E2-E3: CONSUMER MOBILITY

CHAPTER-13

TELECOM INFRASTRUCTURE

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Telecom Infrastructure

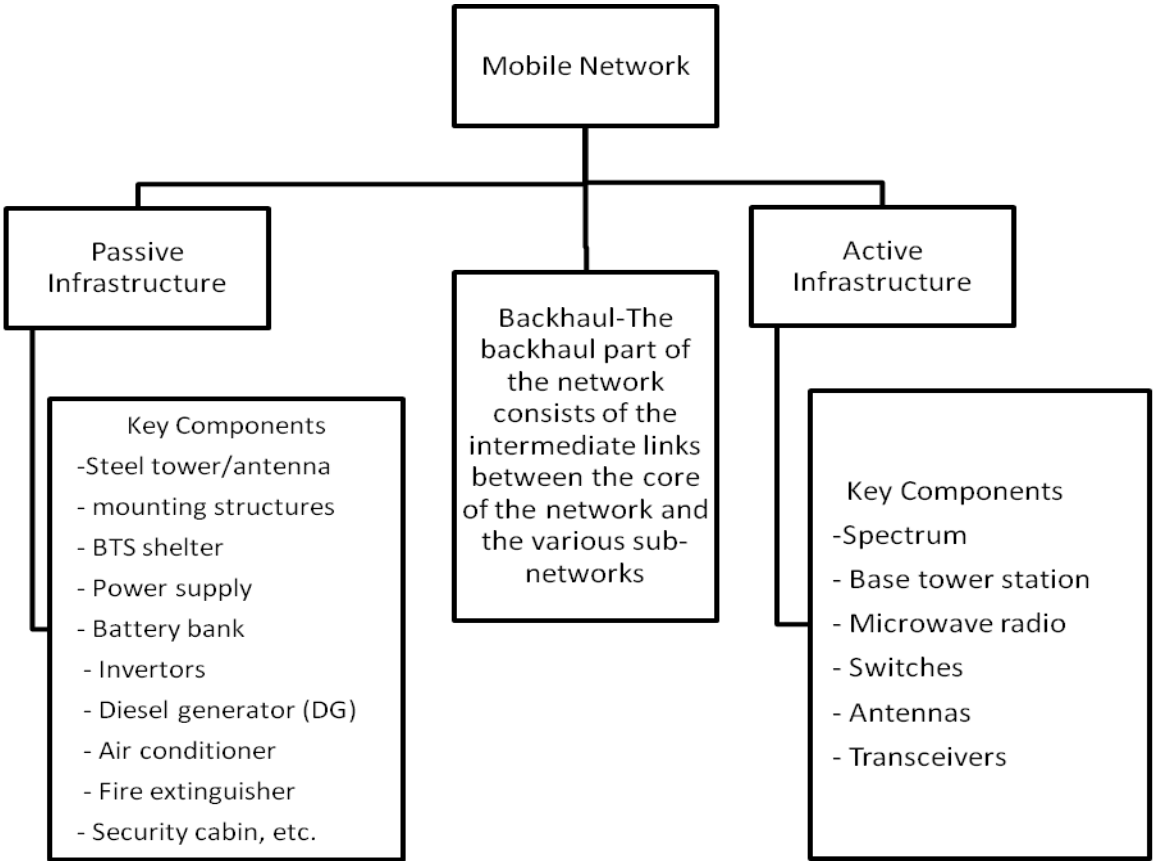
Introduction:

Telecom Network consists of many elements such as switch, transmission, civil, electrical etc. Proper functioning of this infrastructure is necessary for delivery of quality services to the customers which in turn leads to profitability of the operator's business. This handout deliberates on some of the elements of Telecom infrastructure.

Lesson Objectives

1. Components of telecom infrastructure
2. Revenue potential of passive infrastructure
3. Key aspects of passive infrastructure elements

1. **Components of telecom Infrastructure:** A typical mobile network infrastructure can be categorized into three distinct categories namely Passive Infra, Active Infra and Backhaul. Coordinated maintenance, timely up gradation of these elements is the key to success of an operator. A brief structure of these categories is given below:



In this handout, Various passive infrastructure elements will be discussed from the point of view of maintenance and revenue potential.

2. Revenue Potential of Passive Infrastructure: With boom in mobile business, many operators are already existing in the market and many in the pipeline to start business. Existing operators are under intense pressure to expand their network and new entrants under pressure for faster roll out. This coupled with intense price war has lead to telecom operators look for cost cutting and faster roll out opportunities. In mobile network, a very significant cost of investment as well as time goes towards passive infrastructure. Government of India allows sharing of passive infrastructure. BSNL has tried to reap benefits of its vast country wide infrastructure. A few press clippings given below sumup thestory:

Hindu Business Line: Indian mobile network operator Tata Teleservices (TTSL), which offers both GSM-based and CDMA-based mobile voice services under the Tata DoCoMo and Tata Indicom banners respectively, has announced an agreement to share the tower infrastructure of state-owned Bharat Sanchar Nigam Ltd (BSNL). According to the Economic Times the contract between the two operators is for a 15-year period, but financial terms of the deal have not been disclosed. TTSL said the arrangement covered all of the country's telecom circles, and claimed it would allow it to swiftly expand the coverage of its GSM services whilst minimising costs.

A web analytics: "BSNL is aggressively working towards sharing its passive and active infrastructure with the existing and new telecom operators. With an asset base of more than 40,000 towers across the country, BSNL hopes to generate Rs 1,000 crore of revenue within a year from the infrastructure sharing business," the PSU said in a statement.

The Master Sharing Agreement (MSA) for sharing of BSNL towers with some telecom operators was in the final stages and was likely to be finalised soon. In addition, BSNL has also decided to hire infrastructure from various Infrastructure Providers (IPs) to speed up its roll-out of mobile networks in different States. BSNL clicked another high on its infrastructure business as Sistema Shyam Teleservices entered into an agreement for provision of Bandwidth and Passive Infrastructure sharing across India.

For BSNL this is the fourth infrastructure agreement to be signed within couple of months. Earlier it had bagged similar deals with Aircel, Datacom and TTSL.

BSNL's network within the rural areas is considered to be its unique differentiator. "

3. Key aspects of Passive Infrastructure elements:

3.1 Towers & Antenna: Types of Towers Telecom towers are broadly classified on the basis of their placement as Ground-based and Roof-top.
(i) Ground-Based Tower: Erected on the ground, ground-based towers (GBTs) are taller (typically 200 to 400 feet) and are mostly used in rural and semi-urban areas because of the easy availability of real-estate space there. GBTs involve a capital expenditure in the range of Rs. 2.4 to 2.8 million, depending on the height of the tower.

(ii) Roof-Top Tower (RTT): Roof-top towers (RTTs), which are generally placed on the roofs of high-rise buildings, are shorter (than GBTs) and more common in urban and highly populated areas, where there is paucity of real-estate space. Typically, these involve a capital expenditure of Rs. 1.5 to 2 million. It is the height of a telecom tower that determines the number of antennas that can be accommodated, which in turn determines the capacity of the towers, apart from factors such as location and geographical conditions (wind speeds, type of terrain, etc.). Hence, typically, while GBTs can accommodate up to six tenants, RTTs can accommodate two to three tenants.
Master Service Agreements A tower infrastructure company normally enters into separate Master Service Agreements (MSAs) with its occupants/tenants. MSAs are signed between tower infrastructure companies and telecom operators (tenants), and clearly spell out the overall tower requirements of the tenants, the pricing terms, and other binding terms and conditions between the two parties

Key maintenance points: To be verified as and when any faults/defects (like high VSWR) reported or once in a year whichever is earlier.

- Visual check of bolts/nuts and sample check of their tightness,
- Greasing on foundation bolts to be done.
- Check the Antenna connectors and their tightness.
- Check for tightness of antenna fixtures, u clamps etc..
- Check for ingress of water (condition of weather proofing in waveguide) etc
- Check the orientation of antenna of each sector and compare with the old records.
- Check for the down tilt of antennae which also may be compared with old records.
- If any disparity is observed, reinstate in consultation with Optimization team/RP wing.

- Record the checks & changes done and report the changes to RP wing/Optimization team.
- Record the changes in the logbook.

Aviation lamp – Performance of sensor and lamp is to be checked. This is checked by masking the sensor from sunlight and checked for glow of lamp. Glowing shows the good condition. Remove the mask and thus expose the sensor to sunlight. Glowing of lamp should cease. Test results may be recorded in the logbook. If the performance is not satisfactory, replace the lamp/sensor which is faulty.

3.2 Battery: These days, most of the Battery used in BSNL mobile network are VRLA (Valve Regulated Lead Acid Battery) type. Various capacities of Batteries are 120 AH, 400 AH, 600 AH, 1000AH, 1500 AH, 2000 AH, 2500 AH, 3000 AH, 4000 AH & 5000 AH.

Following steps are required for monitoring of the VRLA Batteries:
a) Periodic physical inspection of each cell of the battery for cracks and leaking etc.
b) Discharge of battery for a short duration and recording the voltages of each cell.
c) Measurement of a mark deviation (>30%) in the impedance or conductance of the cell when charger is on as compared to the one recorded at the time of commissioning.
d) Measurement & recording of cell temp periodically.
e) Float Voltage of cells & its comparison with the mid point voltage.
f) Float current in fully charged battery.

Temperature: The rise in battery temperature increases the chemical reaction in the battery. The SMPS power plant takes care of the temperature by reducing the charging voltage and it is 3 milli-volt per degree raise in temp but still it is important to measure individual cell temp periodically and keep record for study and analysis.

Life of VRLA battery:

- Batteries upto 200AH: 4 Years
- Batteries more than 200 AH: 6 years

Maintenance Schedule of VRLA batteries

Daily: Temperature and voltage of a pilot cell and all the cells as far as possible. The pilot cell should be cyclically selected on monthly basis.

Monthly: Voltage of each cell during partial discharge.
Float current measurement
Physical verification

Quarterly: Ensure the tightness of terminal bolts to 11Nm /100Lb inch Conductance measurement
Apply boost charge for 24Hrs.

Yearly : Test discharge the batteries @ C10 and measure the time battery sustains the load till any of the cells fallls to 1.75V.
Noise measurement

Some Do's and Dont's for the maintenance of VRLA Batteries

Do's

- Clean the batteries as and when dust accumulates.
- Keep the batteries away from heat source, sparks, fire etc.,
- Keep the battery room neat and clean
- Charge the batteries once in every six months @ 2.30 vpc for 24hrs, if stored for longer periods
- Wherever cables are used ensure using proper cable size and crimping of the lug to the cable.
- Tighten all terminal bolts to 11 Nm (100 Lb.-inch)
- Re- torque all the terminal bolts once in every six months.
- After any discharge, recharge the batteries when power restores.
- Always use calibrated instruments for measurements.
- Keep the batteries in Air-conditioned environment, wherever possible.

Don'ts

- Do not add water or acid.
- Do not tamper the safety valves.
- Do not over tighten the terminal bolts.

- Do not allow any metal objects to rest on the battery or fall across the battery terminals.
- Do not mix the batteries of different capacities or makes.
- Do not combine ordinary conventional batteries with VRLA batteries.
- Do not install physically damaged cells.
- Do not dump any waste materials in the battery room.

3.3 SMPS(Switched Mode Power Supply) Power plant: The power plant is used to rectify the ac input supply to desired output dc (-48v). The conventional power plants which were in use earlier were based on SCRs or Ferro-resonant techniques. These conventional types of power plants were having following problems:

1. Very large size,
2. Large weight
3. Lower efficiency.
4. No scope for modular expansion.

To get rid of all these problems now SMPS (Switched Mode Power System) power plant are used.. In these systems, the conversion of AC to DC is accomplished in two stages as given below:

First Stage conversion: The input AC voltage is directly rectified to high voltage DC.

Second Stage Conversion:

- Rectified high voltage DC is stored in a capacitor.
- High voltage DC is then converted into a very high frequency AC (20 KHz and higher) by means of very powerful and fast semi-conductor switching devices.
- High frequency AC is stepped down to the required level, by means of a small high frequency transformer.
- Stepped down AC is rectified to DC of desired voltage and filtered by means of high frequency filters.

Life of Power Plant:

Static P/P : 15 years

SMPS P/P: 15 years

Advantages of SMPS Power Plant:

1. Due to high frequency the size of transformers and chokes is reduced to 10 to 15% of the conventional SCR/Thyristor controlled power plants. This makes the power plant compact due to which a lot of saving in floor area is achieved.

2. The batteries (both VRLA as well as flooded Lead acid) are more prone to temperature variations . As most of the SMPS Power Plants employ micro-processor control techniques, the introduction of temperature compensation logic for batteries has become simple and easier.
3. Being small and light in weight, fit perfectly in modular concept.
   Up-gradation of the capacity in modular system is easy; simply plugging-in the additional modules adds to the capacity, with the limit of ultimate capacity and does not require the replacement of existing Power Plant as in the case of conventional Power Plants.
4. These Power Plants have very high reliability and therefore are less prone to faults, which result in low operating cost.
5. SMPS offer a very improved Power Factor (near unity) making the system more efficient and make easy to comply with state electricity board's P.F. norms.
6. These power systems are suitable for VRLA batteries.

3.4 Earthing: Earthing plays a vital role in the protection of equipments and the personnel. Apart from protection from hazardous stray currents in electrical equipment in Telecommunication circuits and equipments, Earthing is provided for the following purposes:

- Reduction of Crosstalk and Noise.
- Protection of costly apparatus and persons against foreign voltages and leakage currents from power wirings touching the metallic frame of the equipment.
- Protection of buildings and equipments from lightning strikes.
- Earthing of power supply systems is used to ensure reliability of power as it helps to provide stability of voltage conditions preventing excess fluctuations and providing a measure of protection against lightning.

Types of Earth Electrodes :

Three types of earth electrodes are commonly used for earthing systems.

1. Spike electrodes: are used where space is not a problem.
2. Plate electrodes: Where there is not much space but digging is not a problem.
3. Strip electrodes: In hilly areas where digging beyond 2-3ft depth is not possible and space is available.
4. Nowadays Chemical Earth is also being made in which a chemical paste is deposited between the plates, which helps in maintaining the required level of moisture and is also known as maintenance free earth. It is specifically useful for hilly areas.

Tips for correct earthing practices: In order to ensure equi-potential bonding, RING EARTH to be provided surrounding the building. All other individual earth connections that is of Power room, Transmission, Switch room ,E/A etc should be first terminated on separate earth distribution plates (edp) (Single Point Earth connectors) and then to be extended to the ring earth. One EDP should be provided outside the building to terminate earth from external connections like cable sheath.

- Earth resistance should be less than 0.5 Ω for electronic exchanges
- Earth resistance is to be measured every six months.
- One dry season must be included in these two occasions.
- For lightning prone areas, it should be measured every month.
- Wherever, it is beyond limits, it should be immediately brought within limits.
- Chemical treatment of the earth is not recommended.
- In lightning prone areas use copper instead of G.I. to form ring earth.
- Earth distribution plate should be insulated from the wall of the building.
- Coiling of earth conductor should be avoided.
- Bending radius of conductor should have at least 1m radius.
- The earthing conductor should not pass through any metallic conduit.
- All joints should be water proof.
- For GI to GI joints proper surface contact should be ensured by inserting lead strip in between.
- Aviation lamp & lighting arrestors of the tower to be looped to tower ring earth.
- Roof top tower is also to be ring earthed.
- Each leg of the tower should be separately connected to the tower ring earth & should be connected to one of the plates of the plate earth.
- Transformer neutral to be earthed separately from ring earth at a minimum distance of 6 m.
- The frame of EA can be connected to ring earth.
- E/A Neutral to be earthed separately & looped to ring earth.
- Wet the earth pits during dry weather to keep the earth resistance within limits

3.5 Types Of Air- Conditioning System:

Air-conditioning system in use may be categorized in to the following types:

1) Window Type Units
2) Split Type Units.
3) Package Type unit

4) Central Air-conditioning System

Each of these has its limitations as well as advantages and the most suitable one should be selected taking all relevant factors into account.

(1) **Window Type Air Conditioners**: Window type air conditioners are completely self-contained units with the compressor, condenser, evaporators, refrigerant piping and air filters, all assembled in a very compact single unit. The motor usually has shaft extension on both sides for air to draw the return air from the room, pass through evaporator and send the cooled air back into the room.

Advantages & Limitations:

- No floor space required and it can be mounted on the window side or on a hole cut in the wall.
- Absence of ducting and plumbing.
- Easy and quick installation.
- Absence of Humidity control, fresh air control and dust control
- Weak air throw
- Not suitable for continuous operation.
- It can be installed in a wall whose outer surface is exposed

(2) **Split Type Air Conditioners** : In split AC units, the condenser & Compressor Unit [outdoor unit] and cooling coil unit [indoor unit] are housed in two separate enclosures and both the indoor and outdoor units are connected through refrigerant pipe line.

Advantages & Limitations:

- Opening in wall/window is not required.
- Indoor units can be placed any where inside the room.
- Effective Dust Control & less noise
- The distance between Indoor and outdoor units should not be more than 30 feet.

(3) Package Type A/C Units : These units are also functionally very similar to the window models but are very much bigger in size and therefore installed on the floors. It can be installed in A/C space with or without duct system. The control panel is conveniently located on the unit itself.

Advantages :

- Structural alterations required are negligible.
- Ease of installation and removal.
- Factory assembly of balanced and tested equipment.
- More flexibility in operation.

(4) Central Air Conditioning Plant : Central air-conditioning plant becomes a necessity when areas to be air-conditioned are large. This system is highly flexible and better controls are possible.

The important factors affecting A/C plant capacity are as under :-

- ❖ Orientation and Location Of Building.
- ❖ Construction Materials Used.
- ❖ Number and types Of Window And Doors.
- ❖ Utility Of The Space.
- ❖ Physical Dimensions Of Space.
- ❖ Lighting.
- ❖ Occupancy.
- ❖ Appliances And Equipments.
- ❖ Ventilation And Infiltration.
- ❖ Leakages And Heat Loss In Ducts.

Preventive Maintenance & Checks for Window /Split AC

Important Daily Checks

- ➢ Check for room temperature.
- ➢ Check for any abnormal sound/vibration.

Important Monthly Checks

- ➢ Clean cooling & condenser coil periodically and comb mashed fins
- ➢ Check filters and clean/ change if required
- ➢ Ensure proper charging of refrigerant
- ➢ Check for tripping of compressor by thermostat
- ➢ Eliminate obstructions in front of condenser, if any

Important Yearly Checks

- ➢ Complete Servicing and testing of Window / split AC unit.

Preventive Maintenance & Checks For Package Ac System

Important Daily Checks

- Check for any vibration in AC unit equipments
- Check for discharge & suction pressure
- Check V-Belt tension of Blower Motor/ condenser motor.
- Check for any frosting at coil
- Check working of fresh air fan.

Important Monthly Checks

- Micro –filter Cleaning.
- Fresh Air Filter cleaning.
- Check for leakage of conditioned air
- Check lubrication of all bearings

Important Yearly Checks

- Complete Servicing of A/C plant before onset of summer

3.6 Important Maintenance Checks For Engine Alternator Set

Daily

1. Check Engine oil level and leakage if any.
2. Check Radiator for water level and leakage if any.
3. Check fuel level.
4. Check that battery charger is in trickle charging position.
5. Check whether insulation of the Exhaust pipe is proper.
6. Check that ventilation of the EA Room is proper.
7. Check oil pressure.
8. Check if lights and exhaust fan are working properly.
9. Check physically before start for loose connection/nut bolt.

Weekly

1. Check Air line connection and filter.
2. Check fan belt, and its tension.

Fortnightly

1. Check Battery voltage, Terminals, Electrolyte level (Top up if necessary) .
2. Check Specific Gravity of Electrolyte.

(After the above checks, start the Engine for No Load/Connected Load and test for 10 minutes the following)

1. Check for any abnormal noise. Shut down the E/A immediately and cause be examined.
2. Check frequency and out put voltage.
3. Check the colour of Exhaust gas
4. Check working of the Indication Lamps.
5. Check working of the Dynamo and Auto Cut off of the Battery charger.
6. Check for any Exhaust gas restriction.
7. Check manual/ auto-changeover from commercial supply on connected load.
8. Record various readings in the logbook.

Monthly

1. Check for tightness of connections in Engine and Control Panel.
2. Watering of earth pits and tightening of connections.
3. Check functioning of safety devices.
4. Check belt tensions.
5. Check battery charger.
6. Check for leakage of fuel line.
7. Check for leakage in exhaust pipes.
8. Inspect the manufacturer's chart for due date of maintenance.

_Half Yearly

1. Cleaning of bus bars & chambers and tightening of nut bolts.
2. Checking of ACB/MCCB tripping mechanism.
3. Earth testing and Meggering.
4. Relays and other protection devices are working properly.

Yearly

1. Tighten all mounting, nut and bolt.
2. Check crankshaft and float.
3. Clean injector inlet screen.
4. Clean and calibrate all injectors.
5. Check fuel pump calibration.
6. Replace fuel pump filter screen and magnet.

3.7 Inverter

In most of the telecom installations, inverters are installed to provide uninterrupted AC supply to OMC terminals. Capacity of invertors used varies from 1KVA to 10KVA depending on the connected AC load. The basic precautions for installation is that inverter should be installed as close to battery room as possible so as to reduce DC voltage loss due to cabling. The inverters may not be loaded beyond 80%of its rated capacity and initial start up load also needs to be taken into account. Only essential equipment may be connected to inverter output. Except few emergency lightings, rest light fittings should be fed from Engine set for backup.

3.8 Fire Safety

Fire Protection: Fire protection measures in telecom building can be classified in two parts :

Passive Fire Protection: Passive fire protection measures are those which are adopted at the planning stage of the building or facility such as :

- Provision of adequate fire resistance of the structure.
- Provision of proper FAR, open spaces.
- Provision of adequate access to sufficient and readily available water supply etc. for fire brigade.

Telephone exchange buildings have been classified as E4 business buildings in the "National Building-Code of India". As such building Material(s) of suitable fire retardant ability as mentioned therein shall only be provided.

Active Fire Protection Measures: Active fire protection measures are those which operate (manual/Automatic) in the event of out break of fire such as:-

- Provision of suitable and adequate Fire detection system with audio visual alarm.
- Wet riser & fire Extinguishers.

Fire Detection And Alarm: If outbreak of fire is detected promptly in its incipient stage and simultaneously, a correct fire fighting media is applied, losses from fire can be minimized. Thus philosophy of fire detection and alarm system is to provide an audio visual signal for alerting the building occupants.

Manual Fire Alarm: All buildings excepting manual local exchange and MAX III, shall have a manual fire alarm system. In multi storied buildings, each floor shall constitute one or more zone depending on the area of floor. Fire alarm switches shall be mounted at

conventional locations in the zones. The call boxes shall be accessible to all occupants without having to travel more than 22.5 mtr and shall be mounted at a height of 1.2 mtr from floor level. It shall be colored red.

Automatic Fire Detection System

- All buildings above 15 m hight and all Digital Electronic exchanges and all the exchanges of 1K or above shall be provided with an automatic fire detection system, in addition to manual fire alarm system. In case of E-10 B exchanges, false floor plenum and false ceiling shall constitute separate zones.
- The detectors shall be of rate of rise of temperature type and smoke type. Wherever smoke detectors are provided, a mixture of photoelectric and ionization type will be used.
- A control indication panel to which detection circuits in all the zones are connected, shall be installed in the fire control room or in the main entrance lobby on the ground floor of the building. Light indications on the panels shall unable the fire to identify the fire site.
- The alarm system shall provide both alert system and evacuation alarm with different distinctive tones.
- The alarm system shall have a battery backup so that in case of mains failure, the backup batteries take over and feed the power to the system.
- A non exchange direct fire emergency magneto telephone shall be provided in the equipment room to all Telecom buildings for direct communication with the fire brigade. One of the extensions of the non exchanges line shall also be available at the ground floor hi the sentry cabin or at the reception. The fire telephone shall be tested daily.

Fire Fighting Appliances:

- Sufficient number of fire Extinguishers (portable type) shall be brought or kept in shelves or mounted on wheels at conspicuous places (but not too close to the equipment). The operating instructions shall be clearly printed on the body of extinguishers.
- Sufficient quality of refills for the extinguishers shall be stored.
- For buildings above 15 mt. in height one wet riser for every 1000 sq. mtr or part therefore of floor area shall be provided. The hydrant shall be so located that it is not father than 30 mt. from any point in the area covered.
- In data centers, automatic flooding system is provided keeping in view the importance and fire risk involved.
- Two water buckets and too sand buckets shall be provided at each floor.
- All fire fighting appliances shall be maintained in working condition.
- For more details the latest "Fire protection manual" of the department can be referred.

Classes of Fire and Fire Extinguishers:

The Nation Fire Protection Association (NFPA) extinguisher standard classifies fire into four types.

CLASS A:Fire in ordinary combustible materials (like wood, cloth, paper, rubber, etc.) Suitable fire extinguishers are WATER, FOAM

CLASS B: Fire inflammable liquids, gasses etc. The fire extinguishers are FOAM, CO2, , DRY POWDER

CLASS C: Fire in live electrical equipment. The fire extinguishers are CO2 , HALON

CLASS D:Fire in reactive metals (Like Mg, Ti, Na, K, etc.). The fire extinguishers are SPECIAL DRY CHEMICAL POWDER .

Note: Fire Drill need to be conducted at regular intervals and all the officials in that building must be aware of escape routes, floor wardens, fire officer, how to read fire alarm panel, working of wet risers etc.

Conclusion: Smooth operation of above elements is crucial to the successful delivery of service through active elements in the network. In order to facilitate prompt action for any deviation in state of health of these passive elements against set benchmarks, alarms are generated and transmitted to OMC/NOC for appropriate actions. Typical alarms extended are Mains fail, Diesel Low, battery Low, Generator ON, DG set Cabin door open(canopy type), Fire, High Temperature etc. These alarms are to be recorded/monitored in MSC, BSC as well as BTS sites. Staff posted for maintenance of these elements must follow above listed precautions & maintenance steps.

Chapter 13: Telecom Infrastructure

Sample Self Study Questions

Subjective questions

1. Which are the three important components of telecom Infrastructure (of typical mobile network) ?
2. What are the key components of passive infrastructure?
3. What are the advantages of the SMPS power plant?
4. What are the different types of air conditioning systems?
5. State the important daily checks to be carried for engine alternator.
6. What are different types of fire extinquishers?

Objective questions

1. All buildings above 15 m hight and all Digital Electronic exchanges and all the exchanges of 1K or above shall be provided with an automatic fire detection system, in addition to manual fire alarm system. (T/F)

2. Active fire protection measures are those which are adopted at the planning stage of the building or facility.(T/F)

3. The inverters may not be loaded beyond 80%of its rated capacity(T/F)

4. In split AC units, the condenser & Compressor Unit [outdoor unit] and cooling coil unit [indoor unit] are housed in two separate enclosures. (T/F)

5. Earth resistance should be less than 0.5 Ω for electronic exchanges(T/F)

6. These days, most of the Battery used in BSNL mobile network are VRLA (T/F)