UP Manila National Service Training Program (NSTP) Common Module

Title: **Environmental Awareness and Protection Module for UP Manila**

Overview: This module encompasses environmental concepts, principles, situationer, and advocacy.

Recognizing the role of education in encouraging the youth to advance the value of environmental protection, the government has enacted Republic Act no. 9512, also known as National Environmental Awareness and Education Act of 2008. This Act promotes environmental awareness through environmental education by integrating environmental education in school curricula at all levels.

At the tertiary level, environmental awareness and protection can be enhanced further through the National Service Training Program (NSTP) by involving students in public and civic concerns, to include "the promotion of the importance of conservation and ecological balance towards sustainable development."

In keeping with RA # 9512, this NSTP module on environmental awareness and protection covers the status of the environment up to the national level while placing emphasis on the importance of initiating and establishing awareness within the local community setting. Environmental concepts and principles, environmental problems and their root causes, and possible solutions/approaches based on sustainable development are presented as part of understanding stewardship towards the various sectors of the environment. Sample environmental problems (i.e., solid waste management, pollution, biodiversity loss, occupational hazards) have been included but it is within the discretion of the college or unit to tackle other relevant issues. As UP Manila is the Health Sciences Center of the University of the Philippines, this module incorporates concepts of ecohealth and discusses health-related issues interlinked with the impacts of environmental problems.

I. OBJECTIVES

1. Learning Objectives
2. Intended learning outcomes
3. A. Module Objectives

   At the end of the three-hour session, the students will be able to:

   a. Understand identified environmental issues and concerns, such as pollution and biodiversity loss, in terms of causes, effects, and mitigation measures.
   b. Recognize the current practices in addressing environmental problems.
   c. Propose a solution to an identified environmental problem.

   B. Module Outcomes

a. Identify problems and underlying factors contributing to the problem within the communities.
b. Recognize the current practices by the community in addressing the problems.
c. Determine the impacts of the identified problems to human and ecosystem health.
d. Construct information, education, and communication (IEC) materials for environmental advocacy.

II. CONTENT

1. Current state of environment (global and local setting)

A. GLOBAL ENVIRONMENT SITUATIONER

a. In this century, the present-day scenario of the environment in Planet Earth can be gleaned from the following:
   i. Population Boom
   ii. Increasing Urbanization
   iii. Intensifying Developmental Activities
   iv. Unabated, Irresponsible Resource Utilization and Depletion
   v. Rapid Environmental Degradation /habitat loss
   vi. Loss of Biodiversity
   vii. Climate Change
   viii. Emerging and Reemerging Diseases

b. Survival of humankind at risk

Humans have obviously exalted a heavy toll on the environment, jeopardizing Mother Nature and consequently, placing at high risk the survival of all organisms and mankind. The present-day state of the environment indicates the kind of creatures we have been and the kind of creatures we need to become in order to survive. Wisdom now dictates a balancing act of sustaining our economic development at the least cost to the environment—waging an environmental revolution in our minds.

Man's complacency and lack of understanding of this delicate balance in nature invariably leads to major catastrophes, such as, decreasing arable lands, groundwater depletion, waterlogging and salt built up in soils, uncontrolled deforestation, excessive soil erosion, overgrazing/overharvesting, pollution, acidification, AMDs, low biodiversity, species extinction due to habitat loss, and climate change. "Global catastrophes are happening and will continue to happen…"

c. The Tragedy of Commons

One of the reasons for these disastrous effects is that of the selfish notion that "if I won't use this resource, someone else will. The little bit I use or pollute is not enough to

matter." Given this anthropocentric world view, by 2025, it is foreseen that humankind will require the equivalent of four earths every year in order to survive. Thus, the survival of mankind entails another revolution. As we try to offset for the greed and blunders of the predecessors, we now enter the ***Sustainability Revolution.***

d. Sustainable Development

Sustainable Development entails meeting the needs of the present without compromising the ability of the future generation to meet their own needs. Its main objective is to ensure that development is a life-sustaining process. This involves the harmonious integration of a sound and viable economy, responsible governance, social cohesion and environmental integrity.

e. Approaches to achieve sustainable development

There are several approaches to achieve sustainable development. Some of these include Integrated Coastal Resource Management, Integrated Water Resource Management, Integrated Forest Resource Management, Sustainable Agriculture, Ecohealth, Women, Water and Environment, Women and Sanitation, United Nations Environment Program's Forest to the Sea/Ridge to Reef).

B. THE PHILIPPINE ENVIRONMENT SITUATIONER

The Philippines is an archipelagic country. It has an intricate network of terrestrial and aquatic ecosystems, giving rise to rich and bountiful sources of food and livelihood due to diverse habitats. Having a tropical climate, it has high precipitation and high light intensity favoring robust growth and establishment of diverse ecosystems. Owing to its high biodiversity, high species richness, high endemicity, and high species equitability, the country has become one of the 17 megacenters of biodiversity in the world. The center of the center of marine biodiversity in the world is also found in the Philippines, that is, at the Verde Island Passage Corridor (Conservation International, __). With its geologic formation and geographic location, it is also endowed with rich and diverse mineral resources. Only 1.4% of the high-potential grade minerals have been exploited.

It lies within the Pacific Ring of Fire (active volcanic and seismic region) and within the typhoon belt rendering it vulnerable to natural disasters, like volcanic eruptions, earthquakes, tsunamis, typhoons/storms surges, floods, and landslides. It is also confronted with severe major anthropogenic-caused environmental degradation.

This situation has been exacerbated by high population rate, rapid urbanization, increasing developmental activities, unsustainable agriculture/loss of agricultural lands, deforestation, soil erosion, habitat loss, decreasing or loss of biodiversity, pollution, improper solid and toxic/hazardous waste disposal, coastal resource mismanagement, overharvesting/overhunting, and climate change.

Irresponsible governance, inadequate public consultation/public participation, unsound economic policies, absence of political will, and no strict implementation of environmental laws have further aggravated the situation.

Major Philippine Environmental Laws

While there are many existing environmental laws, these are not strictly enforced or if these are, these are implemented on a selective/irregular basis. Some of the major laws include:

i. The Ecological Solid Waste Management Act / Republic Act 9003
ii. Clean Air Act / Republic Act 8749
iii. Toxic Substances, Hazardous and Nuclear Waste Law / Republic Act 6969
iv. Pollution Control Law / Presidential Decree 984
v. Environmental Impact Statement System / Presidential Decree 1586

The Department of Environment and Natural Resources (DENR) has reported the following to describe the current state of the Philippines Environment.

a. Air Quality

In Implementing the programs and policies of the Philippine Clean Air Act, the Ambient Air Quality Monitoring Network was established. This includes the Manila Observatory, Ateneo de Manila University, Valenzuela, NAMRIA in Fort Bonifacio, Air Force City Clark Development Corporation, Bureau of Plant Industry, Los Baños, Laguna, Cavite State University in Indang, Cavite, PUP Sta. Mesa, Provincial Agrovet, Brgy. Bolboc, Batangas City, Bureau of Corrections, Muntinlupa, and in Valle Verde, Pasig.

In Metro Manila, out of 1361 firms monitored in the year 2000, the top three highest emission load was TOG, carbon monoxide, nitrous oxide. This was based on the DENR National Ambient Air Quality Guidelines for Criteria Pollutants (to include TSP, PM10, sulfur dioxide, nitrous dioxide, photochemical oxidants like ozone, carbon monoxide and lead). NCR also recorded the highest Total Suspended Particulates (TSP) and sulfur oxide levels from 1973-2001. The TSP levels reaching as high as 200% were above the standards set by DENR.

DENR Secretary Ramon Paje reported last April 21, 2015 that air quality in Metro Manila is still below par. Air pollutant concentration in terms of total suspended particulates (TSP) is way above the international standard of 90 µg/Ncm. It should be noted that on top of this situation, the number of registered vehicles per year has been escalating even up to the present time.

Nonetheless, in an effort to implement the Philippine Clean Air Act (R.A. 8749) comprehensive air quality management policy and program, the DENR is currently

promoting a shift from Euro2 to Euro 4 fuel to be used by cars. The DENR noted that cars are responsible for 80% of air pollution in Metro Manila. Since Euro 4 has 10 times less sulfur content than Euro 2, cars using this fuel being promoted, have lesser contributions to photochemical smog.

b. Water Quality

The Philippines, having a tropical climate typically has high precipitation rate and high light intensity. Huge amount of rainfall favors an abundant supply of surface water and groundwater. These could have been maximized, had it been that there is a coherent environmental policy. As a consequence, deteriorating water quality becomes an additional burden. The most common water pollutants include oil, phosphates, nitrates, heavy metals, plastics, human and animal wastes, persistent organic pollutants, and suspended solids.

Of the nearly 2.2 million metric tons of organic pollution, the domestic sector has contributed 48% of these, followed by the agricultural and the industrial sectors, contributing 37% and 15% respectively.

Coliform bacteria in untreated domestic and industrial wastewater have contaminated 58% of our ground water used as drinking water. This is due to the fact that only 5% of the population is connected to a sewer system while many have flush toilet systems connected to septic tanks. In the absence of sludge treatment and disposal facilities, most effluents are discharged without any treatments, making 2/3 of the country's river systems no longer suitable as source of public water supply. In fact, Pasig River in Manila has been identified by the Asian Development Bank as one of the dirtiest rivers worldwide. Five critical urban areas have been identified to have deteriorating water quality and quantity. These include NCR, Central Luzon, Southern Luzon and Central Visayas. Sixteen major rivers, to include five in Metro Manila, are biologically dead during the dry months due to pollution.

Water pollution has also been a contributory factor to severe health concerns (31% water borne diseases) and problems related to fishing and tourism.

By year 2025, water shortage will be a serious problem in most major cities and in 8 of the 19 major river basins. Climate Change/El Niño could even worsen the present water situation in the country. Groundwater levels went down by 5-10 m within the last several decades leading to ground subsidence and saltwater intrusion.

Recognizing the problem, since 2004, the national government has taken steps to introduce sustainable water resources development management. There are also efforts made to improve water quality in the cities. In 2006, a wetland system of wastewater treatment was constructed in a peri-urban portion of Bayawan City, to enable 700 households of resettled informal settlers to have access to safe water supply

and sanitation facilities. Manila Water (a privately owned water company) planned to construct a wastewater treatment plant in Taguig sometime 2008.

c. Solid Waste

Solid wastes in the Philippines are classified as either domestic (household), farm and agricultural, industrial/commercial, institutional (hospitals, schools), miscellaneous and other specialized wastes, mining waste, and hazardous wastes. Pollutants found in solid wastes include organic matter (kitchen and garden wastes), paper, plastics, metals, medical wastes, toxic and hazardous wastes, other non-biodegradables e.g. disposables and non-recyclables. In year 2000, 76 million Filipinos generated over 10 million tons of municipal solid waste. By 2012, generated waste has been pegged at 14 million tons.

Most of the wastes generated originated from city-based and/or partially developed or mineral exploited rural areas. In Metro Manila alone, during the dry season, kitchen wastes (in markets/households), grass and wood (in street sweeping), plastics (in rivers), and paper (in institutions) have been identified.

Waste disposal facilities in different parts of the Philippines show that as of 2002, Regions 7, 4A, and 3 have the most number of open dumpsites while Region 7 and 4A have more controlled dumpsites than the other key areas in the country.

Budgetary expenditures for handling solid wastes of Metro Manila Development Authority (MMDA) have reached from 73.40 million pesos in 1994 to 434. 30 million pesos in 2000. By percentage weight, textiles (33.5%), paper (12.9%), wood (11.5%)and food wastes (11%) account for the top solid wastes in the Philippines.

d. Toxic and Hazardous Wastes

The Philippines has also problems with a handful of toxic and hazardous wastes (HW). Alkali wastes, oil, inorganic chemical wastes, acid and plating wastes rank as the top five highest HW waste generation. The total hazardous waste generated is estimated at 2,410,281 tons/year. Metro Manila, Southern Tagalog, Central Luzon, and Central Visayas generated the biggest toxic and hazardous wastes. Hazardous wastes are usually either recycled, stored, disposed, placed in a lagoon, or chemically treated. Other forms of treatment (off site, export, incineration, biological treatment, oil separator, as effluents) are also sometimes used in neutralizing these wastes. However, with the Clean Air Act being implemented, incineration has not been utilized for this purpose.

e. State of the Philippine Forest

In 1876, it has been reported that approximately 68% of our lands were forested. It was during the American period that large areas of our lands were opened for

commercial logging, that by 1950s, 25% of forest lands were committed to logging concessions. While there has been numerous legislative laws formulated as early as 1953, have dropped to 35% by 1969 (Haribon Policy Paper No. 5) This 20th century, forest cover has declined from 70% to 20% leaving only about 800,000 hectares of virgin forest. Forty six species are considered endangered, and four species reported to have become extinct. Only 3.2% remains of the total rainforest. From 1934 to 1988 alone, approximately 9.8 million hectares of forests were lost due to illegal logging and intense flood damage in some areas. Mangrove forest areas decreased from 450,000 ha in 1918 to less than 120,000 in 1995 leaving only 112,400 ha of mangroves today.

One scholar noted that government policies lacking in foresight have contributed much to the massive deforestation, causing extensive damage to 17 million hectares of closed forests. What remains to date of these forests is barely 1.2 million hectares due to erroneous granting of logging concessions by the government.

The DENR has reported that the number of illegal logging hotspots have been reduced from 197 in 2011, then 31 in 2014 and to 23 in 2015. Agusan and Surigao provinces in Mindanao and Isabela in Luzon remain the hotspots for illegal logging. A total of 29 million board feet of illegally cut wood has been confiscated since 2014, with 211 cases filed against persons involved in illegal logging.

Deeply concerned with the rapid forest denudation and increasing number of threatened/endangered species, the Rain Forest Restoration Initiative (RFRI) was formed. This is a network of professionals and advocates that aims to re-establish the rainforests by planting indigenous/ native tree species. Subsequently, the Rainforestation Organizations and Advocates to 2020 (“ROAD” to 2020) was launched. And with the One Million Signature Campaign Against Commercial Logging and Mining in Natural Forests, ROAD to 2020 has been progressing, targeting the planting of indigenous tree species in order to recover and conserve biodiversity, optimize supply of forest benefits and ecosystem services, reduce the risk of natural hazards, and enhance options for sustainable livelihood. Eventually this will lead to the restoration of at least one million hectares of rainforests by year 2020.

Similarly, for the year 2015, DENR has targeted to reverse the trend of deforestation. Then Secretary Paje foresees that forested land will number 8.14 million hectares as compared to 7.66 million hectares of denuded area.

Through the National Greening Program (NGP), the government’s reforestation program, trees in 1,005,013 hectares of land have been planted. This was estimated to be 12% above the target for 2014. By 2016, 1.5 billion trees are targeted to be planted in 1.5 million hectares. While NGP has set targets for reforestation, the office has been placed under close scrutiny due to corruption and misreporting.

Biodiversity Conservation Program

Currently, DENR reports that there have been ten more sightings of the critically endangered Philippine Eagle which indicates the population of the Philippine Eagle is increasing. Also the population of the endangered Philippine tamaraw has increased from 274 to 382. Similarly, more sightings of nesting sites for the endangered pawikan have been reported from 14,035 to 17,593. The increasing number of threatened species (especially those covered by the IUCN list of threatened species) warrants the need to conserve biodiversity in identified Key Biodiversity Areas of the country.

Promoting Protected Areas

In a USAID-FPE Project, eight key Biodiversity Key Areas have been identified in Cebu, Negros, Leyte (Eastern Visayas), Luzon and Mindanao. These include MT. Banahaw-San Cristobal Protected Landscape, Polillio Group of Islands Protected Area, North Negros Natural Park, Ilog Hilabangan Watershed Forest Reserve, Hus-as, Dalaguete and Tabunan Critical Forest Habitats, Mt. Nacolod Watershed, Panigan-Tanugan and Talomo-Lipadas Watershed and Arakan Valley. Recently, Mt Hamiguitan in Davao has been declared as the Philippines' latest UNESCO World Heritage Site.

The Philippine Strategy for Sustainable Development

In order to address pressing environmental issues and to sustain development and growth, the Philippines has adopted its own Strategy for Sustainable Development following the Global Agenda 21 Framework. This includes institutionalizing environmental concerns in the administration, putting costs for natural resources, biodiversity conservation, ecosystems restoration, control of population growth and human resource development, establishing growth areas in rural sites, promotion of environmental education, strengthening people's participation, and promoting SMEs (small to medium scale industries), sustainable agriculture and forestry practices.

As a signatory to the 1992 Earth Summit, the Philippines Government has initiated numerous programs, plans and activities to address environmental issues and concerns of the country. The Philippine Agenda 21 has been set as the action plan to achieve sustainable development following the priorities set in the recent Sustainable Development Goals (SDG). Three major components enhance sustainable development. These are government, civil society and business. It is also important that roles and capacities of major groups (especially marginalized sectors to include fisherfolks, farmers, indigenous groups, workers, women, children) have to be strengthened.

2. Examples of Environmental Problems

   A. SOLID WASTE MANAGEMENT

The spread of blood-borne pathogens in health-care waste becomes an antecedent stimulus that prompted the World Health Organization and Stockholm Convention to call for the development and use of best environmental practices and best available techniques for health-care waste management. This response also recognizes both environmental and health risks associated with incineration such as the release of dioxin and mercury as well as the use of reusable sharps wastes. The use of best environmental practices from segregation to storage and transport as well as the use of non-incineration alternative technologies (autoclaving, advanced steam systems, microwave treatment, and alkaline hydrolysis) is essentially described in this module. This aspect of the module will be a valuable instrument that would raise awareness, disseminate information and catalyze prompt action for an environmentally sound health-care waste management.

- Spread of health hazards, in health-care waste
  - World Health Organization issued a policy in 2004
  - Development of national policies, guidelines, and plans for health-care waste management
  - Recognizes the risks associated with incineration
  - Can be problematic in developing countries due to the lack of capacity for emission testing or regulatory enforcement
- Stockholm Convention (May, 2001)
  - Highlighted the problem
  - Required the use of best practices and best available techniques

Global Situationer

Improper management of health-care wastes from hospitals, clinics, and other health facilities poses occupational and public health risks to patients, health workers, waste handlers, haulers, and communities (Emmanuel, 2007).

a. Spread of blood borne pathogens (needle stick injuries) (WHO, 2004)
   - Unsterilized syringes cause between 8 to 16 million cases of hepatitis B, 2.3 to 4.7 million cases of hepatitis C, and 80,000 to 160,000 cases of HIV every year (Kane *et al.*, 1999)
b. Emissions of waste incinerators (Stockholm Convention, 2001)
   - Fly ash, heavy metals, acid gases, organic compounds and pathogens (Batterman, 2004)
   - Increased body burdens and adverse health impacts
     - Increased blood or urine levels of dioxins and furans; polychlorinated biphenyl (PCBs); etc. (Kumagai & Koda, 2005)
     - Higher incidence of cancer among children living near incinerators (Knox, 2000)
     - Associations between incineration and reproductive or developmental disorders or genetic anomalies (Drummer, 2003)

Major Causes

a. Improper management of health-care wastes
    i. Inadequate sterilization and reuse of syringes and other related materials
    ii. Public access to medical wastes particularly sharps (i.e. used needles, glass ampoules, etc.)
b. Improper use and management of medical incinerators
    i. Lack of alternative technologies
    ii. Lack of national policies or guidelines

Global Trends

a. Move away from incineration towards alternative technologies that do not produce any dioxins
b. Number of medical waste incinerators has dropped dramatically
    i. Dropped from 6,200 in 1988 to less than a hundred (USA)
    ii. Complete shutdown (Ireland and Portugal)
    iii. Phased out incineration in favor of non-incinerator alternatives (Canada)
    iv. Closed down of all its on-site hospital incinerators and operates a few large-scale (Germany)
    v. Followed suit, banned or put a moratorium on incinerators (Philippines and major cities like New Delhi and Buenos Aires)
c. Promotion of non-burn alternatives as a long-term strategy
d. Effective waste reduction and segregation

Requirements for Best Environmental Practices (National Level)

a. Legal framework, including designation of responsible authorities and mechanisms for coordination.
b. Regulations and guidelines, including clearly defined obligations, system of inspection and enforcement, and penalties.
c. National strategy or plan of action, including support for regional and local governments.
d. Capacity building measures.
e. Allocation of human and financial resources.

Best Environmental Practices and Alternative Technologies

a. Waste classification
    i. Infectious waste
        - Waste contaminated with blood or body fluids
        - Biological cultures and stocks
        - Anatomical or pathological waste
    ii. Sharps waste (needles, syringes, etc.)
    iii. Chemical hazardous waste
        - Cytotoxic and chemotherapeutic
        - Spent laboratory solvents
        - Cleaners and oils

- Disinfectant and expired pharmaceutical waste

iv. Low-level radioactive waste

v. General domestic waste
   - Recyclable
   - Compostable

b. Waste segregation
   i. Could be according to system of handling, treatment and disposal
      - Entails separation of different types of waste
      - Infectious
      - Sharps
      - Chemically hazardous, Radioactive,
      - Non-hazardous
      - Recyclable
      - Compostable
   ii. Segregating recyclable waste from other non-hazardous waste allows for waste minimization

c. Waste minimization
   i. Inventory control minimizes expired materials and environmentally preferable purchasing (EPP)
      - Procurement of products that do not contain recalcitrant and plastics
        • polyvinyl chloride (PVC), mercury, organophosphate fertilizers, plastics contain di-ethylhexyl-phthalate (DEHP) and other plasticizers that may be linked to birth defects
      - Addresses the life cycle of products brought into the facility and takes into account excessive packaging and the toxicity of substances
        • Cleaning solvents and disinfectants
   ii. Also involves recovery, recycling, reuse and composting in health facilities.
      - Use of recovery devices (commercially available or via waste contractor)

d. Color coding and Labeling
   i. Use of color coded containers
      - Black (non-risk waste)
      - Red (risk-waste with sharps)
      - Yellow (radioactive waste)
      - Green (chemicals i.e. mercury and cadmium)

e. Handling, Storage, Transport, Treatment and Disposal
   i. Should be done by personnel using appropriate personal protective equipment and protocols
      - Gloves
      - Mask
      - Protective gown
      - Protective goggles
      - Containers
      - Approved decontamination procedures
   ii. Must be performed by duly trained personnel

iii. Disposal should be in accordance to the guidelines set by the local government and or institution (normally conducted via a licensed waste contractor)

Alternative Technologies

a. Steam sterilization (Autoclave)
   i. Remove pockets of air that remain inside waste bags
   ii. Enhance disinfection process
b. Microwave treatment
   i. Efficient for microbial inactivation procedure
c. Dry heat sterilization
   i. Dry heat will penetrate all kinds of materials, such as oils, and closed containers
   ii. Dry sterilization of wastes derived from surgical instruments, medical, dental, esthetic, laboratories, industries and other glassware's
d. Alkaline hydrolysis
   i. A treatment of carcasses by means of high temperature (150°C, 3 hours) and high pressure alkaline hydrolysis
   ii. Inactivate pathogens and prions such as transmissible spongiform encephalopathy (TSE)
   iii. Destroy many chemotherapeutic or cytotoxic agents
e. Biological Treatment
   i. Decomposition of biodegradable wastes by living microbes (bacteria and fungi)
   ii. Could be conducted in adjunct with mechanical processes.

B. POLLUTION

Pollutants are separately introduced to the different physical spheres of the earth (geosphere, hydrosphere, and atmosphere) but their effects can be interconnected through material cycles and affect other components, including the biosphere. Pollutants in the water can contaminate the air and land, as well as influence ecosystem and human health. Monitoring air, water, and soil quality can provide information that is vital to sustaining earth resources. National and international guidelines and policies should also be properly implemented to mitigate the impact of pollution.

a. AIR POLLUTION

The continuously increasing rates of industrial practices and urbanization reduce the atmosphere's capability to dissipate pollutants. Emissions from anthropogenic sources continuously degrade air quality. The air pollution problem extends to environment and human health concerns. Air pollutants that lead to serious health problems are known as *air toxins*.

Air pollution sources can be classified into *stationary* and *mobile* sources. Stationary sources include *point sources* such as smokestacks of factories that are considered as discrete controllable sites, *fugitive sources* such as construction sites,

surface mines, and farmlands that are open areas exposed to wind processes, and *area sources* such as industrial areas within an urban community considered as emitters from several sources within a well-defined area. On the other hand, mobile sources include vehicles such as automobiles, train, ships, and aircrafts that move as they emit pollutants.

Air pollutants may also be classified as *primary* and *secondary* pollutants. Those that directly enter the atmosphere are known as primary pollutants (e.g. carbon monoxide, nitrogen oxides, sulfur oxides, volatile organic compounds, and particulates). On the other hand, secondary pollutants are products from the reaction of primary pollutants with normal atmospheric compounds.

Air pollutants

a. Gaseous pollutants – volatile organic compounds (VOCs), sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ground-level ozone (O_3) [a secondary pollutant derived from reactions of heat, sunlight, NO_x, and VOCs], hydrogen sulfide (H_2S), and hydrogen fluoride (HF)
b. Particulate matter (PM) – airborne particles of organic or inorganic solid or liquid substances such as dust, dirt, and soot that are classified by size, i.e., PM 10 (particles less than 10μm in diameter), PM 2.5 (less than 2.5 μm)

Some air pollutants can also classified as greenhouse gases (i.e. water vapor, carbon dioxide (CO_2, methane, ground-level ozone (O_3), nitrous oxides and fluorinated gases). Greenhouse gases include compounds that absorb heat energy emitted from Earth's surface and reradiate it to the ground leading to the greenhouse effect. This in turn leads to the warming of the earth's surface.

Causes of air pollution

a. Natural Causes
    i. Dust and wildfires
    ii. Animals digestion leads to the release of methane
    iii. Some vegetation emits VOCs on warmer days that react with NO_x, SO_2, and carbon compounds to produce hazes rich in ozone.
    iv. Volcanic activity releases water vapor and other pollutants
b. Anthropogenic Causes
    i. Combustion of fossil fuels such as coal, oil, and natural gas in power plants, manufacturing facilities (factories), waste incinerators, furnaces and other fuel-burning heating devices.
    ii. Emissions caused by gasoline-burning vehicles
    iii. Deforestation removes trees that sequester carbon
    iv. Production of methane from wastes in landfills and cattle in animal husbandry
    v. Construction activities that produce dust, etc. and other human activities

Effects on the environment and human health

a. Respiratory diseases
b. Production of smog that discolors the atmosphere and reduces atmospheric clarity and visual range
c. Acid rain that leads to acidification of lakes and streams
d. Nutrient depletion in soils and water bodies
e. Damage to plants such as bleaching of leaves, tissue decay
f. Discoloration, erosion, and decomposition of construction materials such as buildings and monuments

Mitigation

a. Emission-control technologies that reduce both air pollutants and greenhouse gases, such as selective catalytic reduction (SCR) on gas boilers
b. Incorporating principles of integrated pollution prevention and control in air quality legislations
c. Energy-efficient technologies and reduction of energy use
d. Switching from the use of fossil fuels to alternative energy sources
e. Reducing the production of process wastes

b. SOIL POLLUTION

Soil pollution involves contamination from man-made chemicals or due to the alteration of the natural environment. Soil properties may be affected by the land use in the area, whether past or current, as well as the activities associated with it. Proximity to the sources of pollution also promotes soil susceptibility to contamination. Contaminants may also be carried by the wind and deposited by precipitation or as dust. Groundwater and surface water may also affect the spread and transport of contaminants from the source.

Common soil contaminants

a. Organic chemicals, such as hydrocarbons or pesticides
b. Heavy metals, such as arsenic, selenium, cadmium, nickel, or lead

Causes of soil pollution

a. Contamination from waste-disposal sites
b. Inadvertent or deliberate addition of chemicals into the soil including those used for agricultural, commercial and industrial purposes (e.g. petroleum spills, fertilizer use, pesticide use, removal of lead paints)
c. Leakage from underground storage tanks
d. Conversion of natural areas (e.g. forested, rural land) to various land uses (e.g. urbanized areas)

Effects on the environment and human health

a. Increased pollution load from urban practices

b. Chemicals in soil may be taken up by plants or animals and may be ingested by people through consuming contaminated food.
c. Soil contaminants can negatively affect microbial processes, plant vigor, animal health, and overall soil health
d. Damage to crops which can reduce yields

Mitigation and soil treatment

a. Soil surveys provide soil description in terms of soil science and engineering classification and help identify potential problem areas prior to construction of any engineering project
b. Proper planning for optimal land uses
c. Excavation, incineration (not allowed in the Philippines) and disposal
d. Bioremediation

c. WATER POLLUTION

Water is a renewable resource cycled through the different spheres of the earth. It is vital to life forms as well as human sustenance. However, access to clean water has become even more limited with water contamination due to various pollution sources.

Water pollutants

a. Oxygen-demanding waste - dead plant and animal matter (organic matter) in water bodies consumed by aerobic bacteria upon decay reduce oxygen levels in water that may result to death of fish and other organisms.
    i. Sources: agriculture, urban sewage, natural sources such as fallen leaves
b. Pathogenic Organisms - a common measure is human fecal coliform bacteria. It is also used as a common measure of biological pollution. Fecal coliform bacteria are found in human waste.
c. Nutrients - Inorganic nitrogen and phosphorus released from a variety of materials, including fertilizers, detergents, and the products of sewage treatment plants. Forest areas have the lowest concentrations of phosphorus and nitrogen, while the highest concentrations are found in agricultural areas. In urban areas, sources include discharge from wastewater-treatment plants. Treatment plants reduce organic pollutants and pathogens in water, but nutrients may still pass through the system if there is no advance water treatment.
d. Oil– oil tanker accidents at sea discharge oil on the water; oil spills on land can also reach water bodies and pollute it.
e. Toxic Substances
    i. Synthetic Organic Chemicals – pollutants that include compounds of carbon produced naturally by living organisms or synthetically by industrial processes (pest control, pharmaceuticals, and food additives), e.g., Persistent Organic Pollutants (POPs) such as DDT (dichlorodiphenyltrichloroethane), PCBs (polychlorinated biphenyls), Dioxins

ii. Heavy Metals – pollutants such as lead, mercury, zinc, cadmium, silver, and arsenic that are often deposited with natural sediment in the bottom of stream channels, along floodplains, etc.
iii. Radioactive Waste

f. Sediment – It is the greatest water pollutant by volume that may deplete soil and reduce water quality as it may carry pollutants as it enters water bodies.

Causes of water pollution

a. Poor sanitation conditions
b. Improper waste disposal practices
c. Pollutants released by agricultural, industrial, and municipal processes
   i. Nutrients in rivers of the world
   ii. Heavy metals in water systems
   iii. Global production of other chemicals affecting water quality
   iv. Hot water used as coolant in industries
d. Over-extraction of groundwater

Effects on the environment and human health

a. Lack of disease-free drinking water for about 20 percent of the world's population
b. Incidence of waterborne diseases from consumption of contaminated water. *Escherichia coli* (also E. coli), a form of fecal coliform bacteria, can produce toxins in the body that may lead to bloody diarrhea, dehydration, kidney failure, and death.
c. Eutrophication (from the Greek for "well fed") is a process characterized by a rapid increase in the abundance of plant life, particularly algae. The algae block sunlight to plants below and also consume oxygen as they decompose. Here, the oxygen content of the water is lowered, which may result to death of aquatic animals.
d. Metals deposited near bodies of water may be incorporated into plants, including food crops, and animals. Heavy metal poisoning may also result from dissolution of metals in water used for agriculture or domestic purposes.
e. Thermal pollution is the artificial heating of water that decreases the dissolved oxygen level while also increasing the biological oxygen demand of aquatic organisms.
f. Disruption to commercial fisheries, sport fisheries, and tourism
g. Saltwater intrusion occurs when saltwater displaces fresh groundwater.

Mitigation

a. Develop and refine better ways to evaluate water pollution problems and their impact on aquatic life and the health of people.
b. Implement cost-effective new and innovative water treatment technologies.
c. Develop products and processes that minimize production of water pollutants and their release into the environment.
d. Desalination of seawater
e. Wastewater treatment prior to releasing back to the environment
f. Methods of Treating Groundwater

i. Pumping out contaminated water and treatment by filtration, oxidation, air stripping (volatilization of contaminant in an air column), or biological processes
ii. Use of vapor-extraction well and then treatment
iii. Injection of nutrients and oxygen to encourage growth of organisms that degrade the contaminant in the groundwater
iv. Use of contact treatment as contaminated water plume moves through a treatment bed in the path of groundwater movement; neutralization of the contaminant by chemical, physical, or biological processes

C. BIODIVERSITY LOSS

The Philippine archipelago is considered megadiverse because of the numerous plants and animals many of which are also endemic. However, the country also gained the title of being a hotspot as most of the species tend to have reduced population or easily become extinct through time. It is imperative that concerted efforts towards conservation of our flora and fauna be exerted by all sectors of society. One very effective way of conserving our flora and fauna is through education. Having NSTP, as part of the tertiary curriculum with a topic allotted for biodiversity and its loss, is a sure way of enhancing knowledge of our youth towards protection as well as conservation of our species. The fast pace of biodiversity loss in the country needs to be addressed because of its negative impact on our sources of food, clothing, shelter, medicine, industry, its role in nutrient cycle and natural filtering systems, among others. With the threat posed by global climate change and industrialization, it is high time to devise measures and take drastic remedial: steps to prevent biodiversity loss.

Biodiversity is a contraction of biological diversity, introduced by E. O. Wilson. It is the sum total of variation among living organisms, at the genetic, species, and ecosystem levels that reflects the vast wealth of life that has evolved through time. This indicates patterns of distribution of a variety of genetic and biological resources in both terrestrial and aquatic ecosystems" (Zamora, 1980). It includes the variety within species (genetic diversity), between species (species diversity), and between ecosystems (ecosystem diversity). Biodiversity is important as it serves as sources of food, medicine, clothing, natural fuels; and is used as natural filters, and for commercial and industrial purposes and other applications. (Haribon, _)

The Philippines is known to be one of the megacenters of biodiversity in the world having rich and highly unique species. It has two-thirds of the earth's biodiversity and between 70% and 80% of the world's plant and animal species. The country ranks fifth in the number of plant species and maintains 5% of the world's flora. In fact, species endemism is very high, covering at least 25 genera of plants and 49% of terrestrial wildlife, while the country ranks fourth in bird endemism. Many of these unique species are even found exclusively in particular islands (Haribon, __).

A glimpse that the Philippines (Verde Island Passage Corridor, in particular) is the center of center of marine biodiversity in the world, it has been reported that out of 500 known coral species in the world, more than 400 species can be found in the Philippines. This serves as home to some 1,030 fishes and thousands of invertebrates (Haribon).

While the country is a megacenter of biodiversity, it is also one of the world's biodiversity hotspots as it: (a) has the highest number of threatened species (~700 species); (b) has fast habitat destruction causing high species extinction rates; (c) is third in the world in the number of globally threatened bird species; and (d) is the first in the number of critically endangered/endemic bird species (Haribon, __).

Causes of Biodiversity Loss (Sinha and Heaney, __; Haribon, __)

With the fast rate of population growth and increasing developmental activities brought about by globalization and industrialization, our natural resources are being utilized at a very rapid unsustainable pace leading to biodiversity loss. Concretely, loss of biodiversity can be attributed to natural and anthropogenic causes. These include:

a. Increased demand for food and other agro-based resources due to population growth
b. Poverty and inequitable land distribution
c. Commercial exploitation /overexploitation of forest and marine resources
d. Habitat alteration (e.g. conversion of agricultural lands to industrial parks, subdivisions, mining, and others) and habitat destruction
e. Unsustainable agricultural practices (e.g. Improper use of agricultural chemicals)
f. Introduction of invasive alien species, pest and diseases
g. Natural calamities or extreme weather events associated with climate change
h. Possible negative impacts of biotechnology
i. Political and economic policies and constraints

Effects of Biodiversity Loss on Ecosystem Services

Ecosystem services are the benefits that humans derive from various ecosystems. This can be categorized into four, namely:

a. Provisioning services such as food, clean water, timber, fiber, and genetic resources;
b. Regulating services such as the regulation of climate, floods, disease, water quality, and pollination;
c. Cultural services such as recreational, aesthetic, and spiritual benefits;
d. Supporting services such as soil formation, and nutrient cycling.

Mitigation Measures towards Biodiversity Loss

a. Establishing Protected Areas
b. Preventing entry of invasive species
c. Enhancing Education and Information Dissemination
d. Slowing Climate Change
e. Strengthening collaborations among all stakeholders

f. Implementing the National Biodiversity Strategy and Action Plan and ROAD to 2020

D. OCCUPATIONAL HAZARDS: PHYSICAL AGENTS

The environment directly affects man. In return, man affects his environment. Wherever man is, an environment surrounds him. Be it in the community, at home, or at work, there are environmental factors directly and indirectly affecting man. Definitely, a healthy and safe environment enables man to become more productive, and more able to protect the environment that nurtures him.

The work environment affects the health and performance of the workers. Because of this, it is important that it is kept safe. In the Philippines, standards have been set by DOLE through OSHS Rule 1070 Occupational Health and Environmental Control.

According to Rule 1077: Working Environment Measurement under Rule 1070, the employer should maintain and control the working environment, making it a comfortable and healthy condition for the purpose of promoting and maintaining the health of the workers. It involves measurement of temperature, humidity, pressure, illumination, ventilation and concentration of substances and noise.

The term “Physical Agents” is commonly used to describe a group of sources of energy in the environment which have the capability of causing injury or disease to workers. Examples of physical agents include noise, vibration, extremes of temperature, radiation, and pressure.

a. Noise

Noise is an unwanted sound which produces an unpleasant hearing sensation, sometimes disturbing and can impede communication. It is present almost everywhere in our daily life including the workplace, making it probably the most frequent physical hazard.

Occupational noise is a complex of sounds, of variable intensities and pitches, having different characteristics, rhythmic or rhythm less, produced continuously or discontinuously by machines, tools, devices, means of transportation, or human voice.

The audibility of the sound is determined by two parameters: the frequency and the intensity of the sound. *Frequency* expresses the pitch of the sound and is measured in Hertz (Hz) and means the number of vibrations per second. There are high pitch (>3000Hz) and low pitch (<500 Hz).

Intensity expresses the level of the sound or the sound pressure and is measured in decibel (dB) and means the relative value of the acoustic intensity in a logarithmic form. “0”

dB does not mean any sound; it means a sound level where the sound pressure is equal to that of the reference level which corresponds to 0.02 mPa (milliPascal).

Loudness is the subjective human response to sound. It is dependent on sound pressure and frequency.

The level of noise is measured in decibel with sound meters or dosimeters. The human ear does not respond equally to all frequencies: we are much more sensitive to sounds in the frequency range about 1000Hz to 4000Hz than to very low or high frequency sounds. For this reason, the level of sound is measured in terms of sound meters using a filter (A) which records a selection of sounds similar with the human ear, thus the unit is expressed as dB (A).

Threshold limit values refer to the sound pressure that represent conditions under which it is believed that nearly all workers may be repeatedly exposed to without adverse effects on their ability to hear and understand normal speech. It depends on the work specificity (International Standard, ISO 1999-1990.)

Table of Permissible Noise Exposure Limits:

Source: Occupational noise exposure. - 1910.95.*https://www.osha.gov*

Duration/day (Hours)	Sound level (dBA+)
8	**90**
6	**92**
4	**95**
3	**97**
2	**100**
1 ½	**102**
1	**105**
½	**110**
¼	**115***

+sound level in decibels are measured on a sound level meter, weighted network with slow meter response

*no exposure is allowed to continuous intermittent in excess of 115dBA

Exposure to high levels of noise on a regular basis, or very high levels of explosive noise can cause permanent hearing loss or other damage to the ear such as tinnitus. Both hearing loss and tinnitus are irreparable conditions with a significant impact on day-to-day lives.

Noise in the workplace can also create safety risks, where workers are unable to hear warning sounds such as moving machinery and alarms.

Aside from auditory effects, noise can also cause non-auditory effects such assleep disturbances (difficulty of falling asleep, modifications of the sleep phases, decreasing of the profound sleep duration). These can affect the mood of the person. It also has effects on cardiovascular system (increase arterial blood pressure and heart rate), increase respiratory rate and subsequent metabolic changes (catecholamine, cortisol). Behavioral effects, such are concentration difficulties and aggressive behavior may also manifest.

*Ultrasounds*are high-frequency (>20000Hz) sounds which are inaudible, or cannot be heard by the human ear. We can find ultrasounds in industry, medicine (ultrasounds, dental scaling, therapy), and devices against thieves and pests.

Acute effects occur at exposure to 18-30 kHz such as: headache, fatigue at the end of the day, sleepiness during day time, the feeling of pressure inside the ear, walking disturbances, numbness, and sensitivity disturbances. Chronic effects can be: vascular disturbances, increase of the central and skin temperatures, hyperglycemia, increased number of eosinophil. Association with noise exposure can lead to hearing loss and vestibular disturbances.

*Infrasound*is a low-frequency sound (1-20 Hz) that is not audible. Many of the sources of infrasound are natural, resulting from geological (earthquakes, landslides, avalanches) or meteorological events (storms, tornadoes), but there are also artificial sources, such as industrial machines, ventilation systems, air conditioning, aircraft, rail traffic. For example, in the industrial sector, low frequency vibrations of machines can cause infrasound, especially in association with air compressors and ventilation systems. In environment, infrasound may be produced, especially when trains travel at high speed through tunnels. Wind turbines and the movement of tall buildings during windy conditions emit infrasound.

For the infrasound, hearing pain and damage can occur at exposure above 140dB. Studies show that decrease in vigilance is demonstrated in persons acutely exposed to intensities high enough to be heard. In chronic exposures to normal levels present in the environment, there is not enough evidence in order to formulate a clear conclusion regarding the effects on health.

To avoid the health effects on the exposure of noise some technical and medical measures has to be taken. Technical and organizational measures to reduce the level of noise implyelimination/reduction of the noise level at the source (isolation of the source), increasing the distance between source and worker (it is known that the sound pressure level decreases with 6 dB for each time the distance from the point source is doubled), application of appropriate maintenance programs for work equipment, the workplace and workplace systems. Re-organization of work in order to reduce noise may involve rotation to another area and giving adequate resting periods. If despite these measures the noise reaching the worker is still more than 80 dB (A), the employer is obliged to give his workers individual protection equipment, and if the noise is more than 85 dB (A), the worker is

obliged to wear it. The personal protection equipment can be ear plugs or ear muffs. PPE should be the last resort. A good pre-employment examination, periodical medical examinations and proper risk assessment and risk management can be done to screen for and detect hearing difficulties or problems. Audiometric testing should be performed at pre-employment (baseline) and periodical examinations.

Noise should be eliminated at source where possible or reduced to levels where risks are minimal.

b. Vibration

Vibration is the mechanical oscillations of an object about an equilibrium point. It enters the body from the organ in contact with vibrating equipment.

The measurement of vibrations is made with special device similar to the sonometer and the established parameter according to legal standards is the acceleration.

The ACGIH Threshold Limit Values (TLVs) for exposure of the hand to vibration in X, Y, or Z direction*	
Total Daily Exposure Duration (hours)	**Maximum value of frequency weighted acceleration (m/s^2) in any direction***
4 to less than 8 hours	4
2 to less than 4 hours	6
1 to less than 2 hours	8
less than 1hour	12

* Directions of axes in the three-dimensional system

Source: Canadian Centre for Occupational Health & Safety. 1997-2014.

Hand-arm vibration (HAV) exposure occurs when a worker operates hand-held equipment such as a chain saw or jackhammer, vibration affects hands and arms. The vibrations transmitted to the hand-arm system range between medium and high frequencies (20-5000Hz). The target organs of HAV exposure are: the blood vessels of the fingers, the sensitive nerves of the hand and some bone-muscle-articulation structures of the hand-arm system. On top of individual susceptibility, the presence of tensed postures, exaggerated and prolonged muscles contractions which will reduce the blood flow into these muscles may contribute to vibration effects on the body.

Vibration-induced white finger (VWF) is the most common condition among the operators of hand-held vibrating tools. Also known as Raynaud's phenomenon/syndrome, this is manifested through whitening of the tip of the fingers crisis, consecutive to cold

exposure. These can last from a few minutes up to a few hours, accompanied by pain, numbness and reduced thermal sensitivity. These are followed by reactive hyperemia, intense pain, finger cyanosis and local temperature getting back to normal. Usually the hand which manipulates the vibrating tool is affected. The symptoms of VWF are aggravated when the hands are exposed to cold.

There are factors that can influence the effects of HAV. Physical factors include acceleration and frequency of vibration, daily exposure, years of employment involving the vibration exposure, state of tool maintenance and use and availability of PPE. Biodynamic forces include the grip forces (how hard the worker handles the equipment), surface area, location, and mass of parts of the hand in contact with the source of vibration, hardness of the material being contacted by the hand-held tools, for example metal in grinding and chipping, position of the hand and arm relative to the body, texture of handle-soft and compliant versus rigid material, and medical history of injury to fingers and hands, particularly frostbite. Individual factors include operator's control of tool, machine work rate, skill and productivity, individual susceptibility, smoking and use of drugs, disease or prior injury to fingers hands and exposure to other physical and chemical agents.

Whole-body vibration exposure occurs when a worker sits or stands on a vibrating floor or seat, the vibration exposure affects almost the entire body. Usually hazardous exposures are associated with off-road vehicles in industries such as agriculture, forestry, mining, quarrying and with small-fast boats used off-shore. Vehicles such as fork-lift trucks, cranes and even road-vehicles such as lorries and coaches also have the capability of producing high levels of whole-body vibration.

According to the European Module for Undergraduate Teaching of Occupational Medicine (EMUTOM), the health effectsof whole-body vibration include motion sickness (when the vibration exposure occurs in the 0.1 to 2 Hz frequency range); circulatory, gastro-intestinal and renal disorders can occur at the 4-8 Hz; visual disorders can occur at the 5-20 Hz; musculoskeletal disorders especial back pain, with disc modifications, arthrosis modifications, scoliosis. Whole-body vibration exposures, especially in conjunction with poor postures or manual handling, are primarily associated with lower-back pain and injury although upper back and other musculoskeletal problems.

Reduction of whole-body vibration exposure can often be achieved by selecting the right vehicle for the job, improving road surfaces, reducing speeds and modifying suspension systems. Suspension seats are often used to reduce the vibration exposures in industrial vehicles.

e. Temperature

People working in uncomfortably hot and cold environments are more likely to behave unsafely because their ability to make decisions and/or perform manual tasks deteriorates.

The variables dictating human response to heat or cold involve air temperature, air movement, mean radiant temperature, water vapor pressure of air, the type of clothing worn, altogether with physiologic response such as capacity for blood circulation, acclimatization, ability to sweat skin temperature, and risk factors such as age, obesity and illness.

Temperature can be measured in terms of body temperature measurements, environmental measurements and through the use of the Wet bulb Globe temperature index. Although instruments are available to estimate deep body temperature by measuring the temperature in the ear canal or on the skin, these instruments are not sufficiently reliable to use in compliance evaluations.

Environmental heat measurements should be made at, or as close as possible to, the specific work area where the worker is exposed. When a worker is not continuously exposed in a single hot area but moves between two or more areas having different levels of environmental heat, or when the environmental heat varies substantially at a single hot area, environmental heat exposures should be measured for each area and for each level of environmental heat to which employees are exposed.

In the Philippines, in order to assure good ventilation for workers, OSHS has set Rule 1076.05 as standard for Temperature and Humidity. According to this rule, temperature suitable for the type of work performed shall be maintained in enclosed workplaces and that all employees should be protected by insulation of the equipment against radiation and excessive temperature due to steam, hot water pipes and heated machinery. It is also stated that passage rooms shall be provided so workers can gradually adjust to prevailing temperatures in the case of exposure to unduly high or low temperatures.

Permissible Heat Exposure Threshold Limit Value (ACGIH). These TLVs apply to physically fit and acclimatized individuals wearing light summer clothing.

	Workload		
	Light	Moderate	Heavy
Continuous work	30.0C	26.7C	25.0C
75% work, 25% rest/ hour	30.6C	28.0C	259C
50% work, 50% rest/hour	31.4C	29.C	27.9C
25% work, 75% rest/hour	32.2C	31.1C	30.0C

Source: American Conference of Governmental Industrial Hygienists (ACGIH). 1992. *1992-1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.* Cincinnati: American Conference of Governmental Industrial Hygienists.

When the body's means of controlling its internal temperature starts to fail, heat stress occurs. Excessive heat may result in Heat stress disorders such as heat stroke (a thermoregulatory failure), heat exhaustion (resulting from profuse sweating and is characterized by clammy, moist skin, fatigue, anorexia, nausea and vomiting) heat cramps (painful spasms of one or more muscle groups), heat syncope (results from pooling of blood

in the peripheral areas of the body in the body's attempt to release heat), and heat rash (also known as "prickly heat" resulting from the continuous exposure of skin to unevaporated sweat), and heat behavioral disorders (such as transient heat fatigue characterized by impaired sensorimotor and mental response).

There are many ways of controlling heat stress among workers. It can involve engineering controls, administrative controls and individual measures.

Ventilation, air cooling, fans, shielding, and insulation are the five major types of engineering controls used to reduce heat stress in hot work environments. Heat reduction can also be achieved by using power assists and tools that reduce the physical demands placed on a worker.

A properly designed and applied acclimatization (physiologic adaptation) program decreases the risk of heat-related illnesses. Such a program basically involves exposing employees to work in a hot environment for progressively longer periods. NIOSH (1986) says that, for workers who have had previous experience in jobs where heat levels are high enough to produce heat stress, the regimen should be 50% exposure on day one, 60% on day two, 80% on day three, and 100% on day four. For new workers who will be similarly exposed, the regimen should be 20% on day one, with a 20% increase in exposure each additional day.

Cool (50°-60°F) water or any cool liquid (except alcoholic beverages) should be made available to workers to encourage them to drink small amounts frequently, for example one cup every 20 minutes. Ample supplies of liquids should be placed close to the work area.

Exposure to low or cold temperatures likewise have physiologic effects on human beings. Health effects of cold exposure include Hypothermia, Frostbite, Immersion foot and Trenchfoot. Hypothermia is the progressive lowering of the body's core temperature from its normal level of 37C to 26.7C or below. Frostbite happens during exposures to temperatures below freezing resulting in mild to massive superficial tissue damage and gangrene. Immersion foot is the result of prolonged exposure to cool or cold water for days to weeks leading to numbness, extreme edema, hyperemia, anhidrosis and superficial gangrene. Trenchfoot results from exposure to moisture at or near freezing for days. The symptoms are similar to immersion foot.

f. Radiation

Radiation is a complex process through which the energy emitted by a source is transmitted through different media and then absorbed by a support. According to the ionizing capacity of the matter we have ionizing and non-ionizing radiation.

Ionizing radiation are either electromagnetic rays (X-rays or gamma rays) or particles (alpha and beta particles). It occurs naturally (from the radioactive decay of natural radioactive substances such as radon gas and its decay products) but can also be produced artificially. In the workplace, ionizing radiation has many applications in medicine, research, engineering, construction, and nuclear power generation. When ionizing radiation interacts with the human body, it gives its energy to the body tissues.

In the workplace, ionizing radiation presents health risks to workers. According to many researches, workers with long-term exposure to low-levels of ionizing radiation are at risk of developing cancers and DNA mutations. High levels of radiation exposure cause radiation sickness and burns.

Exposure limit values are given in the ionizing radiation EURATOM Directive to ensure that appropriate actions are taken at appropriate exposure levels to ensure the protection of workers. In most European countries the limit for effective dose of occupational workers is set at 20mSv in any single year. Substantially lower dose limits are defined for apprentices, pregnant workers and members of the public affected by work activities.

For ionizing radiation, some parameters can be measured, such as the radioactivity of the radiation source, the energy of the radiation, the amount of radiation in the environment, and the amount of radiation energy absorbed by the human body (the radiation dose).

The radiation dose is the most important measure, from the medical point of view. The radiation dose can be expressed by:
Absorbed dose - the amount of energy absorbed per unit weight of the organ or tissue; measured by **Gray (Gy)**
Equivalent dose - Absorbed Dose in Gy x radiation weighting factor (WR); measured in **Sievert (Sv)**

The equivalent dose takes in consideration the radiation type, because the equal doses of all types of ionizing radiation are not equally harmful.

The Threshold Limit Values (TLVs) published by the ACGIH (American Conference of Governmental Industrial Hygienists) are:

20 mSv - TLV for average annual dose for radiation workers, averaged over five years

50 mSv - TLV for average annual dose for radiation workers

1 mSv - annual dose limit recommended for general public (ICRP - International Commission on Radiological Protection).

The risk of radiation-induced diseases depends on the total radiation dose that a person receives over time.

Protection of workers and others from work activities involving ionizing radiation are controlled through reporting and authorization of hazardous activities, limitation and monitoring of received doses, classification and delineation of work areas, information to and training of workers, medical surveillance of exposed workers.

Non-ionizing radiation include**:** electro-magnetic fields, Infrared, ultraviolet (UV), visual radiation laser, microwave.

Electromagnetic fields (EMFs) arise whenever electrical energy is used. Although most EMF sources at work will produce field strengths that can be considered harmless, hazardous EMFs arise from work processes such as welding, radiofrequency heating and drying, high-field magnetic resonance imaging (MRI) scanners and from radio, TV and telecommunications broadcasting masts. Exposure of workers to high levels of EMFs can give rise to a variety of health effects that depend on the frequency of the electromagnetic radiation. At low frequencies the central nervous system of the body can be affected whilst at high frequencies, heating effects can occur. These acute health effects are extremely rare and do not occur in most day-to-day work situations.

Exposure to *natural optical radiation* (sunlight) is a risk for outdoor workers. Over-exposure of the skin to the UV radiation in sunlight can cause skin cancers and eye damage. Occupations at particular risk include those that involve long-periods of outdoor work such as workers in construction, road maintenance and utilities, agriculture, horticulture and forestry, postal and delivery service, marine activities (for example: in-shore and off-shore sailing, fish-farming, fishing), window cleaning, waste collection, and many others.

Workers should avoid prolonged exposure to sunlight to avoid getting skin reddening (erythema) which is a sign of skin damage as well as an early sign of sunburn. Simple ways to minimize the risks are to take breaks in shaded places, keeping vulnerable areas of the body such as the back and neck covered using suitable UV protective clothing, and use of sunscreen on exposed skin.

Exposure to*artificial optical radiation* may arise from light emitted from all artificial sources, such as light in all its forms such as visible, ultraviolet, infra-red and lasers, but excluding sunlight. The effects of exposure to artificial optical radiation can be both acute and chronic, affecting mainly the skin and eyes.

Where the skin is affected, those exposed may suffer short-term effects of reddening (erythema), blistering and burns. Long-term exposures may cause skin ageing (elastosis) and skin cancer. For the eyes, damage may include inflammation of the cornea (photokeratitis), inflammation of the conjunctiva that lines the eyelids and eye socket (photoconjunctivitis), retinal damage, corneal burns, retinal burns and cataracts.

Lasers are a sub-group of artificial optical radiation that present specific risks to the worker. Injury to the eye can be caused by brief exposures to quite low-powered lasers and

high powered lasers can also burn the skin. The diffuse reflection of higher powered laser beams from a surface can also be hazardous to the eye. Lasers are used in a wide range of applications including medicine and entertainment.

Risks from lasers can be avoided by careful control of the route that the beam takes, avoiding unintended reflections and the use of appropriate protective glasses. For higher powered lasers key switches and interlocks are required to ensure access by suitably trained personnel and avoid unintentional operation. Laser safety classifications are designed to assist in the process of identifying suitable controls for different types of laser product. Lasers are rated against 7 classes defined by EN 60825-19 (Please see Table below).

Table 2: EN 60825-1 laser classes

Class	Hazard	Warning statement*
Class 1	Safe under reasonably foreseeable conditions (Note: Class 1 lasers include high-power lasers that are fully enclosed, such that potentially hazardous radiation is not accessible during use).	-
Class 1M	Safe for the naked eye except if magnifying optics are used.	Do not view directly with optical instruments
Class 2	Safe for short exposures (less than 0.25s). The eye is protected by the blink reflex.	Do not stare into the beam
Class 2M	Safe for short exposures (less than 0.25s). The eye is protected by the blink reflex except if magnifying optics are used.	Do not stare into the beam or view directly with optical instruments
Class 3R	Safe if handled with care, may be dangerous if mishandled. Risk is limited by the blink reflex and natural response to heating of the cornea for infrared radiation.	Avoid direct eye exposure
Class 3B	Direct viewing is hazardous. Protective eyewear is necessary if the beam is accessible. Safety interlocks are required to prevent access to hazardous laser radiation.	Avoid exposure to beam
Class 4	Can burn the skin and cause permanent eye damage. Class 4 lasers can also present a fire hazard. Safety interlocks with manual reset are required to prevent access to hazardous laser radiation.	Avoid eye or skin exposure to direct or scattered radiation
* The warning statements accompany the title: "laser radiation" and laser product type statement on laser product labels in the format: LASER RADIATION *Warning statement* CLASS *x* LASER PRODUCT Additional labelling may also be required dependent upon the laser class and beam accessibility.		

Source Adapted from EN 60825-1:2007

The majority of light sources (such as overhead and task lighting, computer screens and photocopiers) are safe when used properly (e.g. fluorescent lamps fitted with diffusers). However, some sources may present a risk that needs to be controlled (e.g. welding, plasma cutting, UV curing of inks and paints).

The exposure of workers should be controlled by selecting low-emission equipment, restricting access and using screens.

Exposure limits are dependent upon wavelength, the part of the body at risk and the time exposed. The limits are defined in terms of irradiance (the radiated power per square meter incident on a surface, W/m^2), radiance (the radiated power incident on a surface within in a given solid angle, $W/m^2/sr$), or radiant exposure (the integral of the irradiance with time, i.e. the radiant energy per square meter incident on a surface, J/m^2).

If engineering and administrative measures cannot adequately control exposure, workers will need to wear protective clothing to cover exposed areas of skin and to protect the eyes. Normally this means wearing gloves, goggles or face shields. Eye protection should be suitable for the wavelength of radiation to which the worker is exposed.

g. Illumination

Light or visible light is electromagnetic radiation that is visible to the human eye, and is responsible for the sense of sight.

The device for measuring lighting is luxmeter. The measuring unit for lighting is “lux” (luminance) - the luminous flux per unit area at any point on a surface exposed to incident light.

Visual capacity and visual comfort are very important, because many accidents are due to lighting deficiencies or errors made by the worker because it hard to identify objects or the risks associated with machinery, conveyances, dangerous containers and warnings. Poor visibility increases the chances of errors being made, makes work slower, and decreases productivity. Poor lighting may have health effects such as visual fatigue, vision problems in color perception and accommodation, headache and musculoskeletal disorders.

The provisions for illumination are covered in Rule 1075 of the OSHS. According to this, all places where persons work or pass or may have to work or pass in emergency, should be provided with adequate natural or artificial lighting or both, suitable for the operation and the type of work performed. Standards for natural and artificial lighting have been laid, including the avoidance of glare, provision of emergency lighting and maintenance of such systems.

The standards of lighting intensity for different operations of work environment have been provided in Table 8c of the OSHS. (Please see pp 189-190 of the OSHS book).

h. Barometric Pressure

Barometric pressure is the pressure generated by the amount of air particles in the atmosphere on top of or surrounding an object. The activities performed in conditions of abnormal pressure are grouped into two categories: activities performed at hyperbarism (atmosphere compression or decompression) and activities performed at hypobarism (pressure below that of ground level atmospheric pressure).

Decompression sickness (caisson disease) can result from exposure to high or low atmospheric pressure. Under increased atmospheric pressure (such as that experienced by deep-sea divers or tunnel workers), fat-soluble nitrogen gas dissolves in the body fluids and tissues. During decompression the gas comes out of solution and, if decompression is rapid, bubbles are formed in the tissues. These bubbles cause pains in the limbs (known as the bends), breathlessness, angina, headache, dizziness, collapse, coma, and in some cases death. Similarly, the gases in solution in the body tissues under normal atmospheric pressure form bubbles when pressure rapidly decreases, as when aviators in unpressurized aircraft ascend to high altitudes too quickly. Emergency treatment of decompression sickness consists of rapid recompression in a compression chamber with gradual subsequent decompression. The condition can be prevented by allowing sufficient decompression time for the excess nitrogen gas to be expelled naturally.

A problem is that as one ascends higher and higher above sea level, both the total air pressure (the barometric pressure, PB) and the amount of oxygen in the ambient air (that portion of total pressure due to oxygen, PO_2) progressively fall. Most people who travel from sea level to an altitude of 4,500 m develop some symptoms of acute mountain sickness initially. Tolerance to the altitude often improves after the first two or three days because of acclimatization. If acclimatization does not occur, the severe hypoxia of these altitudes has a number of deleterious effects on the body. Maximal work capacity is decreased, and people fatigue more rapidly. Mental efficiency is reduced and many people find it is much more difficult to concentrate. Sleep quality is often poor, with frequent arousals and periodic breathing (the breathing waxes and wanes three or four times every minute) with the result that that the arterial PO_2 falls to low levels following the periods of apnea or reduced breathing. As a result, the amount of work we can accomplish progressively decreases. These principles affect the workplace.

Workplaces with hyperbarism: underwater activities, scuba divers (the pressure exceeds with at least 0.1 atmospheres, the normal value).

Medical measures to prevent hyperbarism may involve proper pre-employment and periodical examinations, paying a special attention to the ENT (ear-nose-throat) examination, ophthalmological, neurological and cardiac examinations. Obese people, age>45, alcholic persons, people suffering from cardiac or respiratory diseases are not allowed to work in such conditions.

Workplaces with hypobarism: pilots, lift workers, mountain climbing and operations done at high altitude.

In addition to the usual type of pre-employment examination, special attention should be given to the cardio-pulmonary system, because working at high altitude makes great demands on the respiratory and cardiovascular systems. Medical conditions such as early chronic obstructive pulmonary disease and asthma will be much more disabling at high

altitude because of the high levels of ventilation, and should be specifically looked for. A heavy cigarette smoker with symptoms of early bronchitis is likely to have difficulty tolerating high altitude. Forced spirometry should be measured in addition to the usual chest examination including chest radiograph. If possible, an exercise test should be carried out because any exercise intolerance will be exaggerated at high altitude. The cardiovascular system should be carefully examined; including an exercise electrocardiogram if that is feasible. Blood counts should be made to exclude workers with unusual degrees of anemia or polycythemia.

Technical measures may prevent hypobarism.The problem was solved because of the pressurization of the planes. For mountain climbers, climbing in stages is recommended.

SUMMARY

The term 'Physical Agents' can be applied to a number of agents that cause a range of adverse health and safety effects on the worker. The agents may present risks to workers in most, if not all, industry categories. For many agents, legal duties have been placed on employers to control workplace exposure to the agents.

The health and safety risks from physical agents are diverse, but these risks can be controlled. The basic control principles that can generally be applied to the agents are: eliminating or reducing emissions at source, reducing transmitted energy using barriers, isolators or absorbers, managing the durations of exposures and the use of protective clothing.

Rule 1070 of OSHS provides rules and regulations on Occupational health and Environmental Control. These standards have been laid down to protect and promote health and safety in the work environment. Under this, several other rules on illumination, noise and general ventilation in the workplace have been set. It is recommended that atmospheric conditions be maintained in workrooms to avoid insufficient air supply, stagnant air, harmful drafts, excessive heat or cold, sudden variations in temperature, excessive humidity or dryness and unpleasant odor.

In addition to these control measures, information, instruction and training for machine users and health surveillance are also important components of successful programs to manage the risks from physical agents.

Man is always subjected to different environmental factors. These may affect his physiology and health, and thus his productivity. Hence, environmental factors must be kept within man's physiologic capacities to enable man to function well, be healthy, and be able to take care of his environment in return.

III. PEDAGOGY

1. Attendance
2. Orientation (*15 minutes*)
3. Lecture (*30 minutes)*: The students may also be asked to read some of the information in advance so as to maximize the topics that will be discussed during the 30-minute lecture.
4. Suggested Activities
   A. Film showing *(30 minutes)*: Choose a video or documentary focusing on current environmental issues and concerns. Prior to film showing, assign students with specific topics related to the activity (i.e. problems, factors leading to the problems, and solutions).
      Sample video: ADB Water Voices: Hidden Paradise – about how informal settlers solved their water problems and transformed their community in Bacolod City
   B. Small/Focus group discussion on the film *(30 minutes)*: Guide questions will be given for each brigade.
      a. Each group will choose a specific environmental issue or concern identified from the video shown.
      b. Discuss among the members of the group measures on how to address the identified problem.
5. Synthesis to be facilitated by the teacher (10 minutes each for (a) problems, (b) factors leading to the problems, and (c) solutions) *(30 minutes)*
6. Short quiz *(15 minutes)*
7. Take Home Activity
   A. Output (e.g. IEC materials such as infographics, poster, short video) will be submitted next meeting.
   B. Rubrics: Content-30%, organization-30%, creativity-20%, clarity of message-20%

IV. ASSESSMENT (GRADE) REQUIREMENTS

A. Attendance		20%
B. Take Home Activity		50%
C. Short Quiz		30%
	TOTAL	100%

V. SCHEDULE OF MEETINGS

This module on **Environmental Awareness and Protection** is applicable for one meeting, which is equivalent to three hours.

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