carried out for the work place, occupational hazards identified and preventive measures put in place to minimize exposure to staff.
- vi. To implement an exposure/accident management programme that ensures adequate
 - a. Return to work procedures,
 - b. Exposure control plans, and
 - c. Emergency procedures.
- vii. To implement an occupational and general health awareness program.
- viii. To implement periodic monitoring and evaluation of the occupational health programme.

Health care workers are exposed to various occupational hazards resulting from handling patients and samples at their work place. To minimize risk of exposure to these hazards it is important to develop an occupational health program. It is the responsibility of the employer to ensure that an operational program is in place. A sound occupational health program should address staff induction, training, fitness to work medical tests, health surveillance program, exposure/accident management plans, and incident reporting, investigation and mitigation plans.

5.2 Staff Induction and Training

5.2.1 Induction Training

This is training given to all new staff and staff transferred to a new job or position. This training shall be given within 30 days of initial employment or assignment to a new job.

Induction training shall cover the following:

- a) Introduction to the work place and facility
- b) Introduction to co-workers, and explanation of reporting structure
- c) Laboratory safety guidelines
- d) Risk assessment of work place identifying all hazards
- e) Training on specific operational procedures and manuals

5.2.2 Occupational Health Training

This is a continuous training given to staff to create awareness of occupational health hazards at the workplace. The training helps the employee to identify such hazards, understand control measures in place to minimise exposure to hazards and know the exposure management plans in place in case of exposure. This training shall be conducted annually.

Occupational health training shall including the following topics:

- i. Potential risks to health in the laboratory and facility (symptoms of disease and mode of transmission) i.e. Laboratory acquired infections (LAI) and hospital acquired infections (HAI).
- ii. Blood borne and other body fluids pathogens
- iii. Precautions to be taken to minimize aerosol formation and prevent exposure, and Hygiene requirements
- iv. Universal precautions
- v. Wearing and use of personal protective equipment (PPE) and work practices
- vi. Handling of potentially infectious materials
- vii. Prevention of incidents/accidents and steps to be taken by workers in the event of an incidents/accidents occurring (biological, chemical, electrical, fire etc hazards)
- viii. Laboratory design, organization of work flow including airflow conditions
- ix. Equipment safety

- x. Good laboratory practice
- xi. Exposure control plan
- xii. Waste handling in the laboratory

These trainings shall be conducted in modular sessions that shall include practical demonstrations. The training shall be facilitated by a competent and facility certified occupational health trainer.

5.3 Fitness to Work Medical Tests and Health Surveillance Program

In accordance with Ministry of Labor, Department of Occupational Safety and Health (DOSH) national laws (OSHA, 2007), arrangements should be made for appropriate fitness to work medical tests and health surveillance of all workers.

For laboratory workers the following shall be put in place to ensure compliance with the Act.

5.3.1 Fitness to work medical tests

This is a medical evaluation of the employee carried out by a DOSH certified occupational health doctor to ascertain the fitness of the employee to carry out the assigned tasks. This evaluation is carried out before the employee takes up the new position.

Every facility shall appoint a DOSH certified occupational health doctor to carry out fitness to work medical tests for all new appointees.

5.3.2 Health surveillance programme

This is a continuous health evaluation programme for all workers within their work environment. The evaluation is dependent on occupational health risk assessment and occupational hazards identified. For laboratory workers, this evaluation shall be done annually or after an incident that could result to exposure or at the onset of symptoms of any work-related illnesses.

Health surveillance programme shall include the following:

- a) Evaluation of employees and job duties
 - a. This will cover evaluation of fitness to work medical tests, and employee job description.

- b) Facility specific risk assessment
 - a. This will define the potential exposure and other risks based upon actual job duties.
- c) Pre-placement medical history
 - a. This will include evaluation of past medical history including
 - i. Medical, surgical, social and family history
 - ii. Allergies and sensitivities (latex, drugs, etc.)
 - iii. Previous occupation history and activity
 - iv. Medications and other treatments
 - v. Active conditions and review of major body systems
 - vi. Review and record past immunization history.

d) Fitness to work medical tests and health surveillance program records management

Every employee in the laboratory shall have a fitness to work medical tests and health surveillance file. These records shall be kept for up to 10 years following the end of occupational exposure.

All cases of disease or death identified in accordance with OSHA, 2007 as resulting from occupational exposure to biological agents shall be notified to the competent authority (DOSH) through the Biosafety and Biosecurity committee in writing.

5.4 Exposure/Accident Management Plans, and Incident Reporting, Investigation and Mitigation Plans

Occupational accidents and exposures cost many institutions large sums of money in compensation and also lost work time due to low staff morale resulting from such accidents and exposures. Implementing adequate accidents/exposure management plans and establishing clear procedures for accidents/exposure reporting, investigation and mitigation helps the institution to recover quickly from loss resulting from accidents and exposures.

5.4.1 Exposure/Accident Management Plans

a) Occupation exposure

Occupational exposures include radiation, electrical, chemical explosions, fire, mechanical, physical and biological. Biological exposures result from exposure to biological hazards, and can result from percutaneous injury (needle-stick or other sharps injury), mucocutaneous splashing (splashing of blood or other body fluids into the eyes, nose, or mouth), specimen contact with intact or non-intact skin, or respiratory exposure by inhalation.

Health care workers are at risk of exposure. The risk shall depend on the risk assessment of the work environment and specific work activity.

b) Occupation accidents

Occupational accidents occur at the workplace or while carrying out workplace activities.

c) Occupational exposure/accident management plans

These are procedures put in place by the facility to ensure that pain and suffering resulting from all occupations exposures and accidents are minimized. These shall include the following:

- i. Training
- ii. Vaccination: Health care workers must be vaccinated against vaccine preventable diseases which include HBV, yellow fever, TB, etc.
- iii. Personal protective equipment: Health care workers must be provided with PPE that adequately protect them from the risks they are exposed to. Proper use of PPE and training is important.
- iv. Post exposure prophylaxis (PEP): There shall be a documented PEP plan in place at every health facility based on risk assessment. Proper PEP management includes incident and accident reporting, management and monitoring. Health care workers shall have access to PEP 24 hours a day and seven days a week.

Post exposure prophylaxis (PEP) interventions are prescribed in national health standards and policy documents. Current prescribed PEPs include:

- a) Human Immunodeficiency Virus (HIV)
- b) Hepatitis B Virus (HBV)
- c) Hepatitis C Virus (HCV)

- d) Tuberculosis (TB)
- e) Meningococcal Meningitis
- f) Viral Hemorrhagic Fevers

Note: PEP for specific agents keep changing, so facility management shall ensure the most current version are used.

5.4.2 Incident Reporting, Investigation and Mitigation Plans.

Reporting occupational incidents and accidents helps facilities to keep track of all occupational incidents and accidents at the facility. Proper investigation will ensure the actual cause of the incident and/or accident is identified so that adequate plans are put in place to prevent reoccurrence.

Successful implementation of these plans requires an effective biosafety committee and/or infection prevention and control committee (IPCC) with support from the hospital management team.

a) Incident/accident reporting

For the facility to effectively implement incident/accident reporting, the following shall be required:

- i. Incident/accident procedure
- ii. Incident/accident reporting tool
- iii. Incident/accident register

b) Incident/accident investigation

For the facility to effectively implement incident/accident investigation, the following shall be required:

- i. Incident/accident procedure
- ii. Incident/accident investigation tool
- iii. Incident/accident investigation report format

c) Incident/accident mitigation plans

For the facility to effectively develop and implement incident/accident mitigation plans, the following shall be required:

- i. Incident/accident risk assessment reports
- ii. Emergency response plans addressing identified likely hazards
- iii. Mitigation monitoring and evaluation tool

CHAPTER SIX

6.0 EMERGENCY PREPAREDNESS FOR BIOMEDICAL LABORATORIES

6.1 Introduction

Emergencies situation are bound to occur in work places, and biomedical laboratories are not an exception. To minimize the impact of these situations each facility shall develop an emergency preparedness and response plan. The plan shall contain the following basic components:

6.2 Emergency Preparedness and Response Plan

a. Executive Summary

The executive summary gives management a brief overview of:

- i. The purpose of the plan
- ii. The facility's emergency management policy;
- iii. Authorities and responsibilities of key personnel
- iv. The types of emergencies that could occur
- v. Where response operations will be managed.

b. Emergency Management Elements

This section of the plan briefly describes the facility's approach to the core elements of emergency management, which are:

- Direction and control
- Communications
- Life safety
- Identification of an emergency response center
- Property protection
- Community outreach
- Recovery and restoration
- Administration and logistics

These elements, which are described in detail in chapter 5, are the foundation for the emergency procedures that your facility will follow to protect personnel and equipment and resume operations.

c. Emergency Response Procedures

The procedures spell out how the facility will respond to emergencies. Whenever possible, develop them as a series of checklists that can be quickly accessed by senior management, department heads, response personnel and employees. Each facility shall develop its own checklist as per generic template in appendix 1.

Determine what actions would be necessary to:

- Assess the situation
- Protect employees, customers, visitors, equipment, vital records and other assets, particularly during the first three days
- Get the facility back up and running.

Specific procedures might be needed for any number of situations such as bomb threats or floods, and for such functions as:

- Warning employees and customers
- Communicating with personnel and external responders e.g. police, fire brigade, ambulance
- Conducting an evacuation and accounting for all persons in the facility
- Managing response activities
- Activating and operating an emergency operations center
- Fighting fires
- Shutting down operations
- Protecting vital records
- Restoring operations

d. Support Documents

Documents that could be needed in an emergency include:

- **Emergency call lists:** lists (wallet size if possible, or in mobile phones) of all persons on and off site who would be involved in responding to an emergency, their responsibilities and their 24-hour telephone numbers

Building and site maps that indicate:

- Utility shutoffs
 - Water hydrants
 - Water main valves
 - Water lines
 - Gas main valves
 - Gas lines
 - Electrical cutoffs
 - Electrical substations
 - Storm drains
 - Sewer lines
 - Location of each building (include name of building, street name and number)
 - Floor plans
 - Alarm and enunciators
 - Fire extinguishers
 - Fire suppression systems
 - Exits
 - Stairways
 - Designated escape routes
 - Restricted areas
 - Hazardous materials (including cleaning supplies and chemicals)
 - High-value items
- **Resource lists:** lists of major resources (equipment, supplies, and services) that could be needed in an emergency; mutual aid agreements with other companies and government agencies.

In an emergency, all personnel should know:

- What is my role?

- Where should I go?

e. Facilities are required to develop:

- Emergency escape procedures and routes
- Procedures for employees who perform or shut down critical operations before an evacuation
- Procedures to account for all employees, visitors and contractors after an evacuation is completed
- Rescue and medical duties for assigned employees
- Procedures for reporting emergencies
- Names of persons or departments to be contacted for information regarding the plan
- Emergency plan review
 - The plan shall be reviewed annually and after every “EVENT”.

While carrying out the review ask the following questions:

- i. What went as planned?
- ii. Where did the plan go wrong?
- iii. Why did it go wrong?
- iv. What can be improved?
- v. Where is training lacking?

6.3 Emergency Preparedness and Response Training

After the preparation of the plan all staff shall be trained as part of the implementation and thereafter staff shall be trained periodically as institution requirement, preferably annually. The training shall cover the following:

- i. Emergency response plan
- ii. Emergency drill
- iii. Employee safety
- iv. Documentation
- v. Review of the plan

CHAPTER SEVEN

7.0 DISINFECTION AND STERILIZATION

A basic knowledge of disinfection and sterilization is crucial for biosafety in the health settings as well as the community. Since contaminated items cannot be disinfected or sterilized promptly, it is equally important to understand the fundamentals of pre-cleaning. The following general principles of disinfection and sterilization apply to all known classes of microbial pathogens, with the exception of prions, which are dealt with separately in the chapter. The specific requirements for decontamination for biosafety will depend on the type of work and the nature of the infectious agent(s) being handled. Laboratories should prepare and implement a specific disinfection and sterilization protocol. For an effective disinfection protocol, consideration should be given to the microorganism being targeted, the characteristics of a specific disinfectant, and environmental issues. Additionally, the health and safety of personnel and environment are always an important consideration.

Factors to consider when selecting a disinfectant

Before selecting a disinfectant to use, there are several factors that must be considered. Some disinfectants are effective for routine disinfection protocols in the laboratory level while others are necessary for outbreak situations. For an effective disinfection protocol, consideration should be given to the microorganism being targeted, the characteristics of a specific disinfectant, and environmental issues. Additionally, the health and safety of personnel and animals are always an important consideration

7.2 Principles of Sterilization and Disinfection

7.2.1 Pre-Cleaning and Cleaning Laboratory Materials

7.2.1.1 Pre-cleaning

Pre-cleaning shall be carried out where the risk of human or animal contact with pathogen-contaminated materials is high and subsequent decontamination is required. Dirt and soil can

shield microorganisms and interfere with the killing action of chemical germicides some of which are only active on pre-cleaned items. In such cases, pre-cleaning is essential to achieve proper disinfection or sterilization. Care shall be taken during pre-cleaning to avoid exposure to infectious agents and the materials used shall be chemically compatible with the germicides to be applied later. The same chemical germicide may be used for both pre-cleaning and disinfection.

7.2.1.2 Cleaning laboratory materials

Cleaning is the removal of visible dirt and stains. This can be achieved either by:

- (a) Brushing, vacuuming or dry dusting
- (b) Washing or damp mopping with water containing detergent.

7.2.2 Disinfection

Disinfecting agents are registered by the Environmental Protection Agency (EPA) as antimicrobial pesticides and are substances used to control, prevent, or destroy harmful microorganisms (i.e., bacteria, viruses, or fungi) on inanimate objects and surfaces. These antimicrobial products have traditionally included sanitizers, disinfectants, and sterilants. Chemical disinfectants can have various effects against microorganisms. Therefore, a basic understanding of the different chemical agents is important.

a) Use of chemical germicides

There are many types of chemicals which can be used as disinfectants and antiseptics. Formulations must therefore be carefully selected for specific needs, and stored, used and disposed off as directed by the manufacturer. The germicidal activity of many chemicals is faster and better at higher temperatures. However, high temperatures can reduce their activity due to faster degradation. Particular care is therefore needed in their use and storage in tropical regions, because of high ambient temperatures. Many germicides are harmful to humans and the environment therefore they should be selected, handled and disposed off with care. For personal safety, proper PPE should be used.

Classification of Chemical Disinfectants (listed alphabetically)

Disinfectants are classified by their chemical nature and each class has its unique characteristics, hazards, toxicities and efficacy against various microorganisms. Environmental conditions, such as the presence of organic matter, pH or water hardness can also impact the action of a disinfectant. Therefore, before using any chemical disinfectant, thoroughly read and follow the label instructions.

The major classes of chemical disinfectants and their characteristics follow.

Note: The use of trade names in this material does not in any way signify endorsement of a particular product. They are only provided as examples.

i. Acids

Examples: acetic acid, citric acid. Acidic disinfectants function by destroying the bonds of nucleic acids and precipitating proteins. Acids also change the pH of the environment making it detrimental to many microorganisms. Concentrated solutions of acids can be caustic, cause chemical burns, and can be toxic at high concentrations in the air. These characteristics limit their use. The antimicrobial activity of acids is highly pH dependant. Acids have a defined but limited use as disinfectants.

Acetic acid is usually sold as glacial acetic acid (95% acetic acid) which is then diluted with water to make a working solution concentration of 5%. The concentrated form is corrosive to the skin and lungs, but the typical dilution (5%) is considered non-toxic and non-irritating. Acetic acid is typically applied by spraying, misting or immersing an item in a diluted solution. Household vinegar is a 4-5% solution of acetic acid (by volume). Acetic acid has poor activity in organic material.

ii. Alcohols

Examples: ethanol, isopropanol. Alcohols are broad spectrum antimicrobial agents that damage microorganisms by denaturing proteins, causing membrane damage and cell lysis. Alcohols are used for surface disinfection, topical antiseptic and hand sanitizing lotions. Alcohols are considered fast-acting capable of killing most bacteria within five minutes of exposure but are

limited in virucidal activity and are ineffective against spores. Ethanol is considered virucidal; isopropanol is not effective against non-enveloped viruses. An important consideration with alcohols is the concentration used, with 70-90% being optimum. Higher concentrations (95%) are actually less effective because some degree of water is required for efficacy (to denature proteins). Alcohols evaporate quickly but leave behind no residue. The activity of alcohols is limited in the presence of organic matter. Alcohols are highly flammable, can cause damage to rubber and plastic, and can be very irritating to injured skin and should not be used near open flames. Mixtures with other agents are more effective than alcohol alone, e.g. 70% (v/v) alcohol with 100 g/l formaldehyde, and alcohol containing 2 g/l available chlorine. A 70% (v/v) aqueous solution of ethanol can be used on skin, work surfaces of laboratory benches and biosafety cabinets, and to soak small pieces of surgical instruments. Since ethanol can dry the skin, it is often mixed with emollients. Alcohol-based hand-rubs are recommended for the decontamination of lightly soiled hands in situations where proper hand-washing is inconvenient or not possible. However, it must be remembered that ethanol is ineffective against spores and may not kill all types of non lipid viruses.

iii. Aldehydes

Examples: formaldehyde, glutaraldehyde. Aldehydes are highly effective, broad spectrum disinfectants, which typically achieve sterilization by denaturing proteins and disrupting nucleic acids. The most commonly used agents are formaldehyde and glutaraldehyde. Aldehydes are effective against bacteria, fungi, viruses, mycobacteria and spores. Aldehydes are noncorrosive to metals, rubber, plastic and cement. These chemicals are highly irritating, toxic to humans or animals with contact or inhalation, and are potentially carcinogenic; therefore their use is limited. Personal protective equipment (i.e., nitrile gloves, fluid resistant gowns, eye protection) should be worn if using these chemicals. Formaldehyde is used as a surface disinfectant and a fumigant and has been used to decontaminate wooden surfaces, bricks and crevices of electronic and mechanical equipment.

Its use must occur in an air tight building, which must remain closed for at least 24 hours after treatment. The efficacy of formaldehyde is dependent on relative humidity and temperature; optimum being humidity close to 70% and a temperature close to 14⁰C. Formalin is 37% solution

of formaldehyde in water. Glutaraldehyde is primarily used as a disinfectant for medical equipment (e.g. endoscopes), but can provide sterilization at prolonged contact times. A 2% concentration is used for high level disinfection. Its efficacy is highly dependent on pH and temperature, working best at a pH greater than 7 and high temperatures. It is considered more efficacious in the presence of organic matter, soaps and hard water than formaldehyde.

iv. Alkalis

Examples: sodium or ammonium hydroxide, sodium carbonate, calcium oxide.

Alkaline agents work by saponifying lipids within the envelopes of microorganisms. The activity of alkali compounds is slow but can be increased by raising the temperature. Alkalis have good microbicidal properties, but are very corrosive agents and personal protection precautions should be observed.

Sodium hydroxide (lye, caustic soda, soda ash) is a strong alkali used to disinfect buildings but is highly caustic. Protective clothing, rubber gloves, and safety glasses should be worn when mixing and applying the chemical. Lye should always be carefully added to water.

Never pour water into lye; a very violent reaction will occur as well as the production of high heat that can melt plastic containers. Sodium hydroxide is corrosive for metals.

Ammonium hydroxide is an effective disinfectant against coccidial oocysts however strong solutions emit intense and pungent fumes. This substance is not considered effective against most bacteria. General disinfection should follow the use of this compound.

v. Biguanides

Example: chlorhexidine. Biguanides are detrimental to microorganisms by reacting with the negatively charged groups on cell membranes which alters the permeability. Biguanides have a broad antibacterial spectrum, however they are limited in their effectiveness against viruses and are not sporicidal, mycobacteriocidal, or fungicidal. Biguanides can only function in a limited pH range (5-7) and are easily inactivated by soaps and detergents. These products are toxic to fish and should not be discharged into the environment.

vi. Halogens

Examples: chlorine or iodine compounds. Halogen compounds are broad spectrum compounds that are considered low toxicity, low cost and easy to use. They do lose potency over time and are not active at temperatures above 43⁰C or at high pHs (>9). Since these compounds lose activity quickly in the presence of organic debris, sunlight and some metals, they must be applied to thoroughly cleaned surfaces for disinfection.

Chlorine compounds function through their electronegative nature to denature proteins and are considered broad spectrum, being effective against bacteria, enveloped and non-enveloped viruses, mycobacteria and fungi. Chlorine is the most widely used chemical germicides in health settings. At elevated concentrations, chlorine compounds can be sporicidal. Sodium hypochlorite (NaOCl) is one of the most widely used chlorine containing disinfectants. In Kenya commercial chlorine bleach (JIK) contains 5.25% sodium hypochlorite in aqueous solution and 50,000 ppm available chlorine. Biocidal activity is determined by the amount of the available chlorine of the solution. Low concentrations (2 to 500 ppm) are active against vegetative bacteria, fungi and most viruses. Rapid sporicidal action can be obtained around 2500 ppm, however this concentration is very corrosive so should be limited in its use.

High concentrations are also irritating to the mucous membranes, eyes and skin. Chlorine compounds are rapidly inactivated by light and some metals so fresh solutions should always be used. Hypochlorites should never be mixed with acids or ammonia as this will result in the release of toxic chlorine gas.

Table for dilution of JIK

Volume of Bleach	Volume of Water	Dilution Ratio	Sodium Hypochlorite (%)	Available Chlorine (PPM)
Undiluted	0	1:0	5.25	52, 500
1	9	1:10	0.5	5,000
1	99	1:100	0.05	500

Note. Chlorine gas is highly toxic. Bleach must therefore be stored and used in well-ventilated areas only. Also, bleach must not be mixed with acids in order to avoid the rapid release of

chlorine gas. Many byproducts of chlorine can be harmful to humans and the environment, so indiscriminate use of chlorine-based disinfectants, and in particular bleach, should be avoided.

Iodine Compounds are broad spectrum and considered effective for a variety of bacteria, mycobacteria, fungi and viruses. Iodines function by denaturing proteins to interfere with the enzymatic systems of microorganisms. Iodines are often formulated with soaps and considered relatively safe. Concentrated iodine compounds can be irritating to the skin, can stain clothes or damage rubber and some metals. Iodine agents are inactivated by QACs and organic debris.

Note. Iodine can be toxic. Organic iodine-based products must be stored at 4–10 °C to avoid the growth of potentially harmful bacteria in them.

Iodophors are iodine complexes that have increased solubility and sustained release of iodine. One of the more commonly used iodophors is povidone-iodine. They are good for general use and are less readily inactivated by organic matter than elemental iodine compounds. The dilution of iodophors actually increases the free iodine concentration and antimicrobial activity.

vii. Oxidizing Agents

Examples: hydrogen peroxide, peracetic acid. Oxidizing agents are broad spectrum, peroxide based compounds that function by denaturing the proteins and lipids of microorganisms. Peroxygen compounds vary in their microbiocidal range, but are considered effective on hard surfaces and equipment. In their diluted form, these agents are relatively safe but may be irritating and damage clothing when concentrated.

Hydrogen peroxide (at a 5-20% concentration) is considered bactericidal, virucidal (non-enveloped viruses may be resistant), fungicidal and at high concentrations sporicidal. Its activity against mycobacteria is limited. Hydrogen peroxide is supplied either as a ready-to-use 3% solution or as a 30% aqueous solution to be diluted to 5–10 times its volume with sterilized water. However, such 3–6% solutions of hydrogen peroxide alone are relatively slow and limited as germicides. Products now available have other ingredients to stabilize the hydrogen peroxide content, to accelerate its germicidal action and to make it less corrosive. Hydrogen peroxide can be used for the decontamination of work surfaces of laboratory benches and biosafety cabinets, and stronger solutions may be suitable for disinfecting heat-sensitive medical/dental devices. The

use of vaporized hydrogen peroxide or peracetic acid (CH₃COOOH) for the decontamination of heat-sensitive medical/surgical devices requires specialized equipment.

Note. Hydrogen peroxide and peroxides can be corrosive to metals such as aluminum, copper, brass and zinc, and can also decolorize fabrics, hair, skin and mucous membranes. Articles treated with them must be thoroughly rinsed before contact with eyes and mucous membranes. They should always be stored away from heat and protected from light.

Peracetic acid is a strong oxidizing agent and is a formulation of hydrogen peroxide and acetic acid. It is considered bactericidal, fungicidal, sporicidal and virucidal. It is also effective against mycobacteria and algae and has some activity in the presence of organic material.

viii. Phenols

Phenols are broad spectrum disinfectants that function by denaturing proteins and inactivating membrane-bound enzymes to alter the cell wall permeability of microorganisms. Phenols can be coal-tar derivatives or synthetic formulations and usually have a milky or cloudy appearance when added to water, as well as a strong pine odor. Lysol is an example of a phenol found in health facility. Phenols are typically formulated in soap solutions to increase their penetrative powers and at 5% concentrations are considered bactericidal, tuberculocidal, fungicidal and virucidal for enveloped viruses. Phenols are not effective against non-enveloped viruses and spores. Phenols do maintain activity in hard water and in the presence of organic matter and have some residual activity after drying. Phenolic disinfectants are generally safe for humans but prolonged exposure to the skin may cause irritation.

ix. Quaternary Ammonium Compounds (QACs)

Examples: Roccal®, Zepharin®, DiQuat®, D-256®. Also known as “quats” or QACs, these compounds are cationic detergents that are attracted to the negatively charged surfaces of microorganisms, where they irreversibly bind phospholipids in the cell membrane and denature proteins impairing permeability. QACs can be from different “generations” depending on their chemistry, with later generations being more germicidal, less foaming and more tolerate to organic loads. QACs are highly effective against Gram positive bacteria, and have good efficacy against Gram-negative bacteria, fungi and enveloped viruses. They are not effective against non-

enveloped viruses or mycobacteria and are considered sporostatic but not sporocidal. QACs have some residual effect, keeping surfaces bacteriostatic for a brief time. They are more active at neutral to slightly alkaline pH but lose their activity at pH less than 3.5. QACs are considered stable in storage but are, in general, easily inactivated by organic matter, detergents, soaps and hard water (this may vary with the “generation”). QACs are toxic to fish and should not be discharged into water sources (i.e., streams, ponds, lakes).

7.2.3 Decontamination of Used Instruments, Equipment and Surfaces

Decontamination is the first step in handling used instruments, equipment and contaminated surfaces.

a. Decontamination Solution

The recommended decontamination agent is a 0.5 percent chlorine solution.

Make a fresh solution every morning, or after 8 hours, or more often if the solution becomes visibly dirty. A 0.5 percent chlorine solution can be made from readily available liquid chlorine or chlorine tablets (NaDCC).

The formula for making a dilute solution from concentrated solutions is as follows:

Total Parts (TP) water = (percentage chlorine in manufacturers concentration ÷ % desired chlorine concentration) - 1

Mix 1 part concentrated bleach solution with the total parts water required.

Example:

To make a 0.5 percent chlorine solution from 5 percent concentrated chlorine solution:

TP water: $(5.0\% \div 0.5\%) - 1 = 10 - 1 = 9$

Add 1 part concentrated solution to 9 parts water.

Cover containers containing 0.5 percent chlorine solution and protect them from light.

Note: Do not mix chlorine solutions with ammonia-based solutions, because toxic gas might be produced.

b. Decontaminating Equipment

Decontaminate large surfaces that might have come in contact with blood and body fluid, Wipe them with a cloth soaked in the 0.5 percent chlorine solution.

c. Decontaminating Used Instruments and Other Items

Keep surgical or examination gloves on after completing the procedure. Decontaminate the instruments while wearing the gloves:

- i. Immediately after use, place all instruments in an approved disinfectant, such as 0.5 percent chlorine solution, for 10 minutes to inactivate most organisms, including HBV and HIV.
- ii. Use plastic, noncorrosive containers for decontamination to prevent sharp instruments from getting dull (due to contact with metal containers) and to prevent instruments from getting rusted (due to electrolysis between two different metals when placed in water).
- iii. Remove instruments from 0.5 percent chlorine solution after 10 minutes and immediately rinse them with cool water to remove residual chlorine before thoroughly cleaning them.
- iv. Remove gloves and dispose of them appropriately.

Note: To prevent rusting, do not soak metal instruments in water for more than one hour, even if they are electroplated. Once instruments and other items have been decontaminated, they can safely be cleaned and sterilized or high-level disinfected.

7.2.4 Sterilization

Definition: This is the process of total destruction of micro organisms (bacteria, viruses, fungus, parasites, spores and endospores) from equipment or surfaces to avoid exposure to employees and the environment.

There are different types of sterilization methods.

a. Autoclaving

There are two types of autoclaving. These are used based on the type of the hazardous material to be disposed.

- **High pressure steam (Autoclaving):**

This is done under steam that raises the temperatures to 121⁰C under pressure of 106 kPa for 20 minutes if unwrapped and 30 minutes if wrapped to kill different types of Microorganisms. The time difference is to allow penetration of heat and contact time for destruction.

- **Dry heat (Oven and dry heat autoclaving)**

Dry heat is applied on the equipment such as glass ware. The temperatures applied here goes above 200⁰C to allow heat penetration to sterilize and render the equipment safe from hazardous materials. For effective sterilization the following should be observed:

- i. Temperatures of 300⁰C for 30 Minutes, 170 °C for 1 hour or 160 °C for 2 hours
- ii. The autoclave shall not be open until the cycle is completed
- iii. Start timing when the autoclave / oven reaches the desired temperature

All autoclaves must be monitored using autoclave tape for every run. Chemical indicators shall be used routinely as per the facility procedures to validate operation of the autoclave. Those that fail to achieve satisfactory results should be removed for repair or replacement. In addition, autoclave should be certified at least annually by a certified biomedical engineer.

b. Chemical soaking

For chemical soaking, refer to chemical disinfection above.

7.2.5 Prions

Prions, the etiologic agents of bovine spongiform encephalopathy and scrapie, are exceptionally resistant to disinfectants, heat, ultraviolet radiation, ionizing radiation and formalin, especially if it is in tissues, dried organic material or at a very high titer. High concentrations of sodium hypochlorite (2% available chlorine) or heated strong solutions of 2-N sodium hydroxide are

reported to inactivate these unconventional infectious agents. These agents also exhibit exceptional thermal stability and have prolonged survival when exposed to dry heat at 160°C. Autoclaving at 138°C for 18 minutes was considered effective for these agents, but is not considered reliable.

These recommended decontamination measures will reduce titers but may be incompletely effective if dealing with high titer material, when agent is protected within dried organic matter, or in tissue preserved in aldehyde fixatives. Rendering at 133°C (271 oF) at 3 bar pressure for a minimum of 20 minutes is used in Great Britain in order to dispose of the infected carcasses.

CHAPTER EIGHT

8.0 TRANSPORTATION OF BIOLOGICAL SPECIMENS AND AGENTS

8.1 Introduction

National and international, regulations shall be adhered to at all times to enable safe and secure transportation of infectious materials. Shipment of biological materials comes with a lot of challenges that emanate from poor packaging and documentation, inefficient courier, and failure to maintain cold chain system. Packaging of infectious materials must be designed properly to minimize potential exposure during transportation. It is only through adherence to the prescribed shipment procedure that the samples can reach the consignee and be analyzed at a near 'original' condition after prolonged transit period.

