RISK ASSESSMENT

HPC- NIMZ will have a number of pharmaceutical manufacturing units. These units are in essence chemical processing units which uses different flammable and hazardous and toxic chemicals. The units may have operations under pressure or in vacuum, at higher or lower temperature. So for these units risk assessment may be required depending upon the quantity of hazardous material stored, used and types of operations. Besides, a 250 MW Gas fuelled engine coupled cogeneration (power & cooling) plant has been proposed. Moreover, about 30 nos. boilers have been proposed to produce steam, which will be required in the process of the different industries as well as utilities. The fuel for both the co-generation plant and the boilers for generating steam (District Heating Plants) will be natural gas. Natural (Piped natural gas) gas will be supplied by GAIL and main gas supply line will be terminated at any one point of HPC. From there, the further distribution to cogeneration plant and District Heating plant will be done. Transfer of natural gas to these plants will be done through a pipeline of 500 mm diameter.
Risk is defined as the unwanted consequences of a particular activity in relation to the likelihood that this may occur.

Hazard is a state or condition having the potential to cause a deviation from uniform or intended behaviour which, in turn, may result in damage to property, people or environment. The word "hazard" does not express a view on the magnitude of the consequences or how likely it is that the harm will actually occur. A "major hazard" is associated with Loss of Containment and has the potential to cause significant damage or multiple fatalities. Again, the term does not imply that such events are likely.

Risk is the combination of the likelihood and the consequences of such incidents. More scientifically, it is defined as the likelihood of a hazard occurrence resulting in an undesirable event. The likelihood may be expressed either as a frequency (i.e. the rate of events per unit time) or a probability (i.e., the chance of the event occurring in specified circumstances). The consequence is defined as an event or chain of events that result from the release of a hazard. The impact or effect is the degree of harm caused by the event.

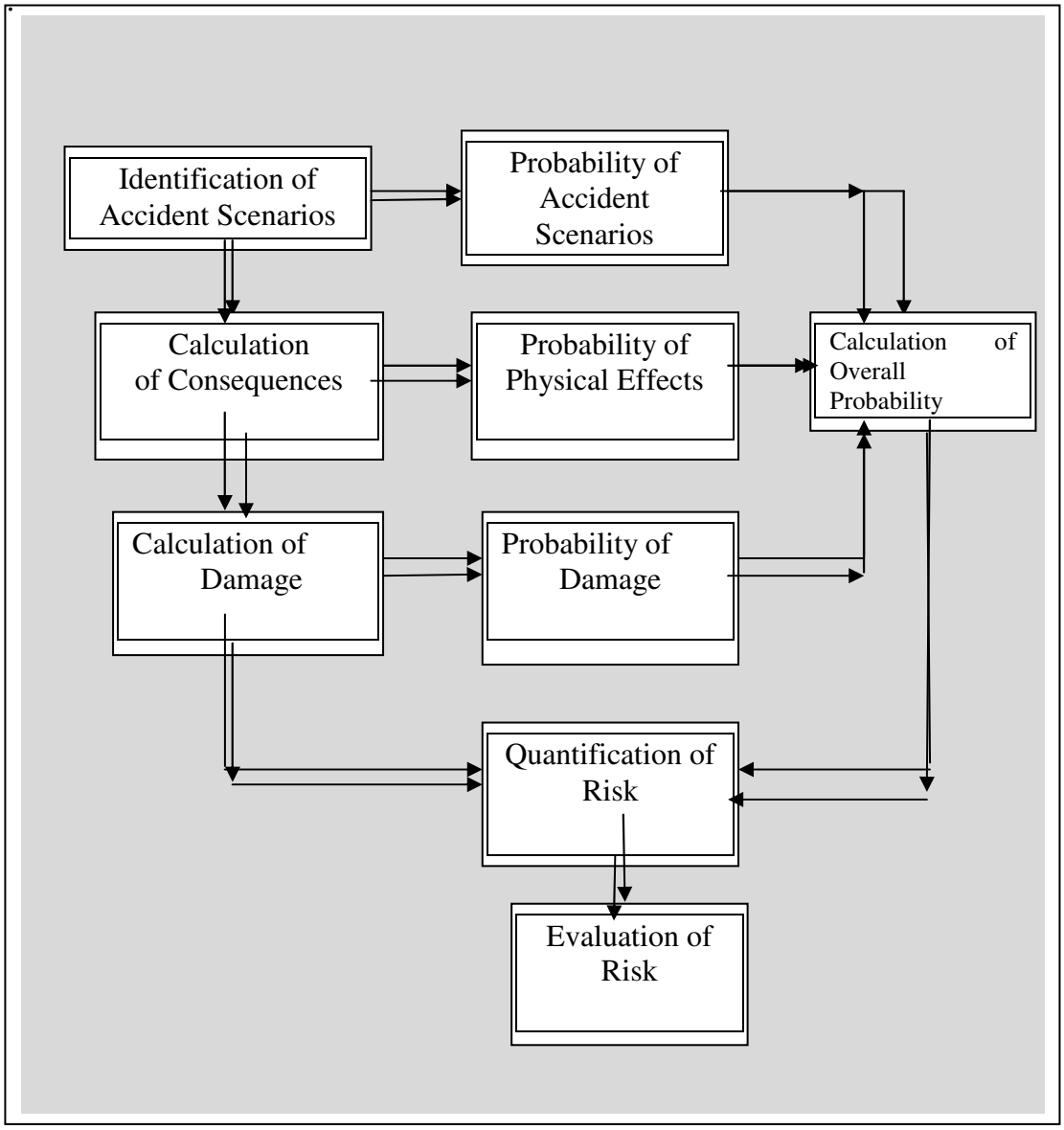
Safety is the inverse of risk. The higher the risk for an occupation or installation, the lower is its safety. The popular understanding of safety sometimes appears to be "zero risk", but this is impossible in an intrinsically hazardous activity.

Quantitative risk assessment (QRA)

Estimation of individual risk or consequence of a single accident scenario depends on a number of factors. Probability of a certain accident depends on probability of failure of a plant component including human error/ failure and failure of designed counter measures. Probability of a certain consequence depends on the probability of wind direction, probability of ignition case of a fire or explosion and finally probability of being injured or killed which depends on the damage criteria. Quantitative risk assessment (QRA) is a means of making a systematic analysis of the risks from hazardous activities, and forming a rational evaluation of their significance, in order to provide input to a decision-making process.

The first stage in a QRA is defined as system definition where the potential hazards associated with a facility or activities are to be analyzed. The hazard identification consists of a qualitative review of possible accidents that may occur.

In parallel with the frequency analysis, consequence modelling evaluates the resulting effects if the accidents occur, and their impact on people, equipment and structures, the environment or business, depending on the defined scope of the QRA study. Estimation of the consequences of each possible event often requires some form of computer modelling. Consequence analysis requires the modelling of a number of distinctive phases, i.e., discharge, dispersion, fires and explosions (for flammable materials).



The scenarios considered for release of flammable and toxic chemicals are:

- Fireball – Immediate ignition of a large amount of vapour gas
- Flash fire - Delayed ignition of zone of gas / vapour
- VCE – Vapour Cloud Explosion – Explosion of a dispersing cloud
- Jet flame – Immediate ignition of a continuous releasing vapour
- Pool fire – Liquefied pool catches fire
- BLEVE – Boiling Liquid Expanding Vapour Explosion – This occurs when a pressurised tank of flammable liquid is subjected to fire. First, it raises the internal pressure and then it weakens the tank shell. This can cause the tank burst catastrophically

releasing a large quantity of boiling liquid which vaporises violently and then may ignite to form a fireball. The BLEVE will also produce large projectiles from the parts of ruptured vessel or from neighbouring equipment and cause significant damage.

- Toxic effect for toxic materials.

Closely liaised with the consequence assessment is the impact assessment, i.e. how does the fire, explosion or toxic cloud affect human beings. When the frequencies and consequences / impact of each modelled event have been estimated, they can be combined to produce risk results. Various forms of risk presentation may be used, commonly grouped as follows: - Individual risk - the risk experienced by an individual person

Thermal damage:
The hazards will cause different levels of damage and its area of concern will be also different. It is therefore useful to decide on the damage criteria relevant to each type of hazard. For the present study only thermal damages are being considered.

Pool fire, jet flame, flash fire will generate heat radiation. Following have been given as the heat flux levels important for hazard analysis.

TABLE 1.1
EFFECT OF HEAT RADIATION

Heat Radiation	Effect
37.5 kw/m^2	Damage to equipment
12.5 kw/m^2	Melting plastic
4.0 kw/m^2	Blistering
1.6 kw/m^2	Severe hot feeling

Thermal damage is a function of amount of heat flux as well as exposure time. This is true both for plant equipment and people.

TABLE 1.2
HEAT RADIATION AND FATALITY

Radiation Level (kw/m^2)	Exposure time in seconds for % fatality		
	1%	50%	99%
1.6	500	1300	3200

4.0	150	370	930
12.5	30	80	200
37.5	8	20	50

Total exposure is expressed by a quantity obtained by the following equation. (Radiation) E+1.333x Time. For 1% human fatality this value is about 1000.

Overpressure Damage

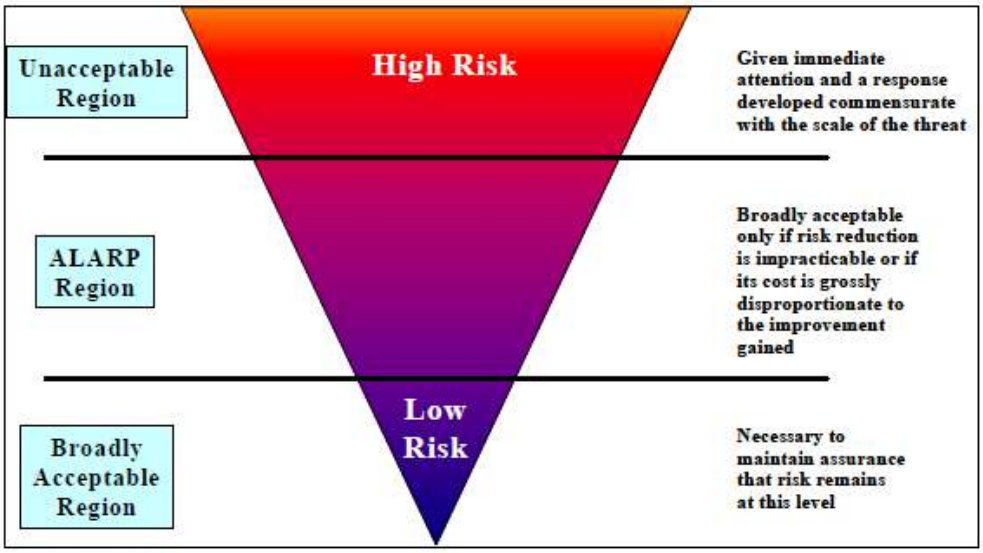
Explosion release a sudden amount of energy which travels as a shock wave or over pressure.

TABLE 1.3
OVERPRESSURE AND DAMAGE

Over pressure (milibar)	**Damage type**
345	Heavy Damage
140	Repairable Damage
70	Major Glass Damage
20	10 % Glass Damage

7.2.2 Risk Criteria

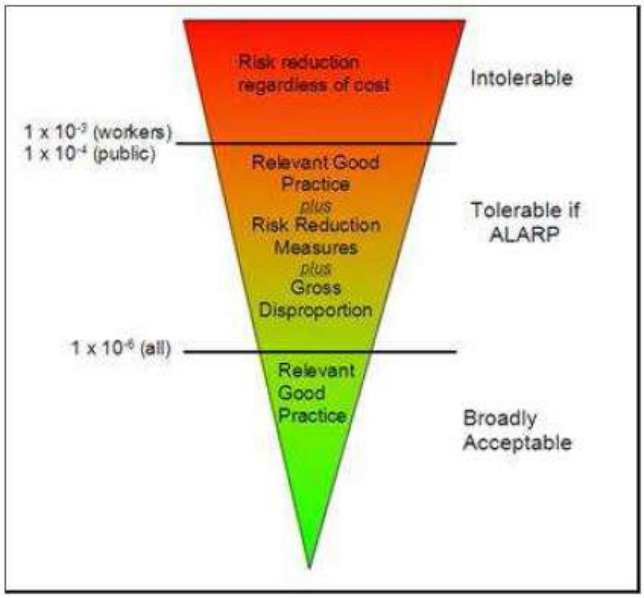
The next stage is to introduce criteria, which are yardsticks to indicate whether the risks are acceptable, or to make some other judgment about their significance. Risk assessment is the process of comparing the level of risk against a set of criteria as well as the identification of major risk contributors. The purpose of risk assessment is to develop mitigation measures for unacceptable generators of risk, as well as to reduce the overall level of risk to As Low as Reasonably Practical (ALARP).



The UK HSE Individual Risk Criteria is generally considered to assess the risk for the proposed project.

Risk criteria for Individual Risk for on-site are as follows:

- Individual risk levels above 1 x 10^{-3} per year will be considered unacceptable and will be reduced, irrespective of cost
- Individual risk levels below 1 x 10^{-6} per year will be broadly acceptable
- Risk levels between 1 x 10^{-3} and 1 x 10^{-6} per year will be reduced to levels as low as reasonably practicable (ALARP). The risk within this region is tolerable only if further risk reduction is considered impracticable because of the cost required to reduce the risk is grossly disproportionate to the improvement achieved.



Identification of Potential Scenarios for Risk Analysis

As natural gas transfer through pipeline to the co-generation plant and District Heating Plants shall possess maximum hazard potential, a quantitative Risk Assessment has been done for this particular component and accordingly, potential risk scenarios have been identified for the risk analysis. Transfer of natural gas to these plants will be done through a pipeline of 500 mm diameter. The pipeline pressure will be 90-100 kg/cm^2. The following scenarios have been identified for the consequence analysis:

(a) 20 mm leak in 500 mm pipeline
(b) Rupture of 500 mm pipeline

Effects of Release

In case of accidental release of Natural Gas under pressure there can be immediate ignition forming jet fire or the gas disperses and may cause flame fire if there is source of ignition within its lower flammable limit (LFL). In addition there is also the probability of blast and for that the over pressure damage distances have also been calculated.

Consequence Analysis

BREEZE HAZ software has been applied for the consequence analysis for the identified scenarios. Stability D (Neutral) has been considered for the calculation. Heat radiation damage distances and LFL distances as calculated for the above mentioned two scenarios are given in **Table-1.4 & Table-1.5** respectively. The overpressure damage distances for this scenarios are given in **Table-7.6**.

TABLE-1.4
HEAT RADIATION DAMAGE DISTANCE

Sl. No.	Scenario Description	Heat radiation damage distances in m for kW/m²			
		37.5	12.5	4.0	1.6
1.	20 mm leak in 500 mm pipeline	21	23	27	31
2.	Rupture of 500 mm pipeline	225	299	395	445

TABLE-1.5
LFL DISTANCE

Sl. No.	Scenario Description	LFL distances in m
1.	20 mm leak in 500 mm pipeline	33
2.	Rupture of 500 mm pipeline	251

TABLE-1.6
OVERPRESSURE DAMAGE DISTANCE

Sl. No.	Scenario Description	Overpressure damage distances (in m)			
		345 mbar	140 mbar	70 mbar	20 mbar
1.	20 mm leak in 500 mm pipeline	36	40	43	46
2.	Rupture of 500 mm pipeline	209	212	216	221

CONCLUSION & RECOMMENDATION

Based on the consequence analysis in the event of a fire, an effective emergency plan will have to be worked out and rehearsed for fire fighting and to evacuate the people safely.

Adequate number of fire and smoke detectors along with Alarms, Panel indications in control room should be provided in fire prone areas. Sufficient isolation valves must be installed.

In on-site emergency plan, provision should be made for adequate combination of fire fighting media located strategically along with crew of trained fire fighters so that fires as envisaged in this study could be quickly controlled.

The emergency response time for arresting release, fire fighting, safe evacuation of plant personnel and safety of stored inventory is critical to people's safety both on-site and off-site. Hence Regular Mock Drill to check preparedness level and resources' efficiency to be conducted.

Well defined standard operating procedures (SoPs) shall be followed. TPM i.e. Total Preventive Maintenance practices may be adopted to improve plant performance and safety.

The plant should be designed, constructed and operated in accordance with the safe engineering practices and standards.

DISASTER MANAGEMENT PLAN

With National Disaster Management Act-2005 in place, Disaster Preparedness at local level through Revenue Dept. must be planned. Local people and employees have now better legal safeguards against industrial disasters. As disaster types, sources, effects are different, it needs multi-disciplinary and multi-organizational approach to tackle such situation.

Types of Disaster

Disaster is an event which causes severe disruption to life of number of people or to the project activities resulting in suffering and loss of life and property.

Disasters can be
I) Natural- flood, cyclone, fire, earthquakes, biological disaster.
II) Manmade- war, riot, sabotage.

Degrees of Disaster

Disaster can be classified in 3 types depending on its effects.

1. LOW -- can cause injury, illness and equipments damage but not very serious and quickly manageable.
2. MID-Critical situation, can cause serious injuries to personnel, serious illness property and equipment damage.
3. HIGH- Catastrophic situation, major danger, can cause deaths, major widespread illness, injuries, loss of major property and equipments.

Stages of Disaster

The duration of disaster's effect can be divided into following stages:

- Warning
- Impact
- Rescue
- Relief
- Rehabilitation

1) Warning:
The natural calamities which may lead to disasters e.g. flood, cyclone can often be predicted. There are possibilities of disasters during local trouble, riot, war etc. also. All facilities to encounter the disaster should be kept ready and employees in full alert.

2) Impact:
This is the time when the disaster actually strikes and very little can be done to counter the situation. The impact period may be of few seconds (like explosion or earthquake) or for days (like flood, fire etc.).

3) Rescue:
This is the most important stage which start before the predicted disaster of just after the impact. All available resources need to be immediately engaged in operation.

4) Relief:

This is a longer stage of work depending on the degree of disaster. Work during this stage will need external help for medical, food, clothing and shelter.

5) Rehabilitation:
   This is an important stage in terms of future planning. It includes rebuilding of damaged properties, restart of project work, compensation etc.

7.3.1 Components of On Site Disaster Management Plan

On site Disaster Management Plan (DMP) is required to meet the emergency condition during disastrous event in the plant. Its objectives are to:

- Rescue and treat casualties
- Safeguard other people & Installations
- Minimize damage
- Control initially and restore ultimately to normal situation
- Arrange rehabilitation of the affective people

It is therefore necessary to develop an onsite disaster management plan through a systematic study of the hazard possibilities.

A summary of the plan is given below. The plan will be revised and detailed after the commissioning of the plant, as then all the units will be in final shape. The exact name and designations of all personnel will be then provided in the plan.

Key Persons and their role:

Site Controller is the person who assumes absolute control of the Complex and determines the action necessary to control the Emergency. He/She will wear a Red & White Helmet to confirm his identity. The General Manager will be the site controller.

Site controller will ensure that all members of his/her team have been informed to collect at Emergency Control centre. He/She will then proceed to Emergency Control Centre to take charge.

After firsthand assessment of situation he/she will give necessary instructions to Emergency Control Team. He/She will maintain a Log book of all the activities.

He/she will keep in touch with the external communication Team.

He/she will ensure that information is sent to outside emergency services (Police and Fire Brigade).

He/she will depute people to,

- Attend to telephone
- Keep in touch with incident controller
- Communicate with Assembly Points
- Meet outside emergency services
- Ensure proper flow of traffic and security
- Meet media/ other people coming at site from outside.
- Arrange for Medical Aid

Incident Controller is the person who goes to the scene of emergency and supervises the actions taken at the incident to overcome the Emergency. Shift Manager will act as Incident Controller. His responsibilities will be

- Direct all efforts to contain and control the incident.
- Keep non-essential persons away from the site.
- Guide outside emergency services at the site.
- Arrange to remove any casualties at the site.
- Keep in touch with Emergency Controller.

Security In-Charge will

a) Actuate the Emergency Siren, if not done already.
b) Send one guard to start the fire pump.
c) Attend to incoming telephone.
d) Await instructions from the Emergency Controller

Communication Officer

Public Relations Officer will act as Communication Officer.

On hearing alarm He will proceed to Emergency Control Centre.

- Maintains communication with Incident Controller and Deputy Incident Controller
- Recruits suitable staff to act as messengers if telephone and other communications fail
- Organizes all requirement of Emergency Control Centre
- Arranges Food, Transport, Nursing Home etc

Personnel Manager

- He will work as Liaison officer. He should be positioned in the office near gate.
- Will deal with police, media and outside enquiries in consultation with Site Controller.
- Will keep in touch with Union
- Will arrange for refreshments if required
- will control traffic movement traffic movement inside the factory and arrange for alternative transport if required
- Will keep a record of attendance of workers, staff, contractor's personnel, and visitors at the Gate which will act as Assembly Point.

Safety Officer

- Will assist the Incident Controller with his special knowledge on the safety aspects in the factory. He will help to identify the hazardous chemicals, hazard zones and zone of probable impact in different accident scenarios
- will select people with special training in safety matters to assist in the control activities

Fire & Security Officer

- His main task is fire fighting and control
- Announce through PAS about the incident zone and any other immediate information needed for the people nearby
- Maintains liaison with the Fire Brigade team from outside

Medical Officer

- Will immediately open a First Aid Centre at Control Centre or at Assembly Point
- Will take up the full responsibility of providing medical assistance during emergency
- Will arrange for outside medical help if required.

Telephone Operator

- On hearing the emergency alarm, he/she will immediately contact Site Controller
- On the advice of Site controller/Incident Controller/Security Officer will ring Fire brigade, Police etc
- Keep telephone board free for urgent communications.

General employees who have not been specified a duty in case of emergency should proceed to/contact the Emergency Assembly Point

in their area. Designated persons will carry out the actions detailed in the Individual Plant Emergency Procedure. The Roll Call leader will hold a Roll call. Personnel not at their normal work place must go to the emergency assembly point. Personnel will remain at these points and await instructions from the Site Controller.

Contractor's Employees

Contractor's employees will be instructed in the Emergency Procedures before commencing work on this site. They will report to the emergency assembly point on this site. Personnel Manager will guide them in case a major decision like evacuation from the factory is taken.

Visitors

Infrequent visitors are registered on each visit. They will be given a Visitors pass which includes an emergency action statement. The responsibility for visitors in emergency situation rests with the person being visited.

Responsibilities outside general shift hours

Shift Supervisior

He will act as Site controller for the time being. As soon as becomes aware of the emergency and its location, he will proceed to the scene. He will assess the scale of the incident and direct operations within the affected areas.

He will contact and inform the Site Controller and Incident Controller immediately. Till their arrival he will continue to perform their duties.
He will contact the departmental head to act as incident controller and guide Safety Officer and Security Officers for containing the damage.

He will call the Medical Officer to the plant if necessary.

Other staff with designated responsibilities will act as instructed.

Infrastructure

Fire Fighting Facilities: The plant will have adequate fire fighting aids including fire hydrants close to the required locations. There will be Portable Fire Extinguishers of different types and sizes are installed in specific places.

The factory siren will be used for raising the alarm and also for ALL CLEAR signal.

First Aid boxes are provided in specific locations including at the Assembly point for administering preliminary treatment. A number of employees are trained for first aid use.

Emergency Control Centre is the point from which the Site Controller directs the movements of Personnel and Equipment during an Emergency.

Contents of Emergency Control Centre:

a. External telephone line and a list of relevant telephone numbers.
b. Internal telephone and telephone list of Emergency Assembly Points.
c. List of Emergency Control Team, who must be called showing addresses and telephone numbers.
d. Emergency Controller's Red & White Helmet.
e. A list of all persons (by title) responsible for groups of employees.
f. Logs and Emergency Controller's checklist.
g. Emergency lighting.
h. Copy of the emergency plan.
i. List of persons trained in First Aid & Fire Fighting.
j. List of safety cabinets and their contents & locations.
k. Battery operated torches.
l. Detailed site plan.
m. First aid equipment including stretchers (in surgery).

Assembly Point is a place containing an internal telephone and paging system, where people can wait in a group during emergency to receive instructions from the Emergency Controller.

External Communication will be done by Site Controller. The following persons and offices may be given updated information as necessary and ask for necessary help.

MITIGATION MEASURES FOR RISK

1. The Live- Work zones are distinctly apart to minimise impact of industries on day to day living.

2. By design, Industrial buildings are proposed to be distant in the critical wind directions, i.e, E-W.
3. Co-gen plants, District heating and cooling systems, Captive power plants are designed to ensure NO-break Supply of power, water, steam and cooling requirements.
4. The central services also significantly reduce the point source of emissions across the site. Control and mitigation measures are also reduced to the central plants and infra hubs.
5. Major Fire stations have coverage of 3-5 Km, and minor fire stations have coverage of 1-2.5Km.
6. Polyclinics and dispensaries are planned as per the desired workforce generation.
7. ZLD based CETPs with various modules in various zones shall be installed to enable necessary expansion as and when needed.
8. Online continuous monitoring systems shall be installed at inlet and outlet of CETPs to have check on its performance.