HAZARD AND RISK MANAGEMENT

SYALLABUS

- WORK PLACE HAZARD
- RISK AND HAZARD MANAGEMENT
- ICH GUIDELINES ON RISK MANAGEMENT
- METHODS AND TOOLS
- ACCIDENTAL PREVENTION
- SAFETY PROGRAMME AND MANAGEMENT
- BOD,COD
- ROLE OF EMERGENCY SERVICES

INTRODUCTION

- Risk management principles are effectively utilized in many areas of business and government including finance , occupational safety ,public health , pharmacovigilance , and by agencies regulating these industries.

PRINCIPLE

PRINCIPLES OF QUALITY RISK MANAGEMENT

Two primary principles of quality risk management are:

- The evaluation of the risk to quality should be based on scientific knowledge and ultimately link to the protection of the patient .
- The level of effort , formality and document of the quality risk management process should be commensurate with the level of risk.

SELF-PROTECTIVE MEASURES AGAINST WORKPLACE HAZARDS

- Developing the program .
- Reporting hazards and developing solutions that improve safety and health .
- Analyzing hazards in each step of routine and non routine jobs , tasks and process.
- Defining /documenting safe work practices .
- Conducting site inspections .
- Developing and revising safety procedures .

Self –protective …

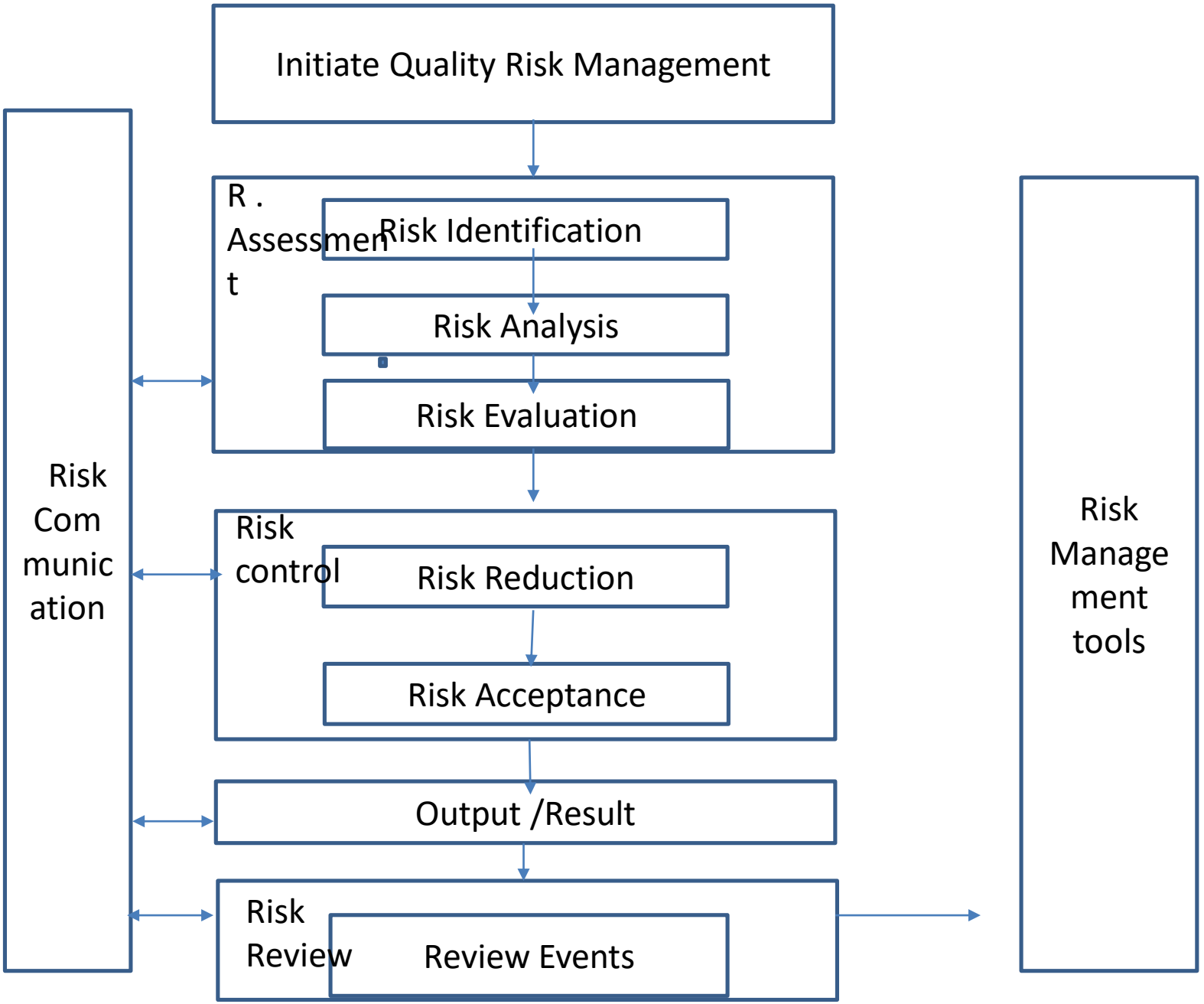
- Participating in incident and close call/near miss investigations.
- Serving as trainers for current coworkers and new hires.
- Developing , implementing , and evaluating training programs.

CRITICAL TRAINING FOR RISK MANAGEMENT

Critical Employee Training

1. Develop comprehensive training courses
2. Monitor participation in training
3. Assess training effectiveness and continuously improve .

Process of Hazards Management



PROCESS OF HAZARDS MANAGEMENT

Step 1: Identification

Step 2: Risk Assessment

Step 3: Controls

- 1: Eliminate
- 2: Isolate
- 3: Minimize

Step 4: Monitor and Review

ICH GUIDELINESS ON RISK ASSESSMENT AND RISK MANAGEMENT METHODS AND TOOLS

Quality Risk Management Q9

This Guideline has been developed by the appropriate ICH Expert working group and has been subject to consultation by the regulatory parties , in accordance with the ICH process.

RISK ASSESSMENT

Risk Assessment Risk assessment consists of the identification of hazards and the analysis and evaluation of risk associated with exposure to those hazards (as defined below). Quality risk assessments begin with a well-defined problem description or risk question.

RISK MANAGEMENT METHODS AND TOOLS

Basic risk management facilitation methods (flowcharts , check sheets etc.)

- Failure Mode Effects Analysis (FMEA)
- Failure Mode , Effects and Criticality Analysis (FMECA)
- Fault Tree Analysis (FTA)
- Hazard Analysis and Critical Control points (HACCP)
- Hazard Operability Analysis (HAZOP)
- Preliminary Hazard Analysis (PHA)
- Risk ranking and filtering
- Supporting statistical tools .

Reference

- https://www.slideshare.net/ramu9682/ich-q9-quality-risk-management-52976101
- https://www.slideshare.net/ankush96/hazard-and-risk-management-92406163

HAZARDS AND RISK MANAGEMENT

Submitted To:

Dr.Sivakamasundhari
Associate Professor
Department Of Pharmacy
Annamalai University.

Presented By:

Sudaroli K
M.Pharm., 1st Year
Quality Assurance
Department Of Pharmacy
Annamalai University.

CONTENTS

FACTORY ACT AND RULES

- Safety of buildings and machinery
- Maintenance of buildings.
- Safety Officers.

PROVISIONS RELATING TO HAZARDOUS PROCESSES

- Power to make rule to supplement this Chapter
- Constitution of Site Appraisal Committees.
- Compulsory disclosure of information by the occupier.
- Specific responsibility of the occupier in relation to hazardous processes.
- Power of Central Government to appoint Inquiry Committee.
- Emergency standards.
- Permissible limits of exposure of chemical and toxic substances.
- Workers' participation in safety management.
- Right of workers to warn about imminent danger.

FUNDAMENTALS OF ACCIDENT PREVENTIONS

Three essential ingredients in any Organization.

- Man
- Machine
- Material

These form three angle of a triangle with Management at center to control them.

It is essential that this triangle is an equilateral triangle, maintaining the essential equilibrium.

H.W.Henriech- analysis accidents in 1931.

- Theories Of Accident Causation

- Frank bird Analuzed1.75 Million Accident In1969.

What is accident ?

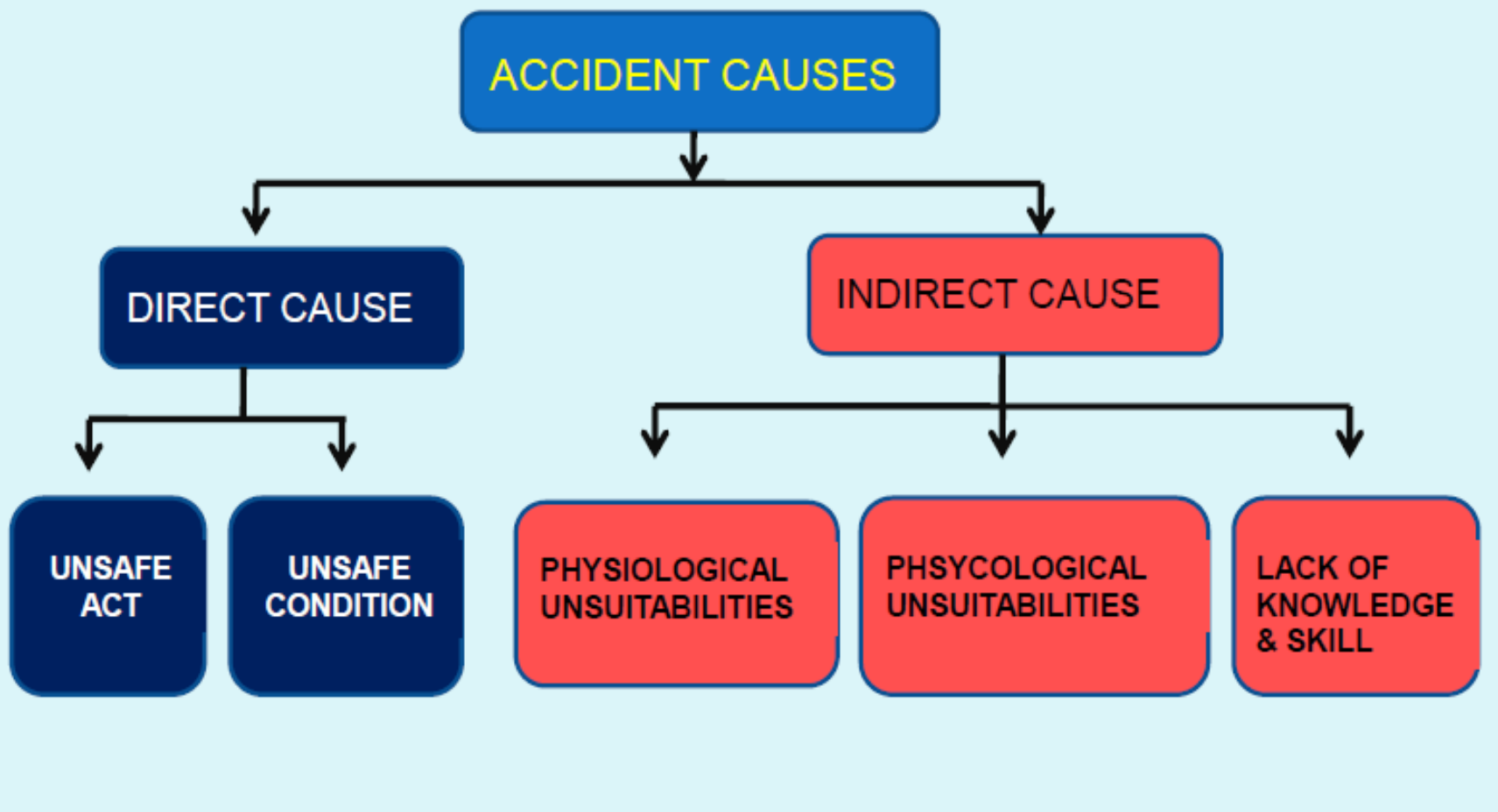
- An unintended, unplanned event which has the potential to cause harm or injury.
- An incident which causes harm or has potential to do so.

Injury is the result of completion of 5 dominos

- Social Environment.
- Fault of the person
- Unsafe Action / Unsafe Condition
- Accident
- Injury

HOW ACCIDENTS OCCUR

CAUSES OF ACCIDENTS



CONTINUED..


Self-actualization: achieving one's full potential, including creative activities
Esteem needs: prestige and feeling of accomplishment
Belongingness and love needs: intimate relationships, friends
Safety needs: security, safety
Physiological needs: food, water, warmth, rest
Self-fulfillment needs
Psychological needs
Basic needs

ELEMENTS OF SAFETY PROGRAMME AND SAFETY MANAGEMENT

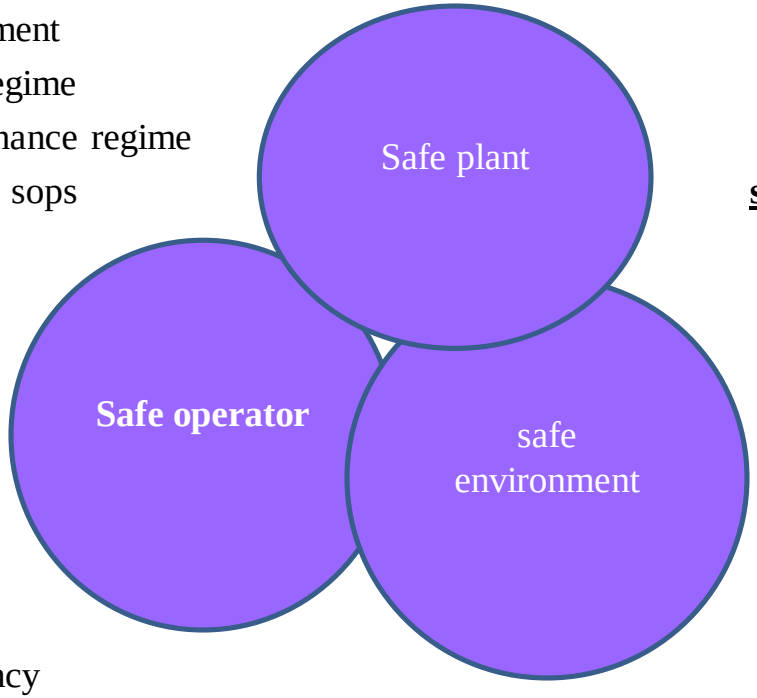
Safe plant

i)Plant hazard assessment

ii) Daily inspection regime

iii)Productive maintenance regime

iv)Plant & equipment sops



safe environment

i) Site inspection & hazarded review

Ii) High level job task review

Iii) WHS management plan

Iv)Manage high risk activities

Safe operator

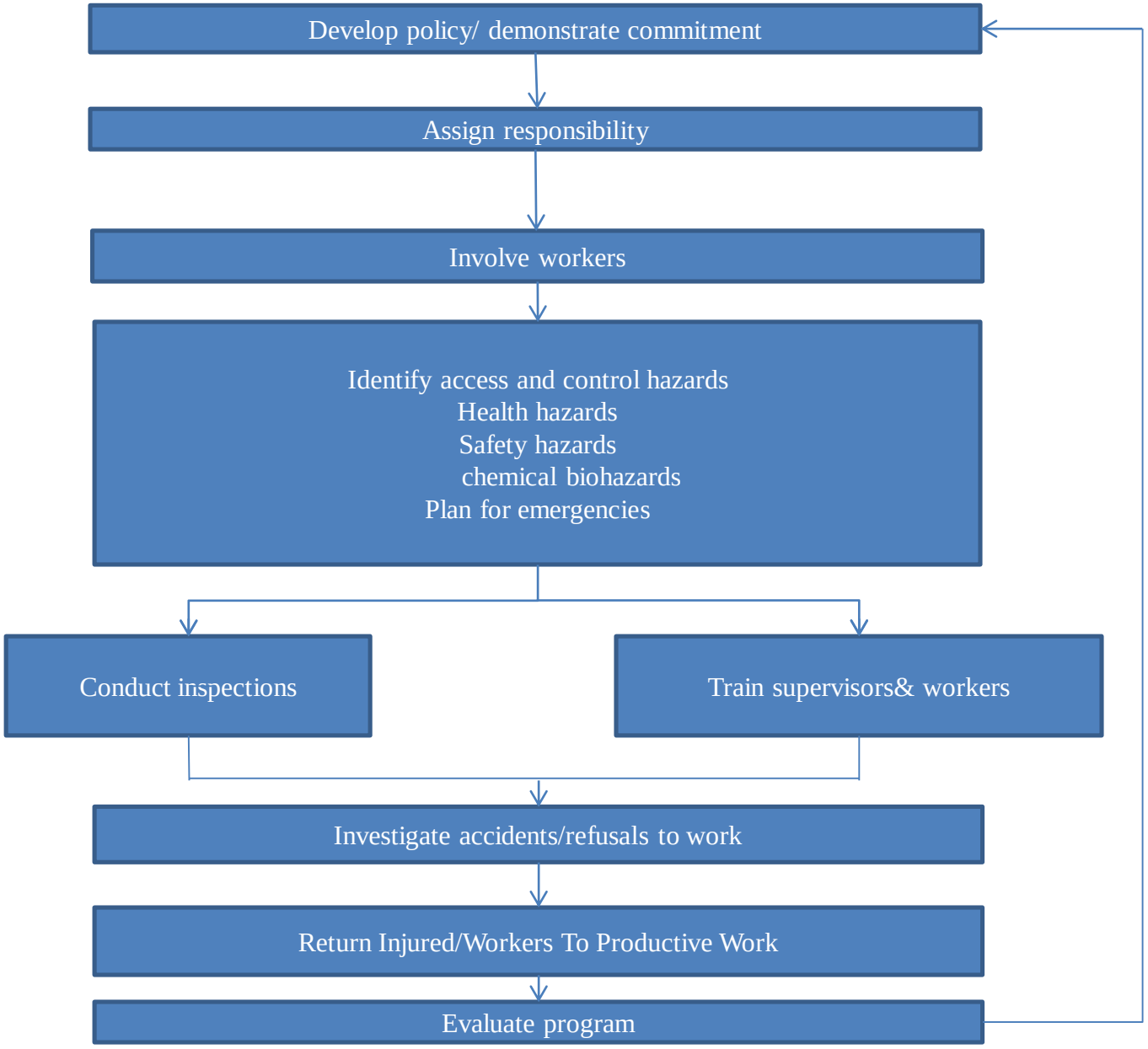
i) Operating timing

ii) Operator competency

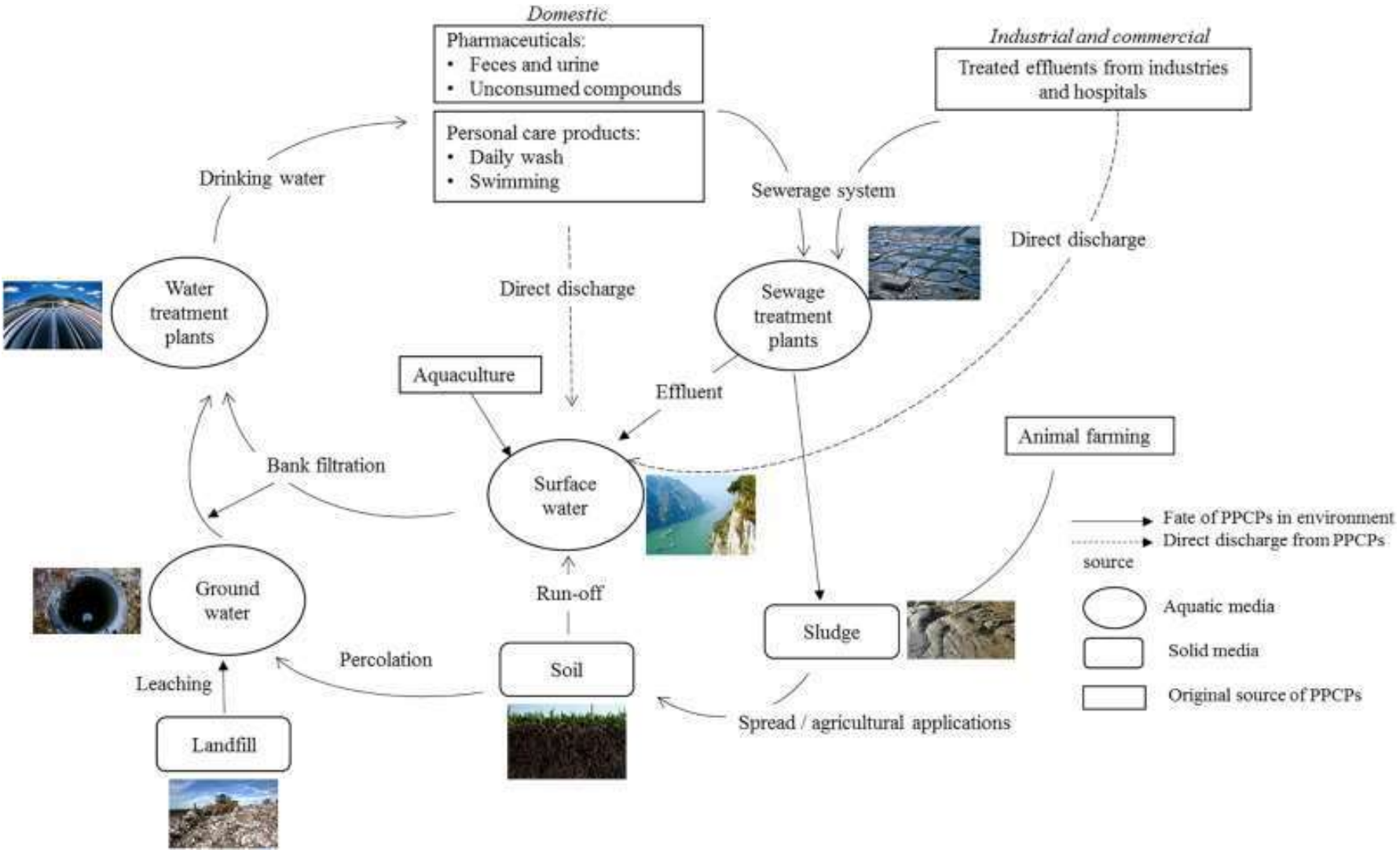
iii)General safety knowledge

iv)Site specific knowledge

HOW IS THE PROGRAM IS DEVELOPED?



PHYSIOCHEMICAL MEASUREMENTS OF EFFLUENTS



TYPES OF EFFLUNT

- Industrial waste water treatment
- Sewage treatment

INDUSTRIAL WASTEWATER TREATMENT

- Industrial wastewater treatment covers the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re- use.

SOURCES OF INDUSTRIAL

WASTE WATER

- Agricultural waste
- Iron and steelindustry
- Mines andquarries
- Food industry
- Complex organic chemicalsindustry
- Nuclear industry

SEWAGE TREATMENT

- It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce an environmentally-safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually a farm fertilizer).
- Using advanced technology it is now possible to re-use sewage effluent for drinking water, although Singapore is the only country to implement such **Sewage treatment**, or **domestic wastewater treatment**, is the process of removing contaminant from wastewater and household sewage both runoff (effluents) and domestic technology on a production scale in its production of NEWWater

VIEW OF TREATMENT PLANT

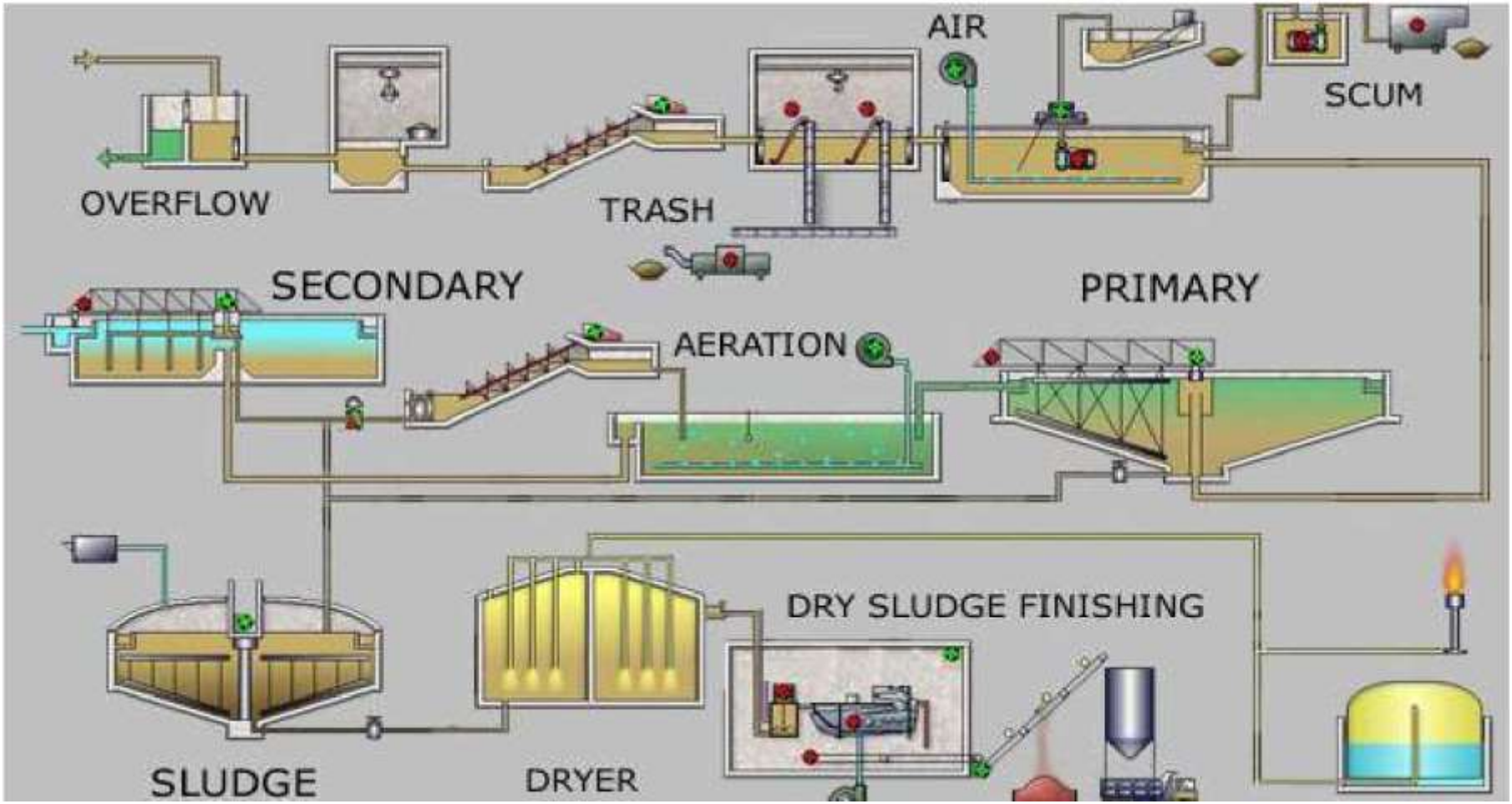
ORIGINS OF SEWAGE

- Sewage is generated by Residential, institutional, commercial industrial establishments,
- It is include house hold waste in liquid form like toilet, bath showers, kitchen.

TYPES OF PROCESS OVERVIEW

- PreTreatment
- Grit Removal
- Flow Equalization
- Fat & Greas Removal
- Primary Treatment
- Secondary Treatment
- Tertiary Treatment

PROCESS FLOW DIAGRAM FOR ATYPICALL ARGESCALE TREATMANT PLANT



ACTIVATED SLUDGE

- In general, activated sludge plants encompass a variety of mechanisms and processes that use dissolved oxygen to promote the growth of biological floc that substantially removes organicmaterial.
- The process traps particulate material and can, under ideal conditions, convert ammonia to nitrite and nitrate ultimately to nitrogengas

PACKAGE PLANTS AND BATCH REACTORS

- One type of system that combines secondary treatment and settlement is the sequencing batch reactor (SBR). Typically, activated sludge is mixed with raw incoming
- sewage, and then mixed and aerated. The settled sludge is run off and re-aerated before a proportion is returned to the headwork's. SBR plants are now being deployed in many parts of the world.

SLUDGE TREATMENT AND DISPOSAL

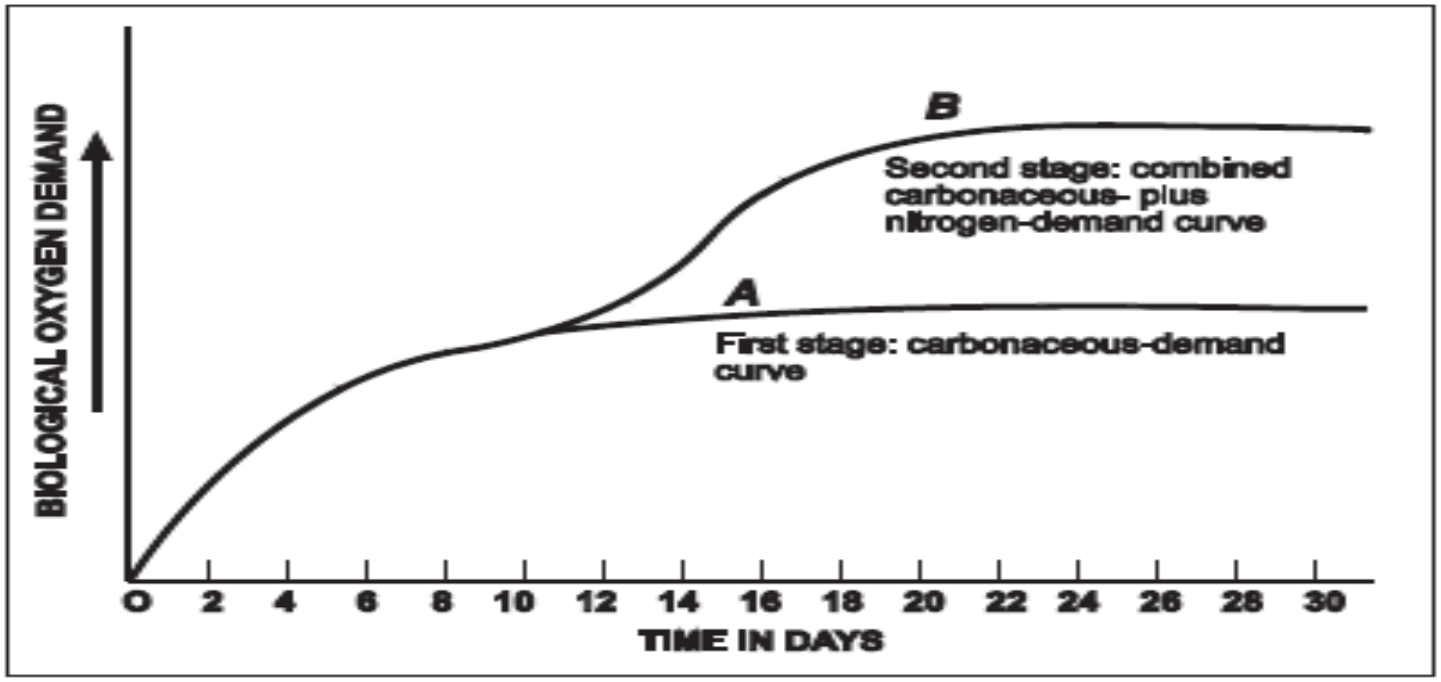
- The sludge's accumulated in a wastewater treatment process must be treated and disposed of in a safe and effective manner. The purpose of digestion is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion , aerobic digestion, and composting . Incineration is also used albeit to a much lesser degree.

EFFECTS ON BIOLOGY

- Oxidation ponds, which are aerobic bodies of water usually 1–2 meters in depth that receive effluent from sedimentation tanks or other forms of primary treatment.
- Dominated by algae
- Polishing ponds are similar to oxidation ponds but receive effluent from an oxidation pond or from a plant with an extended mechanical treatment.
- Dominated by zooplankton

BOD: BIOLOGICAL OXYGEN DEMAND

- Biological oxygen demand (BOD), also known as biochemical oxygen demand, is a bioassay procedure that measures the dissolved oxygen (DO) consumed by bacteria from the decomposition of organic matter.



WHY MEASURE BOD?

- Biological oxygen demand is an important water quality parameter because it greatly influences the concentration of DO that will be in the water.
- The Q-value curve for BOD used in calculating a water quality index2 illustrates the relationship between BOD and water quality—the higher the BOD, the lower the water quality, with 0 to 2 mg/L being associated with high water quality and values greater than 10 mg/L being associated with low water quality (refer to the BOD Test Results chart).

COD :CHEMICAL OXYGEN DEMAND

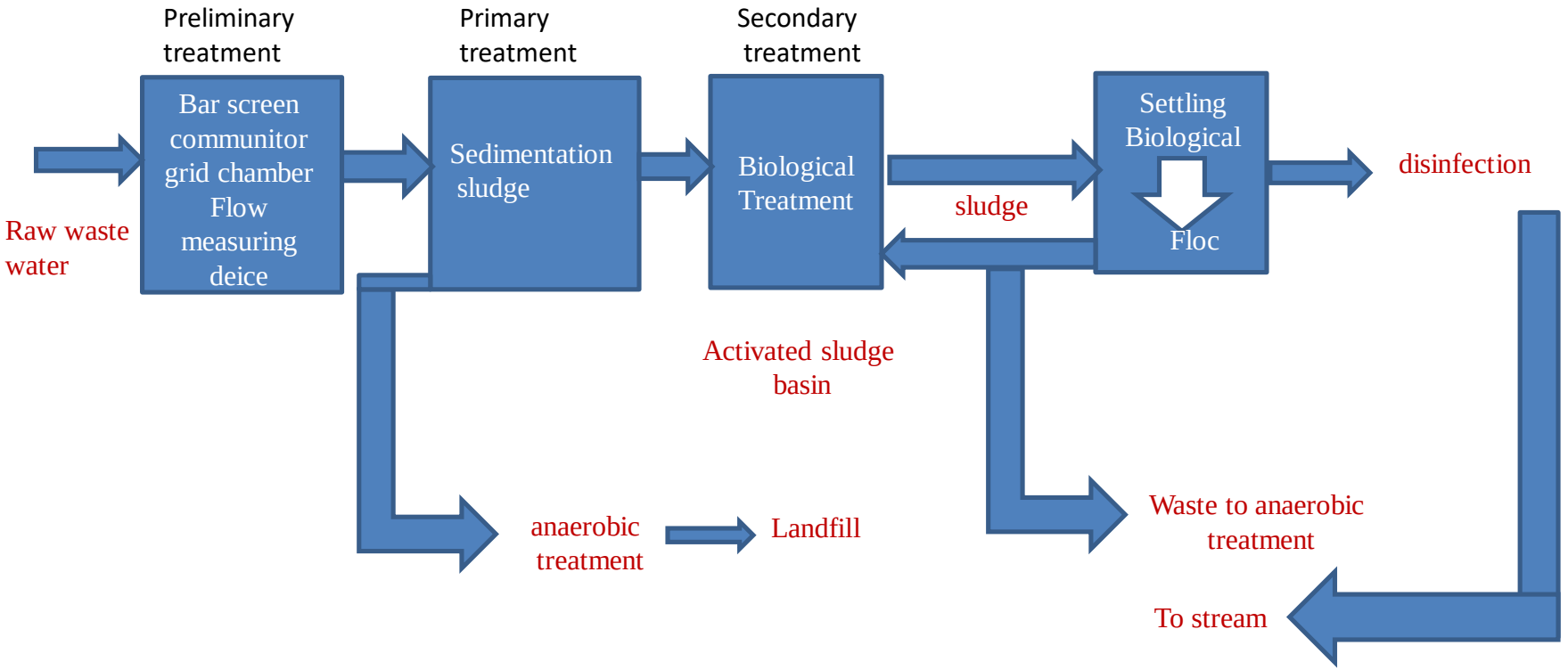
- The COD (Chemical Oxygen Demand) test represents the amount of chemically digestible organics (food). COD measures all organics that were biochemically digestible as well as all the organics that can be digested by heat and sulfuric acid. It is used in the same applications as BOD.
- COD has the advantage over BOD in that the analysis can be completed within a few hours whereas BOD requires 5 days. The major drawback of the COD test is the presence of hazardous chemicals and toxic waste disposal.

DETERMINATION OF SOME CONTAMINANTS

- Liquid chromatography
- Mass spectrometry
- NMR Spectra
- UV Spectra
- Microscopic Technique
- IR spectra

EFFLUENT TREATMENT PROCEDURE

WASTE WATER TREATMENT



FILTRATION

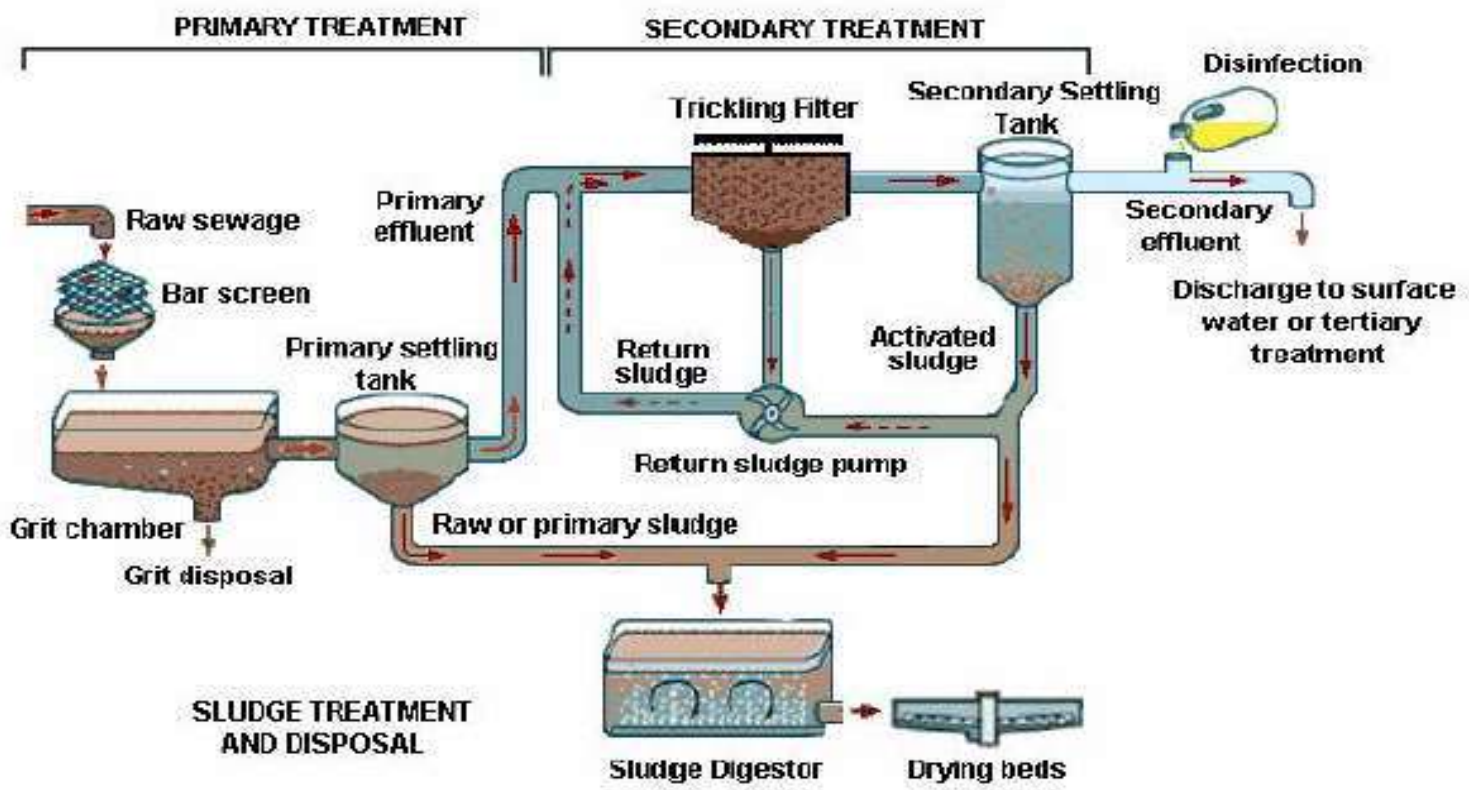


Figure 2–2: Wastewater treatment based on a trickling filter system

ROLE OF EMERGENCY SERVICES

The Emergency Control Organization is responsible for:

- Implementing emergency procedures as prescribed in the Emergency Plan & Procedures
- Ensuring that all personnel within their area of responsibility are trained for their role in an emergency
- Reporting any matters likely to affect the viability of the Emergency Plan & Procedures
- Checking on the effectiveness of emergency systems and equipment

ROLES AND RESPONSIBILITIES

- Chief Warden (Campus Emergency Coordinator)
- Deputy Chief Warden (Emergency Response Officer)
- Communications Officer
- Area Wardens
- Wardens
- Insufficient Wardens
- Staff in charge of Student
- Critical incident management team
- Emergency Management Review Committee
- Eco identification
- Maintenance of warden coverage

ICH GUIDELINES ON RISK ASSESSMENT

- Risk assessment consists of the identification of hazards and the analysis and evaluation of risks associated with exposure to those hazards (as defined below).
- Quality risk assessments begin with a well-defined problem description or risk question. When the risk in question is well defined, an appropriate risk management tool (see examples in section 5) and the types of information needed to address the risk question will be more readily identifiable.
- As an aid to clearly defining the risk(s) for risk assessment purposes, three fundamental questions are often helpful:

ICH GUIDELINES ON RISK ASSESSMENT

- Risk identification is a systematic use of information to identify hazards referring to the risk question or problem description. Information can include historical data, theoretical analysis, informed opinions, and the concerns of stakeholders.
- Risk identification addresses the “What might go wrong?” question, including identifying the possible consequences. This provides the basis for further steps in the quality risk management process.

ICH GUIDELINES ON RISK ASSESSMENT

- Risk analysis is the estimation of the risk associated with the identified hazards. It is the qualitative or quantitative process of linking the likelihood of occurrence and severity of harms. In some risk management tools, the ability to detect the harm (detectability) also factors in the estimation of risk.
- Risk evaluation compares the identified and analyzed risk against given risk criteria. Risk evaluations consider the strength of evidence for all three of the fundamental questions.

ICH GUIDELINES ON RISK ASSESSMENT

- In doing an effective risk assessment, the robustness of the data set is important because it determines the quality of the output.
- Revealing assumptions and reasonable sources of uncertainty will enhance confidence in this output and/or help identify its limitations. Uncertainty is due to combination of incomplete knowledge about a process and its expected or unexpected variability.
-

ICH GUIDELINES ON RISK ASSESSMENT

- Thus, quantitative risk estimation is useful for one particular consequence at a time. Alternatively, some risk management tools use a relative risk measure to combine multiple levels of severity and probability into an overall estimate of relative risk.
- The intermediate steps within a scoring process can sometimes employ quantitative risk estimation

ICH GUIDELINES ON RISK ASSESSMENT

- The output of a risk assessment is either a quantitative estimate of risk or a qualitative description of a range of risk. When risk is expressed quantitatively, a numerical probability is used. Alternatively, risk can be expressed using qualitative descriptors, such as “high”, “medium”, or “low”, which should be defined in as much detail as possible. Sometimes a "risk score" is used to further define descriptors in risk ranking.

ICH GUIDELINES ON RISK ASSESSMENT

- In quantitative risk assessments, a risk estimate provides the likelihood of a specific consequence, given a set of risk-generating circumstances.
- Typical sources of uncertainty include gaps in knowledge gaps in pharmaceutical science and process understanding, sources of harm (e.g., failure modes of a process, sources of variability), and probability of detection of problem.

ICH GUIDELINES ON RISK ASSESSMENT

- The manufacturing and use of a drug (medicinal) product, including its components, necessarily entail some degree of risk. The risk to its quality is just one component of the overall risk.
- It is important to understand that product quality should be maintained throughout the product lifecycle such that the attributes that are important to the quality of the drug (medicinal) product remain consistent with those used in the clinical studies.
- An effective quality risk management approach can further ensure the high quality of the drug (medicinal) product to the patient by providing a proactive .

ICH GUIDELINES ON RISK ASSESSMENT

- It is commonly understood that risk is defined as the combination of the probability of occurrence of harm and the severity of that harm.
- However, achieving a shared understanding of the application of risk management among diverse stakeholders is difficult because each stakeholder might perceive different potential harms, place a different probability on each harm occurring and attribute different severities to each harm.
- In relation to pharmaceuticals, although there are a variety of stakeholders, including patients and medical practitioners as well as government and industry, the protection of the patient by managing the risk to quality should be considered of prime importance.

ICH GUIDELINES ON RISK ASSESSMENT

- Define the problem and/or risk question, including pertinent assumptions identifying the potential for risk;
- Assemble background information and/ or data on the potential hazard, harm or human health impact relevant to the risk assessment;
- Identify a leader and necessary resources; Specify a timeline, deliverables and appropriate level of decision making for the risk management process.

ICH GUIDELINES ON RISK ASSESSMENT

- Risk acceptance is a decision to accept risk. Risk acceptance can be a formal decision to accept the residual risk or it can be a passive decision in which residual risks are not specified.
- For some types of harms, even the best quality risk management practices might not entirely eliminate risk. In these circumstances, it might be agreed that an appropriate quality risk management strategy has been applied and that quality risk is reduced to a specified (acceptable) level.
- This (specified) acceptable level will depend on many parameters and should be decided on a case-by-case basis.

ICH GUIDELINES ON RISK ASSESSMENT

- Risk management should be an ongoing part of the quality management process. A mechanism to review or monitor events should be implemented. The output/results of the risk management process should be reviewed to take into account new knowledge and experience.
- Once a quality risk management process has been initiated, that process should continue to be utilized for events that might impact the original quality risk management decision, whether these events are planned (e.g., results of product review, inspections, audits, change control) or unplanned (e.g., root cause from failure investigations, recall).
- The frequency of any review should be based upon the level of risk. Risk review might include reconsideration of risk acceptance decisions.

REFRENCE

1. Environmental hazards methodologies for risk assessment and management.
2. http://www.slideshre.net.
3. ICH harmonized tripartite guideline quality risk management.

FIRE AND EXPLOSION

FIRE AND EXPLOSION

- **Fire and explosion**
- The effects of accidental fires or explosions can be devastating in terms of live lost , injuries ,damage to property and the environment and to business continuity .
- Working with flammable liquids , dusts , gases and solids is hazards because of the risk of fire and explosion

FIRE

- **BASIC PRINCIPLES OF FIRE**
- Fire is the rapid chemical process in which oxygen combines with another substance in the presence of a heat energy
- The reaction of these elements is called combustion
- During the reaction heat ,light , and flames are given off

Types of fire

- CLASS A: ordinary material such as paper ,wood ,cloth
- CLASS B : flammable liquids or combustible liquids such as gasoline , paint ,propane ,kerosene .
- CLASS C : electrical equipment fires ,appliances swathes ,panels
- Certain metals such as magnesium ,sodium ,potassium ,titanium and aluminium
- CLASS D : Certain metals such as magnesium ,sodium ,potassium ,titanium and aluminium
- CLASS K – fires involving commercial cooking appliances with vegetables oils ,animal oils or fats at high pressure

FIRE PROTECTION AND PREVENTION

- Fire protection includes procedures for preventing ,detecting and extinguishing fire .
- The procedures in these three areas of fire prevention aim to protect
- Employs and properly and to assure the continuity of a plant ‘s operation
- To accomplish these goals it is pessary to develop plant wide fire protection program

INSPECTION

- Setup system of periodic fire inspections for every operation some buildings ,operations and processes require daily inspection , while others can be inspected weekly , monthly or at other intervals
- Buildings that are well designed and provided with protective devices and construction intended to act as fire safety features still need a periodic ,detailed inspection program .
- In some establishments or plants ,the safety and health committee locates and reports fire hazards

INSPECTION……

- In large plants ,this job is handed by a special subcommittee of the safety committee or by a person trained to manage fire risk
- The inspector fire chief or the other individual from the plant who is in charge of fire prevention trained to manage fire risk .
- the determine the directing –finding of reports
- And have a complete list all items to be inspected

INSPECTION OF FIRE EQUIPMENT SHOULD COVER THE FOLLOWING ITEMS

- control valves on pi[ping that supplies water for fire protection
- Hydrants
- Fire pumps
- Hose houses and associated equipment
- Sprinkler system water supplies including tanks
- Automatic sprinkler system
- Special type of protection
- Portable fire extinguishers

INSPECTION OF FIRE EQUIPMENT SHOULD COVER THE FOLLOWING ITEMS……..

- Fire doors ,exists
- Alarm and communication systems and routines
- Communication to fire department

DETECTION OF FIRE HAZARDS :

- Many automatic fire detection systems are used today in industry some include
- Thermal expansion detectors
- Heat sensitive insulation
- Photoelectric fires
- Ionization or radiation sensors and
- Ultraviolet or air detectors

PREVENTION OF FIRE HAZARD

- Well planned design and layout
- Proper ventured system
- Chemicals data sheets
- Proper training of personnel
- Proper maintenance of surroundings
- Use of fire extinguishers ,alarms ,sensors ,detectors

FIRE FIGHTING EQUIPMENTS

- Standpipe and hose system
- Fire alarm
- sprinklers
- Fire extinguisher
- Water
- Carbon dioxide
- ABC dry powder
- Dry powder

FIRE FIGHTING EQUIPMENTS……..

- Foam based extinguisher
- Clean agent fire extinguisher
- Other extinguisher

STAND PIPE AND HOSE SYSTEMS

- Stand pipe systems consist of :
- Piping
- Values
- Hose connections
- Nozzles to provide steams of water for fire suppression
- Wet system
- Dry system

Wet system

- A wet stand pipe is filled with water and is pressurized at all times
- Whenever the systems is activated ,water will charge into the connected hose immediately
- Wet stand pipes can be used by buildings occupants

Dry system

- A dry stand pipe is not filled with water
- The intakes of dry stand pipe are usually located near a road
- Drive way so that a fire engine can supply water to the system
- This system can be used only by fire fighter
- Regulations in may countries require that stand pipe systems be charged by hoses from two
- Different pump trucks which can be accomplish by using both sides of a Siamese connection

Fire alarm

- It is set of equipment working together to detect and alert people through visual and audio appliances when smoke or fire is present
- Active from smoke ,heat detector ,water flow sensors which are automatic or from manual fire alarm pull station

Automatic sprinkler system

- Automatic sprinkler systems are integrated fire suppression systems consisting of a water supply and a network of pipes ,sprinkler heads ,and other components to provide automatic fire suppression in areas of a building
- This system is the most effective for suppressing a class A fires in buildings containing ordinary
- Combustible materials ,such as wood paper and plastic

Sprinklers

- The major components of an automatic sprinkler system is the sprinkler ,which discharge water in specific pattern for extinguishing or controlling fire
- A sprinkler head consists of three major components :
- Nozzle
- Detector
- Water spray pattern deflector

Fire extinguisher

- A Fire extinguisher is a device which can be used to control a fire
- Fire extinguishers can help remove the fire and may stop it form bumming

THINGS TO REMEMBER BEFORE INSTALLATION OF FIRE EXTINGUISHERS

- Brass valve chrome plated heavy duty
- BIS approved
- CE certified
- Maintenance should be donor as per IS 2190:2010
- Must check the colour band according to need

Types of fire extinguisher

- Water
- Carbon dioxide
- ABC type dry powder
- Dry powder
- Foam based extinguisher
- Clean agent extinguisher
- other

water

- Water extinguishers are for class A fires only
- Limitations :
- Do not use on fires involving liquid
- The discharge stream could spread the flammable liquid
- Colour band - red
- Easy and no maintenance and service
- Used in –schools ,apartments

Carbondioxide

- Carbon dioxide can be used on class B AND C fires
- They are usually ineffective on class A fires
- Colour band – black
- Features –colourless
- Odourless
- Used in – rail yards /ware houses

ABC type fire dry powder

- ABC or multi purpose extinguishers comprise of a special fluidized and a siliconized mono ammonium phosphate dry chemicals
- It is use for class A fires and breaks the chain reaction of class B fires
- Easy and more economical to maintain and service
- Used in homes ,offices
- Colour band – blue
- Capacity 1-9 kg

EXPLOSION

- An explosion is a rapid increase in volume and release energy in an extreme manner , usually with the generation of high temperature and the release of gas
- supersonic explosions created by high explosive are known as detonations and travel via supersonic shock waves
- subsonic explosions are created by low explosives through a slower burning process known as deflagration

Electrical explosion

- A high current electrical fault can create an electrical explosion by forming a high energy electrical arc which rapidly vaporizes metal and insulation material
- This arc flash hazard is a danger to persons working on energized sitchgear
- Also exclusive magnetic pressure within an ultra strong electromagnet
- can cause a magnetic explosion

Nuclear explosion

- In addition to stellar nuclear weapon is a type of explosive weapon that destructive force from nuclear fission or form a combination of fission and fusion
- As a result even a nuclear weapon with a small yield is significantly more power full than largest conventional explosives available with a single weapon capable of completely destroying an entire city

Properties of explosions

- Fore
- Velocity
- Evaluation
- Initiation of reaction
- Fragmentation

Fire and explosion -ventilation

- Ventilation are recognised as key topics in the control of fire and explosion hazards on off shore installation
- They have been the subject of various research over the past 10 years and are the subject of increasingly detailed modeling by duty holders as a mean of demonstrating lower risk levels

Explosion proofing

- Ares with potentially explosive atmosphere are divided into Zones , equipment has to be divided into groups and categorise .
- The labelling on the identification plate of certified equipment indicates in which zone the explosion protected equipment can be used
- Division of product groups
- Division into zones
- Division into equipment groups and temp classes

Fire and explosion relief system

- **Relief valves**
- Relief valves are normally the first choice for over pressure protection due to their reliablity , rugardness and re closing feature .
- An ASME code stamp indicates the PRV has gone through a certification process to ensure flow capacity and opening within tolorence

Fire and explosion relief system…….

- **Relief valve types**
- Spring loaded pressure relief valves
- Pilot operated pressure relief valves
- Standard relief valves

Fire and explosion relief system…….

- Location of relief devices
- Isolated equipment items
- Closed piping systems exposed to heating
- Outlet side of fired heaters
- Outlets of turbines
- As close as possible to equipment being protected and etc..

Fire and explosion relief system…….

- **Flaring**
- Flaring as a disposal method , warrants special consideration .
- A flare is a combustion device that uses an open flame to burn combustible gases with combustion air provided by uncontrolled ambient around the flame

Fire and explosion relief system…….

- Safety issues in flare design
- Flame out
- Flash back production
- Burning liquid fallout
- Smoke

Fire and explosion relief system…….

- **Scrubbers**
- Scrubbers are air pollution control devices that use liquid to remove particulate matter or gases steam
- This atomized liquid entrains particles and pollutants gases in order to effectively wash them out of the gas flow

Fire and explosion relief system…….

- **Scrubbers types**
- **Wet industrial scrubber**
- **Dry industrial scrubber**
- **Electrostatic precipitators**

Housekeeping. Maintain good housekeeping. Promptly remove and dispose of accumulations of combustible scrap and debris in all areas of the job site. Use self-closing metal containers to collect waste saturated with flammable or combustible liquids. At all facilities, properly collect, store, and remove combustible and flammable waste products at the end of each workday or at the end of each work shift. Use only noncombustible or UL labeled, nonmetallic containers to dispose of waste and rubbish. Keep
combustible items separate from each other and from noncombustible items.

Grounds Maintenance. Don’t allow rubbish and waste to accumulate. Prevent the growth of tall dry grass, brush, an weeds adjacent to facilities with a maximum 3-foot fire break. Place combustible waste materials outdoors to await subsequent disposal, at least 20 feet from a structure.

Open Flame Devices

Do not leave fires and open flame devices, such as incinerators, torches, and controlled fires, unattended unless they have automatic temperature control and cutoff devices.

Cleaning and Degreasing. Do not use gasoline or liquids with a flashpoint below 100 degrees Fahrenheit for cleaning and degreasing. Use only approved cleaners specifically for the type of equipment or material.

Fireproofing. Maintain adequate clearance between heating facilitiesand combustible materials.

Explosive Gases and Vapors. Do not use open flames or heating elements where flammable gases or vapors may be present.
Buildings and Structures. Ensure non-fire-resistive buildings or structures are at least 25 feet apart. However, consider a group of non-fire resistive buildings with a total ground floor area of no more than 2,000 square feet as one building for this purpose, provided that each building in the group is at least 10 feet away, on each side, from other buildings.

Building Exits. Ensure that exits from all buildings, shops, and other facilities in which personnel work, or which are open to the public, are sufficiently well marked and lighted. Evaluate the adequacy of the means of exit, based on NFPA 101 Life Safety Code.

Inspections. When justified by the size or nature of the operation, security services personnel or other assigned personnel must frequently inspect buildings, storage areas, employee quarters, and work areas.

Requirements for Heating Devices

General. The following requirements must be met prior to the use of heating devices:

a. Approval. Use only heating devices accepted by the area/office manager. Include the following items in acceptance requests:

1. The proposed placement, including distance from combustibles.
2. The service, maintenance, and surveillance schedules.
3. The proposed fuel storage and refueling system.
4. The method for prompt detection of gaseous contamination or oxygen deficiency.

b. Data Plates. Permanently affix a data plate to each heater that provides the following information:

1. Required clearances.
2. Ventilation requirements.
3. Fuel type and input pressure.
4. Lighting and extinguishing instructions.
5. Electrical power supply characteristics.

c. Wood Floors. Mark heaters that are not suitable for use on wood floors and do not place them on combustible materials. When using such heaters, rest them on appropriate noncombustible material equivalent to at least 1 inch of concrete.

The noncombustible material must extend at least 2 feet beyond the heater in all directions.

d. Combustible Covering. Do not use heaters near covers such as tarpaulins, canvas, or similar combustible materials. Locate heaters at least 10 feet away from these and similar materials. Securely fasten or tie down the coverings.

e. Stability. Place heaters on level surfaces to prevent tipping.

f. Installation. Install, vent, operate, and maintain heaters in accordance with the manufacturers' instructions.

g. Spark arresters. Install spark arresters on smokestacks that could otherwise permit sparks to escape.

h. Carbon monoxide monitors.
Facilities where heating devices use combustible fuel require carbon monoxide (CO) monitors.

Grounding. Ground the non-current carrying metal parts of cord and plug connected heaters.

Liquid-Fueled Heaters.

a. General. Heaters may be either direct or indirect fired. Kerosene, stove oil, fuel oil, and diesel oil are permissible fuels. The flashpoint of the fuel must be at least 100 degrees Fahrenheit.

b. Stability. Securely anchor liquid-fueled heaters or locate them to prevent tipping.

d. Fueling. Train employees tasked with fueling to be thoroughly familiar with the manufacturer’s heater operation and fueling instructions.
Before fueling, extinguish the heater and permit it to cool until cool to touch.
Store fuel in, and dispense fuel from, approved flammable liquid containers.

e. Maintenance. Maintain heaters in good operating condition in accordance with the manufacturer’s instructions. **c. Piping.** Leak-test piping, tubing, or hose after installation, using a safe detection means, such as soap suds. When using flexible gas supply lines, they must not be more than 5 feet long.

Natural Gas Heaters.

a. General. Install, operate, and maintain natural gas heaters in accordance with the manufacturer’s instructions.

b. Stability. Securely anchor heaters or locate to prevent tipping.

Supply lines and hose must have a minimum working gauge pressure of 350 pounds per square inch, a minimum burst gauge pressure of 1,750 pounds per square inch, and a pull test of 400 pounds without leakage.

Liquefied Petroleum Gas (LPG) Heaters.

a. General. Install, operate, and maintain LPG heaters in accordance with the manufacturer's instructions. Do not use, locate, or store LPG containers and heating devices below grade or in confined spaces.

b. Protection. Protect heaters, when in use, from damage by location, anchoring, or barricading.

c. Testing. Leak-test piping, tubing, hoses, and flexible hose connections following installation, using a means such as soap suds. Use only flexible gas supply lines that are less than 5 feet long. Supply lines and hose must have a minimum working gauge pressure of 350 pounds per square inch, a minimum burst gauge pressure of 1,750 pounds per square inch, and a pull test of 400 pounds without leakage.

d. Hoses. Use only a hose labeled “LP-gas” or “LPG.” Hoses must have a minimum working gauge pressure of 350 pounds per square inch and a minimum burst gauge pressure of 1,750 pounds per square inch. Keep the hose as short as practical, although long enough to comply with specified safe spacing requirements without kinking or straining the hose or causing it to be close enough to a burner to be damaged by heat.

f. Regulator. Equip heaters with an approved regulator between the cylinder and the supply line.
g. Check Valve. Provide fuel cylinder connectors with an excess flow check to minimize the flow of gas in case of fuel line ruptures.
h. Fuel Cutoff. Equip heaters with an automatic flame loss device that will shut off the gas supply if the flame or pilot light is extinguished.

Application of Fire Protection Requirements

Fire Fighting Response. Each facility must prepare an effective, detailed fire protection plan, including provisions for the fire protection and suppression equipment that are set forth in this section. The area/office manager will review and approve the plan.

Written Agreement. Secure a written agreement for fire response covering the nature and type of assistance available, if possible.
Otherwise, provide a letter to the area/office manager, stating the nature of the assistance, together with the details covering the equipment and personnel to be made available. The agreement must be signed and dated, and reviewed at least annually.

Standpipe and Hydrant Connections. When you receive offsite assistance, make sure that standpipe and hydrant connections are compatible with the equipment available from the fire department providing the assistance.

Reporting. Post emergency telephone numbers and reporting instructions at the job site.

Maintenance. Inspect and maintain fire protection systems, alarms, and fire extinguishers in accordance with NFPA standards. All equipment must be inspected periodically according to inspection table 10-1 and after each use.

Fire Extinguishers.

Select fire extinguishers for a given situation according to the character of the fire(s) anticipated, the construction and occupancy of the facility, the vehicle or hazard to be protected, ambient temperature conditions, and other factors identified in NFPA Standard 10. Select fire extinguishers for the class(es) of hazards to be protected in accordance with the following

Class C hazards—energized electrical equipment. Use carbon dioxide and dry chemical type fire extinguishers. ***Note:*** carbon dioxide fire extinguishers equipped with metal horns are not safe for use on fires in energized electrical equipment and, therefore, are not classified for use on Class C hazards.

a. Class A hazards—ordinary combustibles. Use water and
multipurpose dry chemical type fire extinguishers.
b. Class B hazards—flammable liquids. Use aqueous film forming foam (FFF), film forming fluoroprotein foam (FFFP), carbon dioxide, and dry chemical type extinguishers.

Water Supply.

Install a temporary or permanent water supply with sufficient flow volume and duration to supply the standpipes, hose stations, and sprinkler systems, before or during the construction of the facility to be protected

. In permanent structures under contract in which standpipes are installed, connect the standpipe to the water supply, install the standpipe concurrently with construction of the structure, and maintain the standpipe in operable condition for fire protection use. **Burning Areas.** Do not burn waste materials, except in an approved and permitted incinerator.

Reference

- Http://www.schischeck.com/explosion -proof/fire -production _classification.html
- https://recostello.com/wordpress/relief/pressure-relief-disposal-system-flars
- Wikipedia
- IGC2 : CONTROL OF INTERNATIONAL WORK PLACE HAZARDS