Before transportation of specimens, the following shall be adhered to;

- Ensure the Packaging is properly done.
- Labeling of all the packages shall include the address, biohazard, and package orientation labels.
- Transportation of the packages at the right temperature range, right time period and all other specimen requirements to ensure the integrity of the sample is maintained.
- A completely filled tracking form to ensure the samples are not lost.
- Shippers and carriers are trained on local and international regulations to properly prepare, recognize and respond to the risks posed by these materials

8.2 Packaging for Transportation

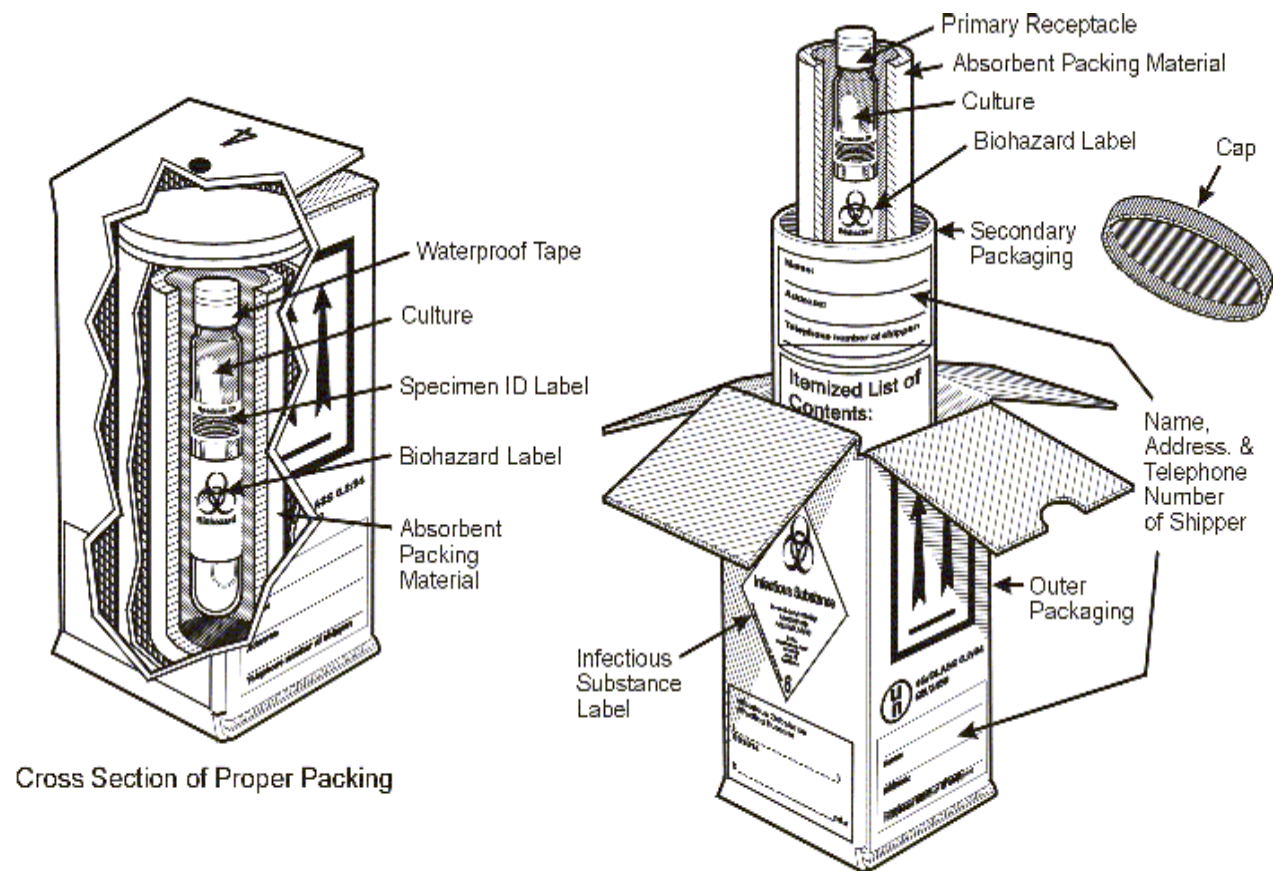
The packaging must consist of three components:

- i. A primary receptacle
- ii. A secondary packaging
- iii. A rigid outer packaging

Primary receptacles must be leak-proof and well secured with a suitable absorbent cushioning material placed between the primary receptacle and the secondary packaging. The absorbent material, such as cotton wool, must be of sufficient quantity to absorb the entire contents of the

primary receptacle(s) such that any release of the liquid substance will not compromise the integrity of the cushioning material or of the outer packaging.

The primary receptacle should then be packaged in a leak proof secondary packaging in such a way that, under normal conditions of transport, it cannot break, be punctured or leak its contents into the secondary packaging. If multiple fragile primary receptacles are placed in a single secondary packaging, they must be either individually wrapped or separated to prevent contact between them. The secondary container is then placed in a tertiary container that protects it from any physical damage while on transit.



Packing and Labeling of Infectious Substances

When packing, ensure;

- i. All specimens are handled as highly infectious
- ii. A secondary container made of a rigid, unbreakable material is used if the primary container is made of glass.

- iii. The shipment will be packed with sufficient coolant material to ensure the ambient temperatures are maintained throughout the transport. Coolant packs (stored in the refrigerator not freezer) should be used where applicable. If samples are to be sent frozen the frozen coolant material or dry ice are used.
- iv. A biohazard label is placed on the outside of the secondary container.
- v. In case of spillage/emergency during transportation the transporter/courier should contact the sender on the phone number in the mailing address.
- vi. That the correct PPE is donned prior to packaging.

8.3 Labeling Instructions

i. Ambient Diagnostic Samples.

- a. Sender and Recipient address labels with phone numbers
- b. UN3373 label
- c. Completed airway bill placed in transparent pouch

ii. Diagnostic Samples on Dry Ice

- a. Sender and Recipient address labels with phone numbers
- b. UN3373 label
- c. Dry ice, Class 9 miscellaneous label (diamond-shaped) and UN1845 label with weight in Kilograms.
- d. Completed airway bill placed in transparent pouch.
- e. Completed original Shipper's Declaration (Commercial invoice) with 3 copies.

iii. Diagnostic Samples in a LN2 shipper

- a. Sender and Recipient address labels with phone numbers.
- b. UN3373 label.
- c. Completed airway bill placed in transparent pouch.
- d. Completed original Shipper's Declaration (Commercial invoice) with 3 copies.

IMPORTANT:

- i. In case of spillage/emergency during transportation the transporter/courier should contact the sender on the phone number in the mailing address.

- ii. Staff should be trained on how to package specimen for transportation locally and internationally.
- iii. At least two members of staff should be trained on IATA guidelines and regulations and certified.

CHAPTER NINE

9.0 CHEMICAL SAFETY

9.1 Introduction

Workers in the health care facilities are exposed to chemical hazards among others. It is therefore, vital that they have proper knowledge of the toxic effects of these chemicals, the routes of exposure, and the hazards that may be associated with their handling and storage. Material safety data sheets (MSDS), which describe the hazards associated with the use of a given chemical, are available from the manufacturer, and should be made available in laboratories where these chemicals are used, e.g. as part of a safety or operations manual. All laboratories should have in place a chemical hygiene plan and "Hazard Communication.

The "Right-to-Know" law as prescribed in the OSHA, 2007 states that every employee has a right to know the properties and potential safety and health hazards of substances to which they may be exposed. The goals of Right to Know are to help reduce the risks involved in working with hazardous materials/chemical, to transmit vital information to employees about real and potential hazards of substances in the work place, to reduce the incidence and cost of illness and injury resulting from hazardous substances.

Definitions and classifications

Hazardous chemicals are often defined and classified according to regulations written for the transport of dangerous goods or by the hazards and degrees of danger they present. They may be listed by their degree of reactivity or instability, or flammability or health hazard or by toxic effects.

9.2 Routes of Exposure

Exposure to hazardous chemicals may occur in several ways:

i. Inhalation

Chemicals may cause irritation, sensitization, allergic reactions, respiratory disease or cancer.

ii. Contact

Contact with skin may cause chemical burns, conjunctivitis of the eyes, or systemic poisoning.

iii. Ingestion

Hazardous chemicals may be accidentally swallowed via mouth pipetting, or contamination of food or drinks

iv. Through broken skin

Hazardous chemicals may enter the body via cuts, abrasions or needle-sticks.

9.3 Chemical Segregation, Storage and Disposal

Chemicals are major cause of hazards at health care settings. In this regard they shall be carefully separated and grouped before storage. Chemical information is outlined in the Material Safety Data Sheet (MSDS). The grouping and storage should be based on the major chemical classes.

9.3.1 Segregation

Chemicals should be grouped based on their compatibility classes as follows:

- **Strong acids and bases:** these includes chemicals with a ph of 1-3 or 11-14 and halogens
- **Flammables:** These are chemicals with low flashpoints and they should be further segregated into organic/inorganic and irritants.
- **Oxidizers:** These are chemicals that generate their own oxygen for combustion.

If a chemical does not belong to either of the above major classes, it should be classified as either organic or inorganic based on the carbon compound content. Designate specific storage areas for each class of chemical, and return reagents to those locations after each use.

Hazardous chemicals should be aliquoted/ handled in a fume hood. The fume hood should not be used for storage.

9.3.2 Chemical Storage

- i. Store hazardous chemicals in an area that is accessible only to authorized laboratory workers
- ii. Minimize quantities and container sizes kept in the laboratory
- iii. Do not store chemicals in aisles, under sinks or on floors, desks or bench tops
- iv. Store chemicals away from sources of heat (e.g., ovens or steam pipes) and direct sunlight
- v. Never stack bottles on top of each other
- vi. Do not store chemicals above eye level(should be below 1.5m)
- vii. Store larger containers on lower shelves
- viii. Store liquids inside chemically-resistant secondary containers (such as trays or tubs) that are large enough to hold spills
- ix. Store chemicals inside closable cabinets or on sturdy shelving that has 12.7 mm-19 mm ($\frac{1}{2}$ - $\frac{3}{4}$ inch) edge guards to prevent containers from falling
- x. Ensure that chemicals cannot fall off the rear of shelves
- xi. Store chemicals based on compatibility and not in alphabetical order. If a chemical presents more than one hazard, segregate according to the primary hazard
- xii. Store volatile toxic and odorous chemicals in a way that prevents release of vapors (e.g., inside closed secondary containers, ventilated cabinets, paraffin sealing)
- xiii. Store flammables requiring refrigeration in explosion-safe or laboratory-safe refrigerators
- xiv. Flammables chemicals should be stored in flammable cabinets while corrosives in corrosive cabinets.
- xv. Label reactive or unstable chemicals (e.g., ethers) with the date of receipt and the date opened
- xvi. Develop a chemical inspection plan/procedure for every facility
- xvii. Dispose off unwanted chemicals promptly through the Waste Management Program (refer to waste management and disposal guidelines).
- xviii. Keep inventory records of chemicals, and update as per the facility procedure
- xix. Chemicals should be store in designated chemical stores. Store the minimum as need arises in the Laboratory
- xx. Use chemicals on rotational basis (Old ones first before the new batches)

Table 2 - Examples of incompatible combinations of some commonly used chemicals.

CHEMICAL	Keep from contact with:
Acetic Acid	chromic acid, nitric acid, hydroxyl compounds, perchloric acid, peroxides, permanganate
Acetylene	chlorine, bromine, copper, fluorine, silver, mercury
Alkali Metals (e.g. Sodium)	water, chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia, Anhydrous	mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium Nitrate	acids, metal powders, flammable liquids, chlorates, nitrites, sulphur, finely divided combustible materials
Aniline	nitric acid, hydrogen peroxide
Bromine	same as chlorine
Carbon, Activated	calcium hypochlorite, all oxidizing agents
Chlorates	ammonium salts, acids, metal powders, sulphur, finely divided combustible materials
Chromic Acid	acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids
Chlorine	ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Copper	acetylene, hydrogen peroxide
Flammable Liquids	ammonium nitrate, inorganic acids, hydrogen peroxide, sodium peroxide, halogens
Hydrocarbons	fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrofluoric Acid	anhydrous ammonia, ammonium hydroxide
Hydrogen Peroxide	copper, chromium, iron, most metals or their salts, alcohols, acetone, aniline, nitromethane, flammable liquids, oxidizing gases
Hydrogen Sulphide	fuming nitric acid, oxidizing gases
Iodine	acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	acetylene, fulminic acid, ammonia
Nitric Acid	acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases
Oxalic Acid	silver, mercury
Perchloric Acid	acetic anhydride, bismuth and its alloys, organic materials

Potassium	carbon tetrachloride, carbon dioxide, water
Potassium Chlorate	sulphuric and other acids
Potassium Permanganate	glycerin, ethylene glycol, benzaldehyde, sulphuric acid
Silver	acetylene, oxalic acid, tartaric acid, ammonia compounds
Sodium Peroxide	alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulphuric Acid	potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)

9.3.3 Disposal

Chemicals should be disposed off safely based on the institution guidelines or policies. The disposal methods are as follows:

- **Neutralization:** Strong acids should be neutralized by recommended alkaline to a pH between 6 and 8. These can be disposed off the drain if the volumes are low. Strong alkalines should be neutralized by water to a pH 6-8 and disposed off the same way. Chemical disposal should be documented
- **Flammables:** Shall be burned in a quality controlled incinerator as per facility guidelines
- **Oxidizers:** Some of the oxidizers can be neutralized while others are disposed off in a thermal oxidizer where the chemical is atomized into a non-poisonous powder.
- **Radioactive:** These should be stored until their half-life is attained.
- **Mercury:** Mercury should be disposed off after neutralization using a mercury spill kit.
NB: Specific disposal procedures shall be defined in the chemical hygiene plan. There should be minimal/ no use of mercury thermometers and blood pressure machines

9.4 Chemical Spill Management

9.4.1 Classification of Spills

There are three main classifications of spills. They are chemical, biological and radiological spills.

9.4.1.1 Chemical Spills

Individuals should be aware of the type of chemicals they are working with in a health care facility. Advance planning and training on how to respond safely to chemical spills should be done to avoid infections, injuries, fire and damage to property. Chemical spill disinfection and clean up should only be done by trained personnel. Spill kits with instructions, absorbents, reactants, and protective equipment should be available to clean up spills as outlined below.

a. Minor Chemical Spills

A minor chemical spill is one that the laboratory staff is capable of handling safely without the assistance of a safety and emergency personnel. The spill is less than 500ml.

In the event of a minor chemical spill;

- Alert people in immediate area of spill and put a warning sign if appropriate.
- Wear protective equipment, including safety goggles, respirators, gloves, and long sleeved lab coat.
- Avoid breathing vapor from the spill.
- Remove visible materials using a cloth soaked in 0.5% chlorine solution working from outside to inside.
- If the hazardous chemical is in powder form, carefully sweep into a dust pan. Avoid vigorous sweeping or other actions which might generate respirable dust.
- Any broken material should be picked up using forceps and discarded into the safety box.
- Clean the spill area with water for total neutralization.
- Contaminated cleanup materials can then be disposed off as chemical waste.

b. Major Chemical Spill

A major chemical spill contains a spill of 500ml or more. In case of a spill on the body, an accident/Injury reporting form should be completed and a copy forwarded to the institutional safety officer/ supervisor

You should follow the guide below for major spills;

- Alert people in the immediate area of spill to evacuate and put a warning sign.

- Attend to injured or contaminated persons and remove them from exposure.
- If spilled material is flammable, turn off ignition and heat sources, cover completely with absorbent material for 30 minutes to allow fumes and particulate matter to settle, mop up the solution and clean with water.
- Report as per your facility guidelines
- Close doors to affected area if possible

c. For Chemical Spill On the Body;

- Flood exposed area with running water from faucet or safety shower for at least 15 minutes
- Remove contaminated clothing and shoes immediately
- Make sure chemical has not accumulated in shoes
- Obtain medical attention, if necessary.
- Report as per your facility guidelines

9.5 Chemical Hygiene Plan (CHP)

This refers to outline procedures to protect employees from health hazards associated with chemicals. It shall follow the OSHA, 2007 guidelines. It shall include and not limited to:

- Occupational health surveillance
- Copies of job hazard analysis
- Annual CHP inspection
- Chemical Inventory
- Required CHP Elements
- MSDS
- Chemical Storage
- PPE
- Engineering and ventilation controls
- Job hazard analysis/ risk assessment report

9.5.1 Required Chemical Hygiene Plan Elements

- i) Standard operating procedures relevant to safety and health considerations for each activity involving the use of hazardous chemicals.
- ii) Criteria that the employer will use to determine and implement control measures to reduce exposure to hazardous materials [i.e., engineering controls, the use of personal protective equipment (PPE), and hygiene practices] with particular attention given to selecting control measures for extremely hazardous materials.
- iii) A requirement to ensure that fume hoods and other protective equipment are functioning properly and identify the specific measures the employer will take to ensure proper and adequate performance of such equipment. The fume shall be ducted outside the Laboratory. Recirculation fume hoods shall not be encouraged due to hazards posed by different chemicals.
- iv) Information to be provided to laboratory personnel working with hazardous substances include:
 - The contents of the Laboratory standard and its appendices.
 - The location and availability of the employer's CHP.
 - The permissible exposure limits (PELs) for OSHA, 2007 regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard.
 - The signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
 - The warning signs and properties presented by different chemicals in place
 - The location and availability of known reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, the Material Safety Data Sheets received from the chemical supplier.
 - The measures workers can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect workers from exposure to hazardous chemicals, such as appropriate work practices,
 - Emergency procedures and personal protective equipment to be used.

- The applicable details of the employer's written CHP.
- v) The circumstances under which a particular laboratory operation, procedure or activity requires prior approval from the employer or the employer's designee before being implemented.
- vi) Designation of personnel responsible for implementing the CHP, including the assignment of a Chemical Hygiene/biosafety Officer and, if appropriate, establishment of a Biosafety and Biosecurity Committee.
- vii) Provisions for additional worker protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances that have a high degree of acute toxicity. Specific consideration must be given to the following provisions and shall be included where appropriate:
 - Establishment of a designated area.
 - Use of containment devices such as fume hoods or glove boxes.
 - Procedures for safe removal of contaminated waste.
 - Decontamination procedures
- viii) The Safety Manager must review and evaluate the effectiveness of the CHP at least annually and update it as necessary.
- ix) The vendor shall provide MSDS together with the chemicals. If the procured chemicals lack MSDS, employees are at liberty to refuse working with that chemical. The vendor shall provide it within two weeks upon requisition or obtain it on the vendor's web site. Note: The MSDS shall be obtained from the same company not different due to variations in percentages of hazardous ingredients.

9.6 Employee Training

- a) Training shall be conducted:
 - a. Within 30 days of initial employment or assignment to a new job.
 - b. Whenever new hazards are introduced to the workplace
 - c. Annually.
- b) Employees must be informed of:
 - a. The Right to Know Law
 - b. Chemicals in the Work Place

c. Location and Availability of Material Safety Data Sheet

c) Training must cover:

a. How to Use and Understand a Material Safety Data Sheet.

b. Physical and Health Hazards.

c. Measures for Personal Protection.

d. Chemical Hygiene Plan.

CHAPTER TEN

10.0 FIRE SAFETY

Laboratory fires can be caused by Bunsen burners, chemical spills reactions, electrical heating units, failure of unattended or defective equipment, or overloaded electrical circuits. These fires cause the highest number of major accidents in the facility. Implementation of an effective fire safety program minimizes the fire impact. The component of an effective fire safety program is as follows;

- i. Fire safety and evacuation plan
- ii. Staff fire safety training plan
- iii. Fire extinguisher training
- iv. Train fire marshals
- v. firefighting equipment located at appropriate points
- vi. Emergency exits and evacuation routes.
- vii. Fire assembly points
- viii. Emergency contacts

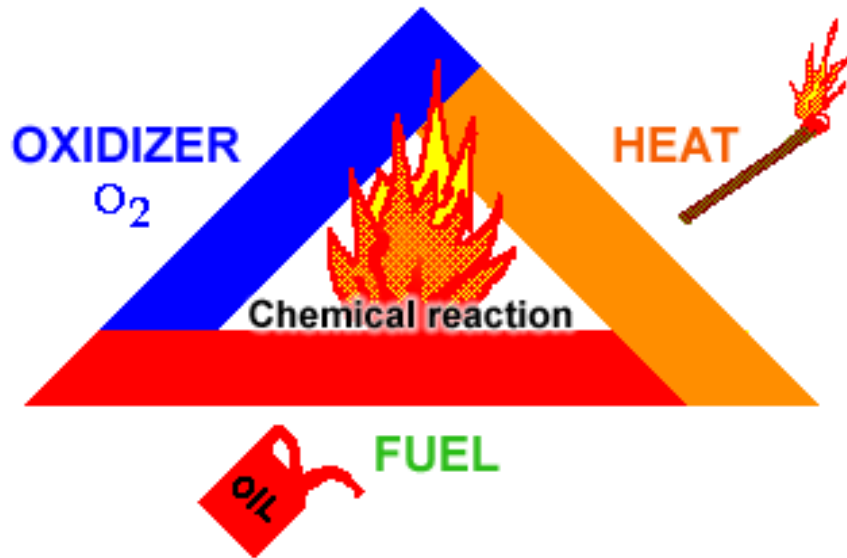
Conduct regular fire drills regularly at the minimum annually. In the event that the general alarm is sounded use the evacuation routes established for your area and follow the instructions of the Evacuation Monitors. Once outside of the building, move away from the doors to enable others to exit.

10.1 The Fire Triangle

Oxygen, heat, and fuel are frequently referred to as the "fire triangle." Add in the fourth element, the chemical reaction, and you have a fire "tetrahedron." It is important to remember: remove one of these four elements, and you will not have a fire or the fire will be extinguished.

Essentially, fire extinguishers put out fire by taking away one or more elements of the fire triangle/tetrahedron.

Fire safety, at its most basic, is based upon the principle of keeping fuel sources and ignition sources separate.



10.2 Classes of Fire

The National Fire Protection Association (NFPA) has defined four classes of fire, according to the type of fuel involved. These are:

- i. *Class A* fires involve combustibles such as paper, wood, cloth, rubber and many plastics.
- ii. *Class B* fires entail burning of liquid fuels like oil-based paints, greases, solvents, oil and gasoline.
- iii. *Class C* fires are of electrical origin (fuse boxes, electric motors, wiring).
- iv. *Class D* fires encompass combustible metals such as magnesium, sodium, potassium and phosphorus.

10.3 Fire Extinguishers

Different types of fire extinguishers are designed to fight different classes of fire. Familiarize yourself with the fire class ratings and the type of the extinguishers to be used in your different work area. It is important so that you will know what types of fire you can attempt to extinguish with them. Each facility is required at the minimum The three most common types of fire extinguishers are:

- i. **Water (APW)** Contain water and compressed air and should be used only on Class A fires

- ii. **Carbon Dioxide (CO₂)** Contains CO₂ and are most effective on Class B and C fires
- iii. **Dry Chemical (ABC, BC, DC)** Rated for multipurpose. Can use on all Class fires. It is natural for a person to use the extinguisher located nearest to a fire. This makes it essential that the correct type and size be placed in close proximity to a potential hazard. Facility personnel should be trained on how to use the extinguisher and the evacuation plan.

10.4 Preventing Fires

The following precautions should be observed when working with or using flammable chemicals in a laboratory. Note that they also apply to flammable chemical waste.

- i. Minimize the quantities of flammable liquids kept in the laboratory.
- ii. Do not exceed the maximum container sizes specified by the National Fire Protection Association (NFPA), as listed in Except for the quantities needed for the work at hand; keep all flammable liquids in NFPA- or fire proof cabinets, approved flammable liquid storage cabinets. Keep cabinet doors closed and latched at all times. Do not store other materials in these cabinets.
- iii. Use and store flammable liquids and gases only in well-ventilated areas. Use a fume hood when working with products that release flammable vapors
- iv. Keep flammable solvent containers, including those for collecting waste, well capped. Place open reservoirs or collection vessels for organic procedures like HPLC inside vented chambers.
- v. Store flammable chemicals that require refrigeration in "explosion-safe" (non-sparking) laboratory refrigerators.
- vi. Keep flammable chemicals away from ignition sources, such as heat, sparks, flames and direct sunlight. Avoid welding or soldering in the vicinity of flammables.
- vii. Bond and ground large metal containers of flammable liquids in storage. To avoid the build-up of static charges, bond containers to each other when dispensing.
- viii. Use portable safety cans for storing, dispensing and transporting flammable liquids.
- ix. Clean spills of flammable liquids promptly.

10.5 Rules for Fighting Fires

Fires can be very dangerous and you should always be certain that you would not endanger yourself or others when attempting to put out a fire. For this reason, when a fire is discovered:

- i. Assist any person in immediate danger to safety, if it can be accomplished without risk to you.
- ii. Activate the building fire alarm system or give notice that a fire has occurred.
- iii. After activation, if the fire is small, you may attempt to use an extinguisher to put out the fire using **PASS**.

10.5.1 How to Use a Fire Extinguisher

It is easy to remember how to use a fire extinguisher if you can remember the acronym **PASS**, which stands for Pull, Aim, Squeeze, and Sweep.

- i. **Pull the pin**-This will allow you to discharge the extinguisher.
- ii. **Aim at the base of the fire**- If you aim at the flames (which is frequently the temptation), the extinguishing agent will fly right through and do no good. You want to hit the fuel at the base of the fire.
- iii. **Squeeze the top handle or lever**- This depresses a button that releases the pressurized extinguishing agent in the extinguisher.
- iv. **Sweep from side to side**- Until the fire is completely out. Start using the fire extinguisher from a safe distance, then move forward. Once the fire is out, keep an eye on the area in case it re-ignites.

Note: Only use PASS when safe to do so.

10.5.2 How to Respond In Case of a Fire

● Evacuation

In case of a fire:-

- i. Sound the alarm, this could be by pulling the fire alarm bell or cry out FIRE! FIRE! Aloud
- ii. In the event that the general alarm is sounded.
 - a. Follow the evacuation routes established for your area

- b. Do not use the elevators.
 - c. Do not run
 - d. Follow the instructions of the Evacuation Monitors.
 - e. When outside the building, move away from the doors to the designated assembly point.
- iii. Assisting other personnel

In summary one shall use “**RACE**” which is an acronym for:

R=Rescue persons in danger (this can be done without putting your life in danger.)

A=Activate or sound alarm

C=Confine the fire by closing doors and windows

E=Extinguish the fire with the nearest fire appropriate fire extinguisher

NEVER FIGHT A FIRE IF:

- i. **You don't know what is burning.** If you don't know what is burning, you don't know what type of extinguisher to use. Even if you have an ABC extinguisher, there may be something in the fire, which is going to explode or produce highly toxic smoke.
- ii. **The fire is spreading rapidly beyond the spot where it started.** The time to use an extinguisher is in the incipient, or beginning, stages of a fire. If the fire is already spreading quickly, it is best to simply evacuate the building, closing doors and windows behind you as you leave.
- iii. **You don't have adequate or appropriate equipment.** If you don't have the correct type or large enough extinguisher, it is best not to try to fight the fire.
- iv. **You might inhale toxic smoke.** If the fire is producing large amounts of smoke that you would have to breathe in order to fight it, it is best not to try. Any sort of combustion will produce some amount of carbon monoxide. These gases can be fatal in very small amounts.

- v. **Your instincts tell you not to.** If you are uncomfortable with the situation for any reason, do not attempt to fight the fire.

The final rule is to always position yourself with an exit or means of escape at your back before you attempt to use an extinguisher to put out a fire. In case the extinguisher malfunctions, or something unexpected happens, you need to be able to get out quickly, and you don't want to become trapped. Just remember; **always keep an exit at your back.**

IMPORTANT

- i. Know two exit routes from your health facility, office, floor, and building. Study these in advance. It is easy to become disoriented during an actual emergency.
- ii. Know the location of fire extinguishers and how to use them. Take the time to read the directions before you need to use them. Report any missing extinguishers immediately.
- iii. Make sure that emergency numbers are posted on your telephone, including your room number. If these numbers are not posted on your phone, call the Fire Safety and Biosafety officer.
- iv. Keep a flashlight in your desk for use during an emergency. Check the batteries quarterly.
- v. Report any unsafe conditions using *the incident* form and report to the Fire Safety and Biosafety officer

CHAPTER ELEVEN

11.0 ELECTRICAL SAFETY

Electrically powered equipment, such as hot plates, stirrers, vacuum pumps, electrophoresis apparatus, lasers, heating mantles, ultrasonicators, power supplies, and microwave ovens are essential elements of many laboratories. These devices can pose a significant hazard to laboratory workers, particularly when mishandled or not maintained. Many laboratory electrical devices have high voltage or high power requirements, carrying even more risk. Large capacitors found in many laser flash lamps and other systems are capable of storing lethal amounts of electrical energy and pose a serious danger even if the power source has been disconnected.

11.1 Electrical Hazards

The major hazards associated with electricity are electrical shock and fire. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

The severity and effects of an electrical shock depend on a number of factors, such as the:

- i. Pathway through the body
- ii. The amount of current
- iii. The length of time of the exposure
- iv. Whether the skin is wet or dry.

Water is a great conductor of plug electricity, allowing current to flow more easily in wet conditions and through wet skin. The effect of the shock may range from a slight tingle to severe burns to cardiac arrest. The chart below shows the general relationship between the degree of injury and amount of current for a 60-cycle hand-to-foot path of one second's duration of shock. While reading this chart, keep in mind that most electrical circuits can provide, under normal conditions, up to 20,000 milliamperes of current flow

Current	Reaction
1 Milliampere	Perception level
5 Milliamperes	Slight shock felt; not painful but disturbing
6-30 Milliamperes	Painful shock; "let-go" range
50-150 Milliamperes	Extreme pain, respiratory arrest, severe muscular contraction
1000-4,300 Milliamperes	Ventricular fibrillation
10,000+ Milliamperes	Cardiac arrest, severe burns and probable death

In addition to the electrical shock hazards, sparks from electrical equipment can serve as an ignition source for flammable or explosive vapors or combustible materials.

11.1.1 Power Loss

Loss of electrical power can create hazardous situations.

- i. Flammable or toxic vapors may be released as a chemical warms when a refrigerator or freezer fails.
- ii. Fume hoods may cease to operate, allowing vapors to be released into the laboratory.
- iii. Biosafety cabinets may cease to operate allowing aerosols be released into the laboratory
- iv. If magnetic or mechanical stirrers fail to operate, safe mixing of reagents may be compromised.

11.2 Preventing Electrical Hazards

There are various ways of protecting people from the hazards caused by electricity, including insulation, guarding, grounding, and electrical protective devices. To minimize electrical hazards, laboratory workers shall carry out the following basic precautions:

- i. Inspect wiring of equipment before each use. Replace damaged or frayed electrical cords immediately.
- ii. Use safe work practices every time electrical equipment is used.

- iii. Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- iv. Limit the use of extension cords. Use only for temporary operations and then only for short periods of time. In all other cases, request installation of a new electrical outlet.
- v. Multi-plug adapters must have circuit breakers or fuses.
- vi. Place exposed electrical conductors (such as those sometimes used with electrophoresis devices) behind shields.
- vii. Minimize the potential for water or chemical spills on or near electrical equipment.

11.2.1 Insulation

All electrical cords shall have sufficient insulation to prevent direct contact with wires. In a laboratory all cords shall be checked before use since corrosive chemicals or solvents may erode the insulation. Damaged cords shall be repaired or taken out of service immediately, especially in wet environments such as cold rooms and near water baths.

11.2.2 Guarding

Live parts of electric equipment operating at 50 volts or more (i.e., electrophoresis devices) shall be guarded against accidental contact. Plexiglas shields may be used to protect against exposed live parts.

11.2.3 Grounding

Only equipment with three-pin plugs should be used in the laboratory. The third pin provides a path to ground for internal electrical short circuits, thereby protecting the user from a potential electrical shock.

11.2.4 Circuit Protection Devices

Circuit protection devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload or short circuit in the wiring system. Ground-fault circuit interrupters, circuit breakers and fuses are three well-known examples of such devices.

Fuses and circuit breakers prevent over-heating of wires and components that might otherwise create fire hazards. They disconnect the circuit when it becomes overloaded. This overload

protection is very useful for equipment that is left on for extended periods of time, such as stirrers, vacuum pumps, drying ovens and other electrical equipment.

The ground-fault circuit interrupter, or GFCI, is designed to shut off electric power if a ground fault is detected, protecting the user from a potential electrical shock. The GFCI is particularly useful near sinks and wet locations.

11.2.5 Motors

In laboratories where volatile flammable materials are used, motor-driven electrical equipment should be equipped with non-sparking induction motors or air motors.

Avoid series-wound motors, such as those generally found in some vacuum pumps, rotary evaporators and stirrers. Series-wound motors are also usually found in household appliances such as blenders, mixers, vacuum cleaners and power drills. These appliances shall not be used unless flammable vapors are adequately controlled.

Although some newer equipment's have spark-free induction motors, the on-off switches and speed controls may be able to produce a spark when they are adjusted because they have exposed contacts. One solution is to remove any switches located on the device and insert a switch on the cord near the plug end.

The following practices may reduce risk of injury or fire when working with electrical equipment:

- i. Avoid contact with energized electrical circuits.
- ii. Use guarding around exposed circuits and sources of live electricity.
- iii. Disconnect the power source before servicing or repairing electrical equipment.
- iv. When it is necessary to handle equipment that is plugged in, be sure hands are dry and, when possible, wear nonconductive gloves and shoes with insulated soles.
- v. If it is safe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material. This precaution reduces the likelihood of accidents that result in current passing through the chest cavity.

- vi. Minimize the use of electrical equipment in cold rooms or other areas where condensation is likely. If equipment must be used in such areas, mount the equipment on a wall or vertical panel.
- vii. If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.
- viii. If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
- ix. Facilities maintenance will be informed of the arrival of new instruments and when repair and/or modifications are performed
 - a. They will check for adequate grounding and current leakage before initial use.
 - b. Will document these checks on their database and/or tags on the equipment.
- x. Call the facilities manager and maintenance immediately to examine circuits with blown fuses or opened a circuit breaker. These warn of electrical problems.
- xi. Do not store flammable materials in biological safety hoods, incubators, or refrigerators that have not been fitted with explosion-proof motors or equivalent shielding.
- xii. The facilities manager and/or laboratory safety officer will maintain documentation of inspections and repairs for each piece of equipment.
- xiii. Yearly, facilities maintenance should check each circuit supporting fixed, electrical receptacles for polarity and ground integrity.

11.2.6 High Voltage or Current

Repairs of high voltage or high current equipment should be performed only by trained electricians and/or biomedical engineers.

11.2.7 Altering Building Wiring and Utilities

Any modifications to existing electrical service in a laboratory or building must be completed or approved by either the building facility manager, an engineer from the Facilities department or the building's Special Facilities staff. All modifications must meet both safety standards and Facilities Engineering design requirements.

CHAPTER TWELVE

12.0 ERGONOMICS

12.1 Introduction

Aside from the risk of working daily with hazardous substances, laboratory personnel are also exposed to many ergonomics risk factors due to the nature of their work and the research they conduct. Ergonomics is the science of fitting workplace conditions and job demands to the capabilities of the working population. Effective and successful "fits" assure high productivity, avoidance of illness and injury risks, and increased satisfaction among the workforce. Although the scope of ergonomics is much broader, the term here refers to assessing those work-related factors that may pose a risk of musculoskeletal disorders (MSD) and recommendations to alleviate them. Laboratory-associated ergonomic risk factors are not any different from those found in the office and general industry and consist of awkward and static postures, high repetition, excessive force (frequent or heavy lifting, pushing, pulling, or carrying of heavy objects), contact stresses, vibration, cold and pinch grip, etc. The level of risk depends on the intensity, frequency, and duration of the exposure to these conditions. This can be a cause for accidents and incidents in the laboratory if not put on check.

The purpose of this section is to disseminate information, give guidelines and procedures to laboratory employers and employees, about how they can control laboratory ergonomics risk factors, improve their level of comfort while performing their jobs, and reduce the risk of acquiring occupational injuries.

12.2 Symptom Recognition

As in the case of chemical exposures, it is equally important to recognize the signs and symptoms associated with the laboratory procedure one is using. Early detection of MSD symptoms helps prevent the onset of MSD. Symptoms associated with repetitive exposure to laboratory ergonomics risk factors include low back pain, pain in the thumb, finger, wrist, forearm, elbow, neck and shoulder. Other early warning signs include burning, cramping, numbness, swelling, tingling, weakness, or fatigue.

12.3 Responsibility

12.3.1 The Employer:

Employers should implement an effective ergonomics process that:

- i. provides management support
- ii. involves employees
- iii. identifies problems
- iv. implements solutions
- v. addresses reports of injuries
- vi. provides training
- vii. Evaluates ergonomics efforts.
- viii. Promote the use of proper techniques, work practices, and equipment.
- ix. Procure ergonomically-designed furniture.
- x. Ensure adequate lighting.

12.3.2 Employees:

Many tasks performed in clinical and research laboratories; place workers at risk of muscle and joint aches and strains. It is the responsibility of the workers to evaluate their working environment and know the activities that may pose an ergonomic risk and know how to overcome them. Use the following tips to lower your exposure to risk:

General recommendations to improve Laboratory Ergonomics

- i. Store heavy objects on shelves below shoulder height whenever possible
- ii. Use a stable footstool or stepladder to reach objects stored on high shelves
- iii. Avoid twisting while carrying an object. The load should be directly in front of the worker
- iv. Store frequently used materials on shelving units which are located between knuckle and chest height
- v. Utilize rotating platforms/shelves to store material close to the worker, reducing unnecessary reaching
- vi. Increase the diameter or span of the tweezers to reduce grip force

- vii. Use anti-fatigue mats or foot rests for areas requiring prolonged standing
- viii. Use thin flexible gloves that fit properly
- ix. Use tools with padded handles or large-diameter handles to reduce required grip force
- x. Shift weight frequently when standing for a prolonged time; use a footrest to prop up one foot at a time
- xi. Vary activities. Change your position and take breaks every 20 minutes to rest muscles and increase blood flow and circulation.
- xii. Report early signs and symptoms of repetitive motion injuries.

12.4 Maintaining Proper Posture in the Laboratory:

- i. Avoid using stools with little-no back support whenever possible
- ii. Sit against the back of the chair
- iii. Use a foot rest to ensure feet are supported
- iv. Avoid head and neck extension whenever possible, adjust the workstation
- v. Use height-adjustable workstations and tables when possible
- vi. Keep elbows close to the body and shoulders relaxed while working
- vii. Keep frequently used trays and supplies within close reach
- viii. If standing for long periods, use supportive shoes and cushioned mats.
- ix. Keep your shoulders relaxed and your elbows close to your sides when working. Avoid reaching out to use instruments and work materials.
- x. Maintain neutral or aligned wrist and arm postures when working. Sit close to your work area, keep objects close, and adjust your chair to match the height of the bench.
- xi. Avoid repetitive or forceful twisting and turning motions (i.e. opening valves or adjusting microscopes). Make sure valves and knobs are clean and in good working order.
- xii. Work with your wrist in a neutral or straight position as if you were shaking hands with someone.
- xiii. Use light pressure when performing tasks such as pipetting.
- xiv. Use electronic pipettes or light touch models whenever possible.
- xv. Select equipment and tools that are the right size for your hand.

- xvi. Use padding and tubing to reduce pressure and force when working. For example, use rubber tubing on forceps to increase diameter and reduce pinch force. Soften sharp edges on work surfaces with padding.
- xvii. Use thin, flexible gloves that fit properly. Ill fitting and poorly designed gloves increase pinch and grip forces when working.

Below are tips to use in some activities in the laboratory:

- **Pipetting:**

- i. Use electronic pipettes with mixing devices whenever possible
- ii. Use light-force/light touch pipette that require little force to activate
- iii. Use shorter pipettes to reduce the elevation required by the hand to hold it
- iv. Take micro breaks every 20-30 minutes to stretch the hand and arm muscles being used
- v. Clean pipettes regularly to prevent sticking
- vi. Use multi-channel pipettes for longer duration tasks
- vii. Rotate pipetting tasks with other laboratory tasks if possible
- viii. Adjust the workstation so the pipetter doesn't have to elevate their arms while pipetting
- ix. Use minimal force when applying pipette tips
- x. Use thin-walled pipettes that fit properly and are easy to eject

- **Using a Microscope:**

- i. Take a micro break every 20-30 minutes to stretch your back and neck
- ii. Use micro breaks to rest eyes and focus on far objects to stretch eyes
- iii. Use adjustable or angled microscope stands and view pieces to avoid forward leaning
- iv. Alternate using a microscope with other laboratory tasks when possible
- v. Try to maintain a neutral spine while using a microscope
- vi. Cut-out work tables allow the technician to get closer to the microscope with a more neutral posture
- vii. When cut-out work stations are not possible, pull the microscope as close to the edge of the table as possible
- viii. Use arm rests or padding to reduce contact stress while using adjustment knobs
- ix. Use chairs with adequate lumbar support

- x. Use television or computer screens when possible to avoid use of eyepieces
- xi. Use foot rests to ensure feet are supported
- xii. Ensure adequate foot room under desk/workstation
- xiii. Tilting the seat forward may reduce need to extend head and neck while using a microscope

- **Workstation Design:**

- i. Sitting or standing, the height of table should encourage the elbow to relax at 90 degrees
- ii. While sitting, height of table should be level with the belly button
- iii. Location of workbench should be minimal distance from other necessary tools
- iv. Workbench height should be adjustable to accommodate the variance in individual height
- v. Workbench height should be adjusted for the type of work:
 - a. light work: at elbow height
 - b. hard work: below elbow height
 - c. precision work: above elbow height

- **Working in Biosafety Cabinets, Fume hoods and Glove boxes:**

- i. Remove false fronts and supplies from under the work area
- ii. Use anti-fatigue floor mats if standing for long periods
- iii. Adjust your chair height so your bellybutton is level with the height of the work surface
- iv. Ensure adequate room under biosafety cabinet/fume hood to stretch legs
- v. Avoid resting your forearms on hard edges, pad the edges or wear elbow pads
- vi. Position work supplies as close as possible
- vii. Place equipment on approved turntables for easy retrieval
- viii. Use diffused lighting to limit glare if available
- ix. Utilize non-glare glass windows or adjustable plexiglass when possible
- x. Utilize job enlargement and spread the biosafety cabinet/fume hood duties over the entire day
- xi. Take micro breaks every 20-30 minutes to stretch muscles and relieve forearm and wrist pressure

- **Microtomes and Cryostats:**
 - i. Lower the workstation to keep arms closer to body
 - ii. Apply padding to the front edge of work surface to eliminate contact stress
 - iii. Retrofit the existing handle with an adapter that will allow the operator to use the hand wheel in a pistol grip position. This will alleviate repetitive wrist flexion and extension
 - iv. Consider the use of an automatic foot pedal instead of using the hand wheel
 - v. Avoid placing utensils such as forceps inside the cryostat
 - vi. Take frequent micro breaks to stretch the hand and forearm muscles
 - vii. Reduce force while operating the hand wheel
 - viii. Use motorized cutting
 - ix. Adjust the feed wheel position to reduce stress

- **Cell Counters:**
 - i. Consider purchasing light touch counters or cell counters with soft keys, these encourage faster counting and decrease hand fatigue
 - ii. Utilize job rotation and spread counting task among many people and spread the task over a longer period of time
 - iii. Pad the edge of the work surface to prevent contact stress on the forearm, wrist and elbow
 - iv. Use micro breaks every 20-30 minutes to stretch hands

- **Micromanipulation and Fine Motor Skills:**
 - i. If available, use plastic vials with fewer threads, reducing twisting motions during capping and uncapping lids
 - ii. Use small pieces of foam to prevent soreness on the fingertips where fingers and forceps articulate. The foam will distribute the force over a greater surface area, reducing the compressive forces on the soft tissue
 - iii. Practice using the forceps between the index and middle finger instead of the thumb and index finger. Then try alternating between the two positions to reduce the use of the thumb
 - iv. Tilt storage bins toward the worker to reduce wrist flexion while reaching for supplies

- v. Encourage micro breaks and utilize hand exercises

- **Tips for Using a Pointing Device**

Computerized laboratory equipment, web surfing and computer use have resulted in prolonged or repetitive use of pointing devices such as mice and trackballs. Upper extremity, shoulder, and back discomfort can result from improper or prolonged use of these devices. Here are some tips to prevent problems.

- i. Keep your pointing device close to your keyboard to avoid long reach.
- ii. Select a keyboard tray large enough for your keyboard and pointing device.
- iii. Position the pointer at the same level as your keyboard. Avoid reaching over the keyboard to use your mouse.
- iv. Elevate the pointer with a small pad or book to reduce shoulder discomfort.
- v. Consider using a mouse bridge to position your mouse over your 10-key pad, if unused.
- vi. Use your hand, wrist, and forearm as a unit. Your wrist and hand should work as an extension of your forearm.
- vii. Do not twist or move your wrist from side to side, or up and down when working.
- viii. Keep your hand relaxed. Do not hold your pointing device with a tight grip.
- ix. When not using the pointing device, let it go.
- x. Keep your fingers relaxed. Do not hold your fingers above the activation buttons when using the point device.
- xi. Keep your thumb relaxed. Do not keep your thumb in a bent position when using the pointer.
- xii. Avoid excessive thumb movements to operate a trackball. Use your fingers to spread the workload.
- xiii. Consider alternating hands if you are a high volume user. But, use caution when switching hands, and make sure the device is made for the hand you are using. Give yourself time to get used to the change.

Alternate Between Different Devices; Use Available Tools

- i. Shortcuts, keystrokes and custom settings can be helpful in reducing your workload.
- ii. Customize settings. The size, speed, and response of the pointer can be controlled for efficient operation.

- iii. Incorporate keyboard shortcuts, or alternatives, into your work techniques. The following are some commonly used shortcuts:
 - a. F1 (Help) Alt (Active the menu bar)
 - b. Esc (Close a combo box or dialog box)
 - c. Ctrl-A (Select all)
 - d. Ctrl-P (Print) Ctrl-S (Save)
 - e. Alt-Tab (Move between active screens)

- **Tips for Lifting Safely**

- i. Pre-plan; know where you are going before you lift. Choose a clear path.
- ii. Increase balance by keeping your feet shoulder width apart. One foot should be slightly forward.
- iii. Take a deep breath, and tighten your stomach muscles before you lift.
- iv. Bend at your knees and hips, not your waist. Lift using your leg muscles to reduce the load on your back.
- v. Lift up smoothly, do not jerk as you lift. Sudden movement and weight shifts can injure your back.
- vi. Face the load you are lifting.
- vii. Hold the load close to your body at waist height.
- viii. Turn with your feet, not your back, to avoid twisting when lifting.

Note: *Refer to Appendix 2 for a sample evaluation checklist to assist identify risk factors that can contribute to MSDs.*

CHAPTER THIRTEEN

13.0 Laboratory Waste Management

Waste is anything that is to be discarded. Infectious laboratory waste is a potential reservoir of pathogenic microorganisms and therefore requires appropriate safe handling. Safe management of health care waste is a key issue in controlling and reducing HAIs which includes laboratory acquired infections (LAIs). Each laboratory should have a waste management plan that entails collection, segregation, packaging, storage, transportation and disposal of waste. The plan should be able to outline the treatment of regulated and non-regulated waste from health facilities and especially laboratories. Laboratory wastes and contaminated materials represent hazards to laboratory staff, community and the environment. The uncontrolled dumping of health care waste can pose danger to the environment and community. Regulated waste includes substances that contain blood or other potentially infectious material that poses danger to humans and can cause disease.

The purpose of proper waste management is to:

- i. Minimize waste
- ii. Protect people from accidental injury
- iii. Prevent the spread of infection within health care facility (patients, clients, and HCWs)
- iv. Prevent the spread of infection to the community
- v. Safely dispose hazardous materials (HAZMATs)
- vi. Protect the environment

13.1 Types of Waste

Health care generated waste includes:

- i. General/non-infectious waste.
- ii. Sharps
- iii. Chemical waste
- iv. Pathological/anatomical waste.

- v. Blood and body fluids
- vi. Equipment effluent
- vii. Radioactive waste
- viii. Animal waste
- ix. Pharmaceutical waste

13.2 Waste Minimization

In order to minimize the amount of hazardous waste presented for disposal, it is important to follow these guidelines:

- i. *Avoid overstocking*: one of the main sources of laboratory waste is surplus stock - the result of over buying. Recent pricing arrangements with suppliers have greatly reduced the benefits of purchasing chemicals in large volumes. Also, there is little need to store large quantities of chemicals, as orders are generally shipped the day after an order is received.
- ii. *Do not accept donations of materials* that you don't plan to use. Many companies have traditionally unloaded unwanted reagents by donating them to laboratories, which eventually transfers the cost of disposal to the laboratories
- iii. *Substitute hazardous experimental materials* for non-hazardous ones. For example, use aqueous-based, biodegradable scintillation fluids whenever possible.
- iv. Dispose waste as soon it is generated to avoid stockpiling.
- v. Avoid overstocking commodities which may lead to expiry and therefore requiring disposal.
- vi. Proper commodity management practices should be implemented.

13.3 Principles of Waste Management

Waste management process will include the following:

- i. Collection
- ii. Segregation (separation)
- iii. Packaging
- iv. Treatment
- v. Storage

- vi. Transport
- vii. Disposal

i. Waste Collection

Waste collection is a component of waste management which results in the passage of waste material from the point of generation to either the point of storage, treatment or disposal; it eliminates the possibility of interaction with humans, animals or the environment hence minimizing exposures to medical waste.

During waste collection, ensure;

- Wastes do not accumulate at the point of production.
- Waste bags are tightly closed or sealed when they are about three-quarters full before transportation and should *not* be closed by stapling
- Sharps containers are puncture resistant closable, leak proof and should be sealed and disposed when $\frac{3}{4}$ full.

The following recommendations should be followed by the ancillary workers in charge of waste collection:

- Waste should be collected daily (or as frequently as required) and transported to the designated central storage site.
- Specific routes should be planned to prevent exposure of staff and patients to potential risks & to minimize the passage of waste through patient care and other clean areas.
- No bags should be removed unless they are labeled with their point of production (hospital and ward or department) and contents.
- The bags or containers should be replaced immediately with new ones of the same type.
- A supply of fresh collection bags or containers should be readily available at all locations where waste is produced.
- The person in charge should ensure that adequate supplies (3 months) are available and that procurement is timely to ensure the facility does not run out of the bags.
- Waste transportation trolleys for infectious waste and sharps should be marked with the international bio-hazard sign and only be used for infectious waste and sharps.

- The logistics staff should be specially trained for the transportation of hazardous substances.
- Procedures for the handling of accidents and spillages must be readily available
- Equipment for spillages must be available

ii. Waste Segregation

Waste segregation is the separation of different types of wastes based on risks levels. It is the initial and crucial point in waste handling process that will help determine the amount and type of waste for treatment and disposal. Designate waste at the point of origin and separate regulated waste from non regulated waste. Separate sharps and broken contaminated glass and put in rigid, puncture resistant containers. Lock/seal sharps containers when $\frac{3}{4}$ full. Health care waste shall be segregated by placing it in color-coded bags supported in bins of matching colors to minimize damage and retain spillage.

Color Coded Waste Management



iii. Packaging

Packaging of regulated waste can be described as containment of waste and is used to ensure the safety, protection of personnel and environment. This can be achieved by:-

- a. Ensuring all regulated waste is sealed properly with tape.
- b. Placing bags in upright position to prevent spillage of liquid.
- c. Storing regulated waste in approved red plastic bags that are impervious to moisture, puncture resistant, and display the distinctive biohazard symbol.
- d. Using durable reusable containers for storage of regulated waste and ensure containers are cleaned and decontaminated with approved disinfectant each time they are emptied.
- e. Using packaging that maintains its integrity during storage and transport.

iv. Treating of Infectious Waste

Infectious waste should be treated by the methods described below to render it noninfectious before disposal.

a. Autoclaving

- Autoclaves must be operated at a minimum temperature of 121° C for a minimum of 20 minutes. Holding period should be increased to 30 minutes when autoclaving blood.
- Each package of waste in a load should have autoclave tape and chemical indicator to indicate the attainment of adequate temperature and pressure conditions.
- All autoclaves must be evaluated monthly under full-load conditions for effectiveness against biological indicator that is quality controlled. Those that fail to achieve satisfactory results should be removed for repair or replacement.
- The autoclave should be certified at least annually.

Treatment by autoclaving should be done on cultures, blood and blood products before disposal

b. Chemical Treatment of Cultures

- Sodium and potassium hypochlorite at 15 percent v/v concentration are approved chemical solutions for treating surface colonies and colonies in suspensions.
- All cultures should be submerged for a minimum of 20 minutes to ensure that waste is rendered noninfectious.
- Cultures can be incinerated.

c. Rendering

This should be done on animal carcasses that are cooked at a recommended temperature into a solution before disposal.

Bulk (24-hour) urine specimens are a special case. They may be safely disposed of by directly emptying them into a sluice or pit latrine.

v. Storage of Regulated Waste

If regulated waste is not to be disposed off immediately, then it needs to be stored in a holding area. This place should at the minimum have the following:-

- a. Store waste in a designated location with limited access.
- b. Floors should be impervious to liquid and room with good ventilation to control odors.
- c. Keeping storage area clean will keep vermin and other vectors away.
- d. Post the area prominently with the universal biohazard symbol.
- e. Storage of regulated waste should be at a minimum amount of time and should be specified in the institution waste management plan.

vi. Transportation of Regulated Waste

Regulated waste has to be transported from the laboratory to the disposal location. Containers used to transport regulated waste should be marked as regulated waste immediately after packing. The universal biohazard symbol should be displayed prominently on transporting containers. Keep personnel protective equipment and disinfectant available in case of spillage. Records should be kept when regulated waste is transported and should contain at the minimum the following:

- a. Name of generating site
- b. Name of individual transporting waste
- c. Phone number and contact person at generated site.
- d. Number of bags and or boxes transported.
- e. Time of departure from generated site.
- f. Time of arrival at incineration site.

vii. Methods of Disposal of Waste:

a. Incineration

Incineration is the controlled burning of solid, liquid, or gaseous combustible wastes to unrecognized form. Incineration provides high temperatures and destroys microorganisms. It also reduces the volume of waste to be buried and is one of the recommended methods for disposing wastes. Simple incinerators can be built from locally available materials e.g. bricks, concrete blocks, or used fuel or oil drums. In general, such an incinerator is useful only for small health care facilities that do not have large quantities of infectious waste. If the health care facility is large, it is more efficient to build or install an incinerator large enough to accommodate all of the facility's waste-disposal needs. The facility should have a schedule for incineration to avoid accumulation of waste at the incinerator.

For efficient burning:

- i. Ensure the incinerator is not overloaded,
- ii. Both the chambers are functioning,
- iii. The venturi is in place and the temperature gauge is functioning.
- iv. Ensure the incinerator is quality controlled and serviced annually.
- v. Accumulated ash shall be removed from the incinerator and deposited in a land fill.

The following waste should not be incinerated:

- i. Pressurized gas containers (aerosol cans)
- ii. Large amounts of reactive chemical waste
- iii. Silver salts and photographic or radiographic wastes
- iv. Plastic containing polyvinyl chloride (blood bags, IV sets, or disposable syringes)
- v. Waste containing high mercury or cadmium content, for example, broken thermometers, used batteries, and lead-lined wooden panels

General Tips for Waste Disposal

- i. Do not push or pack regulated waste by feet or hands.
- ii. Use clearly marked containers for each type of waste to ensure optimal segregation

- iii. Containers should be located in the immediate area of use
- iv. Use heavy-duty utility gloves and appropriate PPE when handling wastes.
 - v. Decontaminate and clean heavy-duty utility gloves between uses.
 - vi. Handle wastes carefully to avoid spills or splashes.
 - vii. Always wash your hands after removing gloves and handling contaminated wastes.
- viii. Avoid transferring contaminated waste from one container to another.
 - ix. If incineration is not possible, then careful burial is the next best alternative.
 - x. Dispose off used toxic chemicals or medicine containers properly
 - xi. Rinse glass containers thoroughly with water. Glass containers may be washed with detergent, rinsed, dried, and reused.
 - xii. For plastic containers that contained toxic substances, such as glutaraldehyde, rinse three times with water and dispose off by incineration, burial, or both. These containers may be used for sharps-disposal containers, but do not reuse them for any other purpose.
- xiii. Equipment that is used to hold and transport wastes must not be used for any other purpose in the laboratory or health care facility.
- xiv. Contaminated waste containers should be cleaned each time they are emptied and non-contaminated ones whenever they are visibly soiled. Contaminated waste containers should be labeled clearly.

Contingency and Emergency Plan

If spills or damage of container are encountered during storage, handling or transporting of regulated waste the following will be done:

- i. Put on gloves, goggles and protective outer garments.
- ii. Use copious amount of disinfectant to clean up spills.
- iii. Place waste in new biohazard bags or containers and seal properly.
- iv. Contact safety officer and file report in the safety folder.
- v. When transporting regulated waste; gloves, disinfectant and adsorbent material should be carried to address any emergency spills
- vi. Disposal of all solid and liquid wastes shall be in compliance with the government's Environmental Management and Coordination Act.

Training

Trainings shall be conducted after a waste management plan has been developed and instituted.

Training shall include but not limited to the following;

- i. Explanation of waste management plan.
- ii. Assigned roles and responsibilities for implementation of the plan.
- iii. Modes of transmission and prevention of blood borne pathogens.
- iv. Location and proper use of personal protective equipment.
- v. Meaning of color codes, the biohazards symbol and precautions to follow in handling regulated waste.
- vi. Procedure to follow if needle stick or other exposure incident occurs.

CHAPTER FOURTEEN

14.0 RISK ASSESSMENT

14.1 Introduction

Risk is defined as the probability that a specific adverse event will occur in a specific time period or as a result of a specific situation. It is the combination of likelihood and consequence of a hazard being realized. Risk assessment is an important step in protecting laboratory workers, the equipments and the infrastructure, as well as complying with the law (OSHA 2007).

Risk assessment is a thorough look at the workplace to identify those things, situations, processes that may cause harm, particularly to people. After identification is made, evaluate how likely and severe the risk is; and then decide what measures should be in place to effectively prevent or control the harm from happening. A risk assessment seeks to answer four simple, related questions:

- i. Is there a need?
- ii. For action?
- iii. How bad?
- iv. How often?

Why is risk assessment important?

Laboratory workers and others have a right to be protected from harm caused by a failure to take reasonable control measures. When thinking about risk assessment in the laboratory, remember:

- **A hazard** is anything that may cause harm, such as chemicals, electricity, working with biological materials, and operating laboratory equipment etc;
- **The risk** is the chance, high or low, that somebody could be harmed by these and other hazards, together with an indication of how serious the harm could be.

The purpose of the practice of biorisk assessment is prevention and containment of related risks. Risk assessment is essential for effective implementation of a biosafety program this is through the identification of the underlying biosafety gaps that are essential in formulation of the preventive and corrective measures including selection of appropriate biosafety levels, equipment and biosafety practices that prevent work related infections.

Risk assessments are very important as they form an integral part of a good occupational health and safety management plan. They help to:

- Create awareness of hazards and risks.
- Identify who may be at risk (employees, cleaners, visitors, contractors, the public, etc).
- Determine if existing control measures are adequate or if more should be done.
- Prevent injuries or illnesses when done at the design or planning stage.
- Prioritize hazards and control measures.

Biosafety risk assessment shall be conducted in accordance with the National Biorisk assessment checklist (see Appendix) and the guidelines/principles as stipulated in the National Biosafety training curriculum

14.2 Biorisk Assessment Process

14.2.1 Initiating the Assessment

- i. The facility shall be informed at least 30 days on the plan to perform a biorisk assessment by the lead assessor/auditor. In the case of internal assessments, the facility shall develop specific schedule of the audits.
- ii. Provide the facility with the assessment tools i.e. the checklist to be used, and confidentiality commitment documents in advance

14.2.2 Formation of the Risk Assessment Team

Risk assessment shall be conducted by a team of trained biosafety assessor with a team leader identified among them.

- **Team Leader**

Qualifications

- i. Must be trained in accordance with the national biosafety biosecurity training curriculum
- ii. Demonstrate knowledge and comprehension of the national laboratory biosafety guidelines
- iii. Have demonstrable experience, skills and techniques of biosafety assessment
- iv. Have hands on experience on the areas of assessment

- v. Understand the biosafety essentials and the requirements of the national biosafety assessment checklist.
- vi. Have demonstrable leadership qualities and have a good command of the assessment process

Responsibilities

- i. Form the assessment team and develop the assessment plan
- ii. Formulate the scope of the assessment and communicate in advance to the facility
- iii. Communicate with the facility under assessment
- iv. Organize for the preliminary meetings by the assessment team when planning the assessment
- v. Ensure the availability of the assessment tools and adherence to the prerequisite assessment processes.
- vi. Being the contact person with the facility under assessment
- vii. Lead the opening meetings with the facility staff before the start of the assessment
- viii. Lead the conduct of the assessment, agree on the grading of the assessment findings and compilation of final report with recommendations
- ix. Ensure confidentiality of the assessment findings

Assessment Team Members

Qualifications

- i. Must be trained in accordance with the national biosafety biosecurity curriculum
- ii. Demonstrate knowledge and comprehension of the national laboratory biosafety guidelines
- iii. Have hands on experience on the areas of assessment
- iv. Understand the biosafety essentials and the requirements of the national biosafety assessment checklist.
- v. Have demonstrable experience, skills and techniques of biosafety assessment

Responsibilities

- i. Prepare and conduct the assessment in accordance with the schedule and leadership of the team leader

- ii. Present the documented assessment findings to the assessment team for review and inclusion in the final report
- iii. Shall maintain confidentiality of the assessment findings
- iv. Undertake any other responsibility as may be assigned by the team leader during the process.
- v. Ensure all the requirements of the assessment are available

14.2.3 Conducting the Assessment

- i. Team leader to chair the opening meeting and define the scope (areas of assessment), duration, methods, principles and purpose of the assessment
- ii. The team conducts the assessment using the stipulated assessment tools. The assessment tool shall have the follow five steps.
 - a. Identify the hazards
 - b. Decide who might be harmed and how
 - c. Evaluate the risks and decide on precaution
 - d. Record your findings and implement them
 - e. Review your assessment and update if necessary
- iii. Provide the preliminary report of the assessment findings
 - The team compiles and writes a detailed report with factual evidence traceable to the operation.
 - The team develops recommendations for preventive and corrective measures on the findings during the assessment exercise.
 - The risk assessment report is then handed to the biosafety committee for review and approval
 - A copy of the assessment report to be handed over to the facility management

The risk assessment report template should take the following table format appendix 2

14.2.4 Responsibility of the Facility Management

- i. The employer should make sure that the staff is trained and measures put in place to reduce risks in the laboratory. In all cases should make sure that the staff or their representative is involved in the process of risk assessment.

- ii. The laboratory head or designee should make sure there is a Biosafety and Biosecurity manual and policy in place, the staff is trained and it is reviewed annually. Should also with the other laboratory staff members appoint a safety officer.
- iii. Approve the risk assessment process and provide the required resources for the process
- iv. The laboratory manager shall ensure that adequate and timely risk assessments are performed and work closely with the facility's safety committee to ensure that appropriate Infection prevention control measures and other laboratory safety issues are being implemented,
- v. Once performed, risk assessments should be routinely reviewed and revised as per the established facility schedule by the biosafety committee

In laboratories, the risks are well known and the necessary control measures shall be applied. Periodically verify that the Laboratory Information Card (LIC) and other hazard warnings are current. In the laboratory, carry out weekly and/or as per the facility safety checklist inspections on the condition of the following among others:

- i. Fire extinguishers
- ii. Emergency wash devices such as eyewashes and drench hoses (run these for several minutes and update inspection tags).
- iii. First aid kit contents
- iv. Fume hood and other ventilation devices
- v. Tubing for circulating water, vacuum, gases
- vi. Chemical storage compartments

14.3 Risk Mitigation Measures

After a risk has been assessed, analyzed and managed, then measures should be put in place to prevent recurrence. This is referred to as risk management and is simply recognizing which events (hazards) may lead to harm in the future and minimizing their likelihood (how often?) and consequence (how bad?).

The preventative and control measures for work related exposure are specific to the type of hazard.

CHAPTER FIFTEEN

15.0 Biosecurity, Bioethics and Dual use Research

15.1 Introduction

The general public expects laboratory personnel to act responsibly and not to expose the community to biorisks, to follow safe working practices (biosafety) associated with practices that will help keep their work and materials safe and secure (biosecurity), and to follow an ethical code of conduct (bioethics). It is the technical and moral duty of laboratory managers and laboratory workers, with the support of national authorities, to reassure the general public, to persuade them that the activities being conducted are beneficial and necessary, and to prove that the biorisks inherent to laboratory work are controlled with appropriate safeguards to meet their expectations. Poor concentration, denial of responsibilities, inappropriate accountability, incomplete record-keeping, suboptimal facility infrastructure, refusal to acknowledge ethical considerations, lack of (or lack of respect for) codes of conduct, etc. may be at the origin of laboratory-acquired infections, loss of material and inappropriate manipulations, or even possibly intentional/ malicious misuse.

15.2 Definitions

Bioethics

Bioethics is the study of the ethical and moral implications of biological discoveries, biomedical advances, and their applications in the fields of diagnosis, genetic engineering and drug research. In this document, bioethics is one of the three components that contribute to a successful biorisk management culture.

Laboratory biosecurity

Laboratory biosecurity describes the protection, control and accountability for valuable biological materials (VBM, see definition below) within laboratories, in order to prevent their unauthorized access, loss, theft, misuse, diversion or intentional release.

Dual use research

Knowledge and technologies generated by life sciences research for peaceful purposes but that may be misused to pose a threat to public health and/or national security.

15.3 Laboratory biosecurity as a complement to laboratory biosafety

Laboratory biosafety and biosecurity mitigate different risks, but they share a common goal of keeping VBM safely and securely inside the areas where they are used and stored.

Laboratory biosafety is used to describe the containment principles, technologies and practices that are implemented to prevent unintentional exposure to pathogens and toxins, or their accidental release. This translates to understanding and routine application of Standard Precautions to protect the people working with biological materials.

Laboratory biosecurity may be addressed through the coordination of administrative, regulatory and physical security procedures and practices implemented in a working environment that utilizes good biosafety practices, and where responsibilities and accountabilities are clearly defined. Biosafety and laboratory biosecurity are complementary therefore, the implementation of specific biosafety activities already covers some biosecurity aspects.

When risk assessment is performed as an integral part of an institution's biosafety programme, information is gathered regarding the type of organisms available, their physical location, the personnel who has access to them, and the identification of those responsible for them. A laboratory biosecurity risk assessment further helps to establish whether this biological material is valuable and warrants security provisions for its protection and may be insufficiently covered through recommended biosafety practices.

Each laboratory should prepare a specific laboratory biosecurity program to manage the identified biorisks and must be represent activities of the institution's various needs. They should include input from scientific directors, principal investigators, biosafety officers, laboratory scientific staff, maintenance staff, administrators, information technology staff, law-enforcement agencies and security staff, if appropriate. A sound code of practice should be included for personnel practice. Laboratory biosecurity measures should be based on a comprehensive programme of accountability for VBM that includes:

- i. Regularly updated inventories with storage locations
- ii. Identification and selection of personnel with access
- iii. Plans of use of VBM

- iv. Clearance and approval processes
- v. Documentation of internal and external transfers within and between facilities, and of any
- vi. Inactivation and/or disposal of the material.

Likewise, institutional laboratory biosecurity protocols should include how to handle breaches or near-breaches in laboratory biosecurity including:

- i. Incident notification
- ii. Reporting protocols
- iii. Investigation reports
- iv. Recommendations and remedies
- v. Oversight and guidance through the Biosafety Committee.
- vi. How to handle discrepancies in inventory results
- vii. Describe the specific training to be offered, when and how often
- viii. The involvement, roles and responsibilities of all staff and responders
- ix. Action taken in the event of security breach

Documenting procedures to manage behavior and the interaction of workers with the facility and its equipment should also be considered. These issues should be addressed according to a goal-setting approach to make sure the objective of minimizing biorisks is reached, rather than following a prescriptive approach to demonstrate compliance to a given set of rules.

15.3.1 Laboratory biosafety vs. laboratory biosecurity

i. Similarities

Good laboratory biosafety practices reinforce and strengthen laboratory biosecurity systems. Appropriate levels of biosafety may be achieved through carefully designed and implemented work practices, even at low level health care facilities. These include among others; self-closing doors, restricted access, physical separation from traffic areas, break-resistant windows and an emergency response plan may all be common to both biosafety and laboratory biosecurity.

The availability of “reliable and adequate electricity supply and emergency lighting” as well as a “stand-by generator” helps to ensure the function of critical biosafety equipment (ventilation systems, biological safety cabinets, autoclaves, etc.), it also supports components of physical security systems that may depend on electrical supply. However, even though

biosafety and laboratory biosecurity are in most respects compatible, a number of potential conflicts exist that need to be resolved.

ii. Conflicts

In the absence of careful implementation, various aspects of biosafety may conflict with laboratory biosecurity. For example, controls that reduce unauthorized access might also hinder an emergency response by fire or rescue personnel. Mechanisms need to be established that allow entry by emergency responders but ensure uninterrupted and constant laboratory biosecurity, control, accountability and traceability of VBM. Likewise, staff members must be able to quickly and safely exit a laboratory during an emergency without at the same time allowing unrestricted access to sensitive VBM. Signage may also represent a potential conflict between biosafety and laboratory biosecurity. In the past, biohazard signs placed on laboratory doors identified the biological agents present in the laboratory. However, as a laboratory biosecurity measure to better protect sensitive VBM, the information on biohazard signs should be limited to the laboratory biosafety level, the name and telephone number of the responsible investigator, and emergency contact information. Therefore when preparing the laboratory evacuation and response plan the roles and responsibility of everybody using the laboratory including the first responders should be stated clearly and all parties trained.

15.3.2 Laboratory biosecurity programme

A comprehensive laboratory biosecurity programme involves:

- i. Identification of VBM
- ii. Associated agent-based microbiological risk assessment and laboratory biosecurity risk assessment
- iii. Bioethical and scientific analysis of research projects before they are authorized
- iv. Allocation of responsibilities and authorities among staff and facility managers
- v. Communication between parties involved
- vi. Development of and training on emergency plans; and
- vii. Tailored biosecurity training for employees of the facility and for external first responders.

All these steps should be the result of a transparent and documented reasoning process that carefully evaluates the impact of biorisk management breaches, and prepares and plans for worst-case scenarios. Individual components of this programme are described below.

15.3.3 Elements of a laboratory biosecurity plan

Laboratory biosecurity should specifically address the policies and procedures associated with physical biosecurity, staff security, transportation security, material control and information security. It should also include emergency response protocols that address security-related issues, such as specific instructions concerning when outside responders may be called (fire brigade, emergency medical personnel or security personnel), including the protocol to follow once on-site and the scope of authority of all parties involved. It is important for the laboratory security plan to anticipate the most likely situations that would require exceptional access. Just as training is essential for good biosafety practices, it is also essential to train for good biosecurity practices, particularly in emergency situations. Hence regular training of all personnel on security policies and procedures helps ensure correct implementation.

The following are the key elements of an effective biosecurity plan:

- i. Securing laboratory equipment
- ii. Physical biosecurity
- iii. Personnel management
- iv. Information security
- v. Management of laboratory biosecurity activities

15.3.4 Laboratory biosecurity risk assessment

While the backbone of the practice of biosafety is a microbiological risk assessment, effective laboratory biosecurity programmes should, in addition, perform appropriate laboratory biosecurity risk assessments, followed by the development, approval and endorsement of strategies for their management. Assessment of the suitability of personnel, training and adherence to VBM protection procedures are tools that may be used to achieve these goals. It is important that these biorisk assessment efforts be regularly re-evaluated in an ongoing program to respond to the requirements of national and institutional standards. Biorisk risk assessment has been covered extensively under chapter 14 of this guideline and also and biosecurity the curriculum.

15.4 Dual use research Potential misuse of bioscience

Bioscience research has contributed to the progress of humanity through the development of new vaccines, drugs and drug delivery mechanisms, disease diagnostics and improved understanding of human health. However, bioscience has the potential to harm if misused, i.e.

the biosciences are inherently dual-use. Although the vast majority of applications of bioscience have been used for good and peaceful purposes, the potential for harmful misuse may suggest the need for specific protective measures for laboratory facilities, the VBM they contain, the work performed, and the staff involved.

However, the potential misuse of the biosciences represents a global threat that requires a balanced approach to laboratory biosecurity, acknowledging both its risks and benefits. Such a balanced approach strives to protect the valid role and function of biological laboratories while safeguarding the VBM they may contain. A possible approach to minimizing the dual-use of materials and equipment within a facility is to give a competent biosafety and laboratory biosecurity manager/ committee the responsibility for the laboratory activities and scientific programme, in consultation with the principal investigator, for approving research projects and authorizing experiments, in compliance with national requirements and bioethical considerations. The role of the institutional biosafety committee in this context is described elsewhere in this guideline.

15.4.1 Dual-Use Research as Currently Defined

Covers laboratory activities, experiments, studies, or research that would:

- i. Enhance the harmful consequences of a biological agent, toxin or chemical by augmenting properties such as virulence, infectivity, stability, transmissibility, or the ability of the biological agent, toxin or chemical to be disseminated.
- ii. Increase the dissemination of a potentially harmful chemical or alter its absorption and pharmacokinetics to increase toxicity.
- iii. Impart resistance to a biological agent, toxin, or chemical to clinically and/or agriculturally useful preventive and treatment interventions, such as common vaccination or basic treatment.
- iv. Enable a biological agent, toxin, or chemical to evade detection methodologies.
- v. Enhance the susceptibility of a host population to the harmful consequences of a biological agent, toxin, or chemical.
- vi. Disrupt immunity or the effectiveness of an immunization or medical countermeasure or alter the host range or tropism of a biological agent, toxin or chemical.
- vii. Generate or reconstitute a biological agent, toxin, or chemical for which there are no known or widely available prevention and treatment that could evade detection or for which there is no known immunity or natural body defense.

15.5 Legitimate research, codes of conduct and codes of practice (Ethics)

The advances of science open doors to infinite possibilities to make use of acquired knowledge and techniques. National authorities and laboratory managers should be able to provide for a legislative and/or regulatory framework defining legitimate and ethical research projects and keep an oversight on laboratory activities and personnel. These have to be in consultation with the National Council for Science and Technology (NCST) which mandates the institutional Ethical committees.

NOTE: Systems and controls should be in place to avoid illegitimate or unethical research.

Researchers, laboratory workers and biosafety and laboratory biosecurity managers should communicate and collaborate, and strive to find the correct ethical balance for the activities performed. A voluntary code of conduct can be more effective than one that is imposed provided it is understood and agreed among stakeholders. The code of conduct should involve evaluation of the purpose of the work, consideration for its impact the publication of research results, and enumerate considerations and conditions for or against the publication of results that may have dual-use implications.

Appendix 1 Employee Exposure Report Form

To be completed by staff within 12 hours of incident/accident

Last Name _____ First Name: _____ Middle Initial _____

Lab/Section _____ Job Title: _____ ID/Personal No. _____

Date/Time of Exposures: _____/_____/_____

Hazard(s): _____

Type of Exposure (e.g. inhalation, ingestion, contact, fall): _____

Cause of Exposure _____

Was personal protective equipment available? Yes _____ No _____

Was personal protective equipment used? Yes _____ No _____

What type of personal protective equipment was used? _____

Severity of Exposure: (Minor, Moderate or Major) _____

Describe: _____

Attention required: 1. First Aid 2. Medical Treatment (admission, outpatient)
3. Not necessary

Did employee lose time from work? Yes No Estimate of lost time: _____

Were other employees exposed? List Names _____

How would you prevent recurrence? _____

Exposed employee's signature _____ Date _____

Supervisor's Name: _____ Signature: _____ Date _____

Appendix 2 Laboratory Ergonomic Workstation Evaluation Checklist

This checklist can help identify risk factors that can contribute to work-related musculoskeletal problems. Contact your supervisor to obtain help or assistance with issues that are identified.

Laboratory Benches:

- i. Is the height of your bench appropriate for work tasks? Precision work above elbow height; light work just below elbow height; heavy work 6 inches below elbow height)
- ii. Do you wear supportive shoes and/or have a floor mat for standing tasks?
- iii. Can you prop up a foot on a stool or ledge when standing in one spot?
- iv. Do you work at a bench cut-out?
- v. Does the bench have rounded or padded edges?

Bench Chair or Stool:

- i. Does your chair support your back while you work?
- ii. Does the seat and seatback tilt forward?
- iii. Are your feet on the floor, a foot-ring or a footrest?
- iv. If you have armrests, can they be adjusted to support your arms when working?

Microscopes

- i. Can you view the eyepiece while sitting in an upright position?
- ii. Is the microscope pulled out to the edge of the workbench?
- iii. Are your arms supported and relaxed when using the microscope?

Pipetting

- i. Are electronic, light-touch, or latch mode pipettes available for intensive pipetting?
- ii. Is the pipette designed for multiple finger use (instead of only the thumb)?
- iii. Are trays, beakers and supplies placed within easy reach?
- iv. Are your wrists in a straight or neutral position when working?

Biological Safety Cabinets:

- i. Are your arms relaxed when working in the fume hood?
- ii. Are work supplies within easy reach in the cabinet?
- iii. Are vials, tubes and receptacles as low profile as possible?
- iv. Can you see your work without tilting your head and neck?
- v. Can you alternate sitting and standing while working?

Miscellaneous

- i. Can you operate your microtome with your hand in a pistol grip position?
- ii. Do you alternate fingers when using pinch grips or forceps?
- iii. Are vials easy to cap and thread?
- iv. Are supplies and tools within easy reach?
- v. Are chemical and gas valves easy to reach and turn?
- vi. Are bottle dispensers and bottom dispensing carboys available to dispense liquids?
- vii. Are heavy bottles and boxes stored on low shelves?
- viii. Do you try to take a break and change tasks every 20-30 minutes?

Appendix 3 Risk Assessment Templates

I. Procedure for identifying risks

The biorisk assessment form should be completed for any activity, task, etc. before the activity begins.

Step	Action	Deliverable
1	Identify hazards and their potential for causing harm.	An inventory of hazards.
2	Rank hazards by priority	A ranked list of hazards. This list will be useful in planning further action.
4	Implement controls.	Controls are in place and functioning appropriately.
5	Measure the effectiveness of controls.	Monitor periodically to confirm controls continue to function.
6	Make changes to improve continuously.	Monitor for improvements.

II. Sample of a biorisk assessment form

The following is a sample. Be sure to customize it for your needs at your workplace.

Facility Name and Address	
Name of person doing assessment:	
Date:	
Activity / Procedure being assessed:	
Known or expected hazards associated with the activity:	
The risk of injury and its severity likely to arise from these hazards:	
Who/What is at risk?	
Measure to be taken to reduce the level of risk:	
Training prerequisites:	
Level of risk remaining:	
Action to be taken in an emergency:	
References, if any:	
Signature of Assessor:	

Adapted from Canadian Centre for Occupational Health & Safety (1997-2012)

Appendix 4

Kenya National biosafety checklist

County:					
District:					
Laboratory's (Facility) Name:					
Total number of laboratory personnel:					
Assessors Name:					
Date of assessment:					
Answer each question under the appropriate column.					
SAFETY CHECKLIST QUESTIONS (For each yes award marks as indicated)					
Laboratory premises and facility design	YES	NO		Comments/ description	Awarded Marks
Do the premises meet national and local building requirements(observe)					
Are the premises generally uncluttered and free from obstructions					
Are there any structural defects in floors, stairways, walls, benches and roofs?(observe)					
Is the floor and stairs slip-resistant?(observe)					
Is the working space adequate for safe operation?(observe)					
Does the laboratory have a separate room for safe phlebotomy and sample collection?(observe)					
Are the premises clean? (Observe)					
Are there hand washing sinks in each of the of the rooms?(Observe)					
Are there easily (safe to use) elbow operated water taps?					
Are benches surfaces resistant to solvents and corrosive chemicals?(observe)					
Are working benches surfaces water washable, impervious and disinfectant-proof?(observe)					
Does the laboratory have a reliable power back up system in cases of black out?					
Is there restricted access to authorized personnel?(Enquire and observe) Where there is proof of restricted access biohazard signage, Sign-In Sheets, Locked Doors, Biometric Readers, Guards, (award 2marks) Others ----- ----- ----- -----					

Availability and status of emergency support(observe)					
Total Score out of 15 points					
Observation and additional comments					
Storage Facilities	YES	NO		Comments/ description	Awarded Marks
Are storage facilities available in the laboratory?(confirm by seeing the store)					
Are storage facilities, shelves, etc. arranged so that stores are secure against sliding, collapse or falls?(Observe)					
Are the shelves clearly labeled?(Observe)					
Are storage facilities kept free from accumulations of rubbish, unwanted materials? (Observe)					
Are freezers and storage areas lockable? (Observe)					
Are ladders available in the store and are they maintained in good condition?					
Are non-slip safety rungs provided in each ladder?					
Are portable metal ladders legibly marked with signs reading “Caution do not use around electrical equipment”					
Total Score out of 4 points					
Comment on the general organization of the stores					
Sanitation and staff facilities	YES	NO		Comments/ description	Awarded Marks
Are the premises maintained in a clean, orderly and sanitary condition?(Observe)					
Is drinking-water available for use by the staffs?					
Are clean and adequate toilet (WC) and washing facilities provided separately for male and female staff?					
Is water, soap and paper/dryer towels provided?					
Are there changing rooms provided for					

male and female staffs?					
Are there lockers for street clothing for individual staff members?					
Is there a staff room for the staffs?					
Is there an adequate organization for the collection and disposal of general rubbish and waste? (Observe)					
Total Score out of 8 points					
Comment on sanitation and staff facilities					
Heating and ventilation	YES	NO		Comments/ description	Awarde d Marks
Is there a comfortable working temperature?					
Are thermometers available for monitoring room temperature?					
Are blinds fitted to windows that are exposed to full sunlight?					
Is the ventilation adequate? (Observe)					
Are there HEPA filters in the ventilation system?					
Does mechanical ventilation compromising of airflows in and around biological safety cabinets and fume cupboards?					
Do windows and doors form at least 15% of the wall?(Observe)					
Total Score out of 7 points					
comments on laboratory heating and ventilation of the lab:					
Lighting	YES	NO		Comments/ description	Awarde d Marks
Is the general illumination in the lab adequate?					
Is task (local) lighting provided at work benches?					
Are all areas well-lit, with no dark or ill-lit corners in laboratory rooms and corridors?					
Total Score out of 3 points					
Comment on the general lighting					
Services	YES	NO		Comments/ description	Awarde d Marks

Is each laboratory room provided with enough sinks, water, electricity and gas outlets for safe working?(Observe)					
Is there an adequate inspection and maintenance programme for fuses, , multiplugs and adaptors, lights, cables, pipes, etc. and is it documented?(Documented evidence required)					
Are faults equipment's corrected within a reasonable time?					
Are internal engineering and maintenance services available, with skilled engineers and craftsmen who also have some knowledge of the nature of the work of the laboratory?					
Is the access of visitors, cleaning staff, engineering and maintenance personnel to various laboratory areas controlled and documented?					
If no internal engineering and maintenance services are available, have local engineers and builders been contacted and familiarized with the equipment and work of the laboratory?					
Are all laboratory equipment's on service contract? (Documented evidence required if yes)					
Are Equipment manuals and SOP's available and are laboratory personnel trained on this?					
Are cleaning services available?					
Is the access of cleaning personnel to various laboratory areas controlled and documented?					
Is Laboratory information management system (LIMS) available and secured?					
Are staffs trained on LIMS?					
Is the lab using the data that they are generating internally to inform decisions?					
A brief description on how they are using their own data:					
Total Score out of 13 points					
Comment on services					
Laboratory biosecurity	YES	NO		Comments/ description	Awarde d Marks
What valuable biological materials are handled in your laboratory? (List them in the section provided below)					

	YES	NO		Comments/ description	Awarde d Marks
Does the lab keep an inventory of all the valuable biological materials in their custody? E.g. (Archived pathogens, vaccines, toxins etc) (see the inventory)					
Has a risk assessment been performed to define risks that a security system should protect against?					
Have acceptable risks and incidence response planning parameters been defined?					
Is the whole building securely locked when unoccupied?					
Are doors and windows break-proof?					
Are rooms containing hazardous materials and expensive equipment locked when unoccupied?					
Is access to such rooms, equipment and materials appropriately controlled and documented?					
Are policy documents on biosecurity available in the laboratory? (confirm by seeing a copy)					
Total Score out of 8 points					
Fire prevention and fire protection	YES	NO		Comments/ description	Awarde d Marks
Is there a fire alarm system?					
Are the exit doors in good order?					
Is there a fire detection system in the laboratory?					
Is the fire detection system in good working order and regularly tested?(check dates of last service)					
Are portable fire extinguishers maintained fully charged and in working order, and kept in designated places at all times??					
Do the fire extinguishers have operational and maintainace manuals available for everyone to read?					
Are the fire extinguishers serviced? (Observe the last service date and date due for next service)					
Are the staffs trained on the use of the fire extinguishers?					
Are personnel trained to respond to fire emergencies?					

Are fire alarm stations accessible?					
Are all exits marked by proper, illuminated signs?					
Are exit keys easily accessible in case of an emergency?					
Is access to exits marked where the routes to them are not immediately visible?					
Are all exits unobstructed and unlocked when the building is occupied?					
Is access to exits arranged so that it is not necessary to pass through a high-hazard area to escape?					
Do all exits lead to an open space outside the lab building?					
Are corridors, aisles and circulation areas clear and unobstructed for movement of staff and fire-fighting equipment?					
Is all fire-fighting equipment and apparatus easily identified by an appropriate color code?					
Are laboratory rooms with potential fire hazards equipped with appropriate extinguishers and/or fire blankets for emergency use?					
If flammable liquids and gases are used in any room, is the mechanical ventilation sufficient to remove vapors before they reach a hazardous concentration?					
Total Score out of 20 points					
Comments on fire prevention and fire protection					
Personal protection	YES	NO		Comments/ description	Awarde d Marks
Is protective clothing (e.g. gowns, coveralls, aprons, gloves) of approved design and fabric provided for all staff for normal work, e.g. gowns, coveralls, aprons, gloves?					
Is additional protective clothing provided for work with hazardous chemicals and radioactive and carcinogenic substances, e.g. rubber aprons and gloves for chemicals and for dealing with spillages; heat-resistant gloves for unloading autoclaves and ovens, Cryogenic gloves for unloading freezers?					
Are safety glasses, goggles and shields (visors) provided?(confirm availability)					
Are there eye-wash stations and are they checked weekly for functionality? (Observe)					

Are there emergency showers and are they checked monthly for functionality (drench facilities)?					
Are respirators available, regularly cleaned, disinfected, inspected and stored in a clean and sanitary condition?					
Are appropriate filters provided for the correct types of respirators, e.g. HEPA filters for microorganisms, appropriate filters for gases or particulates?					
Are respirators fit-tested?					
Has training on the proper use of respirators been conducted?					
Are staffs wearing proper PPE at the time of visit?(Observe)					
Total Score out of 10 points					
Comment on personal protection					
Health and safety of staff	YES	NO		Comments/ description	Awarde d Marks
Is there an occupational exposure prophylaxis program in your facility?					
Are first-aid boxes provided at strategic locations?					
Are qualified first-aiders available?					
Are such first-aiders trained to deal with emergencies peculiar to the laboratory e.g. contact with corrosive chemicals, accidental ingestion of poisons and infectious materials?					
Are post-exposure prophylaxis policies and SOPs available?(Get evidence of the documents)					
Are these SOPs posted in areas where all staffs can see?					
Are non-laboratory workers, e.g. cleaners, waste handlers and clerical staff, instructed on the potential hazards of the laboratory and the material it handles?					
Are notices prominently posted giving clear information about the location of first-aiders, telephone numbers of emergency services, etc.?					
Are women of childbearing age and immuno compromised staff warned of the consequences of work with certain microorganisms, carcinogens, mutagens and teratogens?					

Are women of childbearing age and immuno compromised staff told that if they are, or suspect that they are, pregnant/sick they should inform the appropriate member of the medical/scientific staff so that alternative working arrangements may be made for them if necessary?					
Are skin tests and/or radiological facilities available for staff who work with tuberculosis materials or other materials requiring such measures?					
Are proper records maintained of illnesses and accidents?					
Are laboratory personnel offered appropriate vaccination?					
Are proper records maintained on the immunization status of the laboratory staffs? (If present = 2marks)					
Does the lab have a person responsible for biosafety? (If present = 2marks)					
Are warning and accident prevention signs used to minimize work hazards?					
Does the lab have a safety/occurrence log?(Confirm by seeing the document)					
Are occupational injuries or illnesses documented in the safety / occurrence log?					
Are personnel trained to follow appropriate biosafety practices?					
List the trainings that the lab personnel have had related to safety and the number trained for each training:					
Is there a system of disseminating the training contents to the other members of staff in the laboratory?					
Are laboratory staffs encouraged to report potential exposures?					
Total Score out of 22 points					
Comment and observations					
Laboratory equipment	YES	NO		Comments/ description	Awarde d Marks
Are all equipment certified safe for use?					
Are SOPs available for all the equipment's?					
Are procedures available for decontaminating equipment prior to maintenance?					
Are biological safety cabinets and fume cupboards regularly tested and serviced?					
Are autoclaves and other pressure vessels					

regularly inspected?					
Are centrifuge buckets and rotors regularly inspected?					
Are HEPA filters regularly changed?					
Are pipettes used instead of hypodermic needles?					
Is cracked and chipped glassware always discarded and not reused?					
Are there safe receptacles for broken glass?					
Are plastics used instead of glass where feasible?					
Are sharps disposal containers available and being used?					
Total Score out of 12 points					
Comment based on observation					
Handling of Infectious materials	YES	NO		Comments/ description	Awarde d Marks
Are specimens received in a safe condition?					
Observe and comment on the specimen reception and phlebotomy area					
	YES	NO		Comments/ description	Awarde d Marks
Are records kept of incoming infectious materials?					
Are specimens unpacked in biological safety cabinets with care and attention to possible breakage and leakage?					
Are gloves and other protective clothing worn for unpacking specimens?(observe and enquire on the practice)					
Are personnel trained to ship infectious substances according to current national and/or international regulations? (probe for understanding on triple packaging concept)					
Are work benches kept clean and tidy? (observe)					
Are color coded bins available for waste disposal in the laboratory? (observe)					
Are color coded bin liners available in the laboratory? (observe)					
Is laboratory waste being segregated properly? (observe)					
Is the laboratory waste treated before disposal?					
Are waste handlers trained on waste management?					

	YES	NO		Comments/ description	Awarde d Marks
Are discarded infectious materials removed daily or more often and disposed of safely?					
What is the final method of laboratory waste disposal for your laboratory?					
	Total Score out of 10 points				
	Observe and comment				
	YES	NO		Comments/ description	Awarde d Marks
Are all members of the staff aware of procedures for dealing with breakage and spillage of cultures and infectious materials?					
Is the performance of sterilizers checked by the appropriate chemical, physical and biological indicators?					
Is there a procedure for decontaminating centrifuges regularly?					
Are sealed buckets provided for centrifuges?					
Are appropriate disinfectants being used and Are they used correctly?					
	Total Score out of 5 points				
	Observe and comment				
Flammable liquid storage	YES	NO		Comments/ description	Awarde d Marks
Is the storage facility for bulk flammable liquids separated from the main building?(Observe)					
Is it clearly labeled as a fire-risk area?(Observe)					
Does it have a gravity or mechanical exhaust ventilation system that is separate from the main building system?					
Are the switches for lighting sealed or placed outside the building?(Observe)					
Are the light fittings inside sealed to protect against ignition of vapor's by sparking?(Observe)					
Are flammable liquids stored in proper, ventilated containers that are made of non-combustible materials?(Observe)					

Are the contents of all containers correctly described on the labels?(Observe)					
Are appropriate fire extinguishers and/or fire blankets placed outside but near to the flammable liquid store?(Observe)					
Are “No smoking” signs clearly displayed inside and outside the flammable liquid store?(Observe)					
Are only minimum amounts of flammable substances stored in laboratory rooms?(Observe and enquire)					
Are they stored in properly constructed flammable storage cabinets?					
Are these cabinets adequately labeled with “Flammable liquid – Fire hazard” signs?					
Are personnel trained to properly use and transport flammable liquids?					
How are expired chemicals managed and disposed?					
Compressed and liquefied gases	YES	NO		Comments/ description	Awarde d Marks
Is each portable gas container legibly marked with its contents and correctly color-coded?					
Are compressed-gas cylinders and their high-pressure and reduction valves regularly inspected?					
Are reduction valves regularly maintained?					
Is a pressure-relief device connected when a cylinder is in use?					
Are protection caps in place when cylinders are not in use or are being transported?					
Are all compressed gas cylinders secured so that they cannot fall, especially in the event of natural disaster?					
Are cylinders and liquid petroleum gas tanks kept away from sources of heat?					
Are personnel trained to properly use and transport compressed and liquefied gases?					
Total Score out of 20 points					
Comment on chemical safety					
Electrical hazards	YES	NO		Comments/ description	Awarde d Marks
Are all new electrical installations and all replacements, modifications or repairs made and maintained in accordance with national electrical safety regulations?					

Does the interior wiring have an earthed/grounded conductor (i.e. a three-wire system)?					
Are circuit-breakers and earth-fault interrupters fitted to all laboratory circuits?					
Do all electrical appliances have testing laboratory approval?					
Are the flexible connecting cables of all equipment as short as practicable, in good condition, and not frayed, damaged or spliced?					
Is each electric socket outlet used for only one appliance (no adapters to be used)?					
Total Score out of 6 points					
Comment on electric safety as observed and reported					
Chemicals and radioactive substances	YES	NO		Comments/ description	Awarde d Marks
Are incompatible chemicals effectively separated when stored or handled?					
Are all chemicals correctly labeled with names, expiry dates and warnings?					
Are chemical hazard warning charts prominently displayed?					
Are spill kits provided in clearly labeled areas? (Observe)					
Are staffs trained to deal with spills?					
Are flammable substances correctly and safely stored in minimal amounts in approved cabinets?					
Are bottle carriers provided?					
Total Score out of 7 points					
Comment					
For laboratories working with radioactive materials	YES	NO		Comments/ description	Awarde d Marks
Are staffs appropriately trained to safely work with radioactive materials?					
Are proper records of stocks and use of radioactive substances maintained?					
Are radioactivity screens provided?					
Are personal radiation exposures monitored?					
Is there a spill kit to contain radiology spills?					
Total Score out of 5 points					

	Comment					
	OVERALL SCORE OUT OFF 175 (% SCORE)					
	Comments					
	General assessment comment and recommendations:					
	Supervisor	Review:	_____			
	Date:	_____				
	Assessor:	_____				
	Date:	_____				

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