

NPTI

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*Understanding Various Areas Of Technical  
Aspects Of Distribution*

*For Batch From Afghanistan*

Program Presenter

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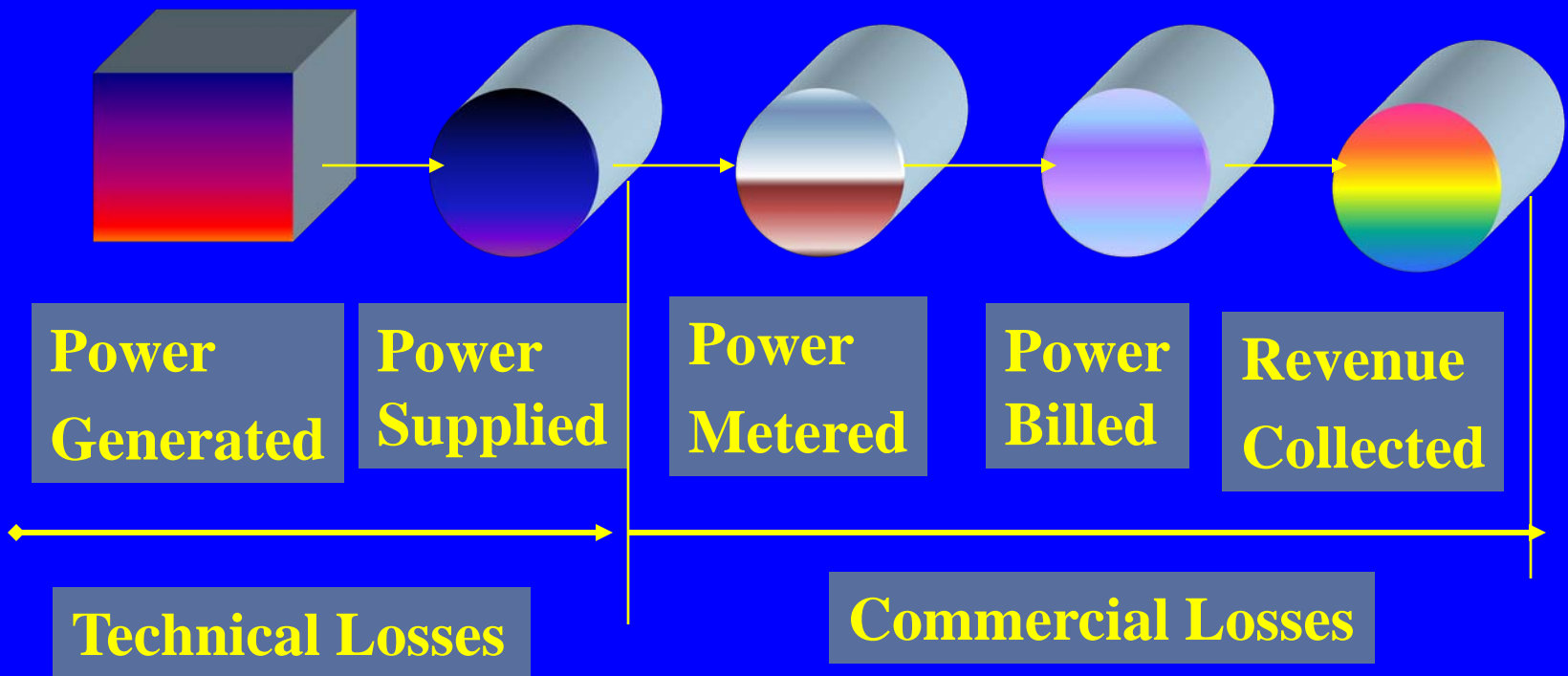
# **DISTRIBUTION STREAM**

## **ISSUES & CHALLENGES**

# Distribution System Issues

- DISTRIBUTION NETWORK
- Loss Making Elements
- Operation And Maintenance System
- CAUSES OF FAILURES Of TRANSFORMERS
- Distribution Planning
- Maintenance And Monitoring
- AT&C Losses& Revenue Cycle Management
- Maladies Of Distribution
- Increasing Reliability
- CRM-Consumer priorities
- Metering
- Energy Conservation

# Power Supply Chain

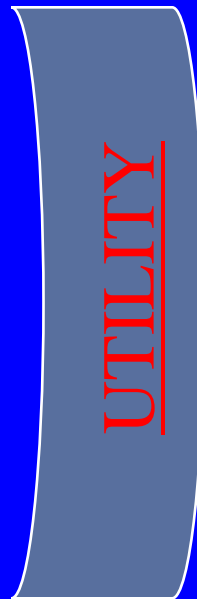


# Utility's Dilemma



Consumer

## Front-end



## Back-end

Generator

Trans. Utility

Govt.

Trader

Regulator

# Banes Of Distribution

**Burgeoning Losses -**

**Dilapidated Distribution Network –**

**Harassed Consumers with no fault management system, wrong billing, inadequate payment channels,**

**A work force with very little skill level.**

**No Corporate structure**

**Lack of accountability, initiative & service attitude**

**No administrative infrastructure and Dilapidated/Unsanitary buildings/Offices**



# DISTRIBUTION NETWORK

# Loss Making Elements

- Long And Overloaded of Distribution Feeders
- Over loading of Distribution Transformers
- Under loading of Transformers .
- Non-replacement of defective and stopped meters
- Poor workmanship resulting in hot spots& equipment failure .
- Weak and inadequate system due to low investments .
- Too many Transformation stages.
- Low power factor.
- Poor Quality of equipment.
- Inadequate maintenance.
- Improper load management.
- System is in very bad shape
- Theft of electricity is very high

# Operation And Maintenance System

- Preventive maintenance
- Fault Analysis
- Orders for spares mostly OEMS
- Strict observation of safety practices.
- Management of break downs
- Plant and equipment record
- Reliability indexes
- Zones/district score cards

# Distribution Planning

- Delivering supply as near to the load centers as possible.
- Voltage variations within + 6% on LT and + 10% on 33kV.
- System demand be met even with outage of the largest capacity transformer.
- AAAC instead of ACSR (All Aluminum Alloy Conductor), which is lighter in weight and has longer life on account of resistance to corrosion.
- Timely and correct meter reading.
- Timely delivery of bills.
- Proper accounting of amount paid by the consumer.
- Simple procedures for registration of new customers and commencement of their billing.
- Introduction of latest technologies including DSM, energy efficient transformers, ABC and associated gears.
- Timely System augmentation

## Maladies Of Distribution :-

- **Untrained and ageing manpower**
- **Metering in bad shape**
- **System in bad shape**
- **High Theft of electricity**
- **Staff unconcerned about service to consumer**
- **Energy accounting non existent**
- **Consumer data not up to date**
- **Asset registers not available**
- **Annual accounts not complete for years**
- **Erratic billing**
- **Belated assessment.**
- **Non-friendly commercial policies.**
- **Single window service just a myth**
- **Matching investments lacking.**

# Key Factors in Distribution Management

- Control of DTR Failures.
- Response time to rectification of faults.
- Facility Management.
- Asset Management.
- Optimization of Network.
- Interconnection of DTRs for Reliability.
- Types and qualities of Transformers.
- Application of transformers.
- Minimum changeovers.

# Commercial Discipline

## Key Turnaround Factor

Tackling the lack of commercial discipline in the power sector has to be the top priority; without this, no other remedy will work

- Raising tariffs would be meaningless – nor can the quality of service be expected to be improved – unless accompanied by stricter commercial discipline
- From this perspective – accelerated reform in distribution with or without privatization seems the most attractive option for the whole sector

The direction in this regard has been consistent in last few years but the pace needs further momentum

# Commercial Losses

- **Unmetered Consumers such as Unauthorized Colonies/Clusters**
- **Continuous Provisional billing**
- **Non Performing meters (Tampered, slow running, stalled, damaged)**
- **Meters bypassed**
- **Meter reading errors**
- **Processing errors**
- **Non delivery of bills**
- **Non recovery of dues**

# Operating Costs

- Poor materials management.
- Non scientific inventory.
- Incompetence in handling eqpt.
- Incompetent contractor pool.
- Lack of planning.
- Preventive / predictive maintenance absent.
- Prolonged breakdowns.
- Work culture missing.
- Safety culture not in the blood.
- Repetitive short term purchases.
- Multiplicity of makes of all equipment.
- So high inventories.
- And maintenance crews.



# Steps Needed For Controlling Losses

- Study of existing working conditions/status of equipment in sub-stations and identify equipment-needing replacement/ renovation.
- Short circuit and load flow analysis for the system to identify the elements causing overloaded/critically-loaded circuits calling for strengthening.
- Estimation of technical losses at each voltage level in existing system.
- Protection philosophy, relay co-ordination and protection settings in various sub-stations, lines and feeders.
- Identification of network modifications including installation of capacitor banks for technical loss reduction.
- Estimation of the maximum demands on various sub-stations at 11kv buses.
- Ascertaining peak load on the system by collection of information regarding power import through various feeders and development of daily load curve.
- Conducting system studies to estimate the feeder loadings, voltage profile and losses in the 33kv system including 33kv feeders, 33/11kv and 33/11kv transformers.

# Distribution Automation

- Automatic sectionalizers, auto-reclosers.
- Adoption of distribution automation by Telemeter such data to the distribution control center like MW/MVAR flow through transformers, through feeders, bus voltage, station battery voltage, energy flowing through the feeders, on/off position of feeders and transformers, transformer tap positions, Buchholz relay and temperature alarms of transformers, fire alarms etc.
- Adoption of customer interface automation like AMR, Remote reprogramming of meters, Remote connect and disconnect supplies, automated customer claims analysis.
- IVR (Interactive Voice Response) for consumer complaints.
- Computerized registration of complaints with call-hunting facilities.

# DISTRIBUTION SUBSTATIONS

# Best Practices in Operation And Maintenance of Sub-station Equipment, And Auxiliaries

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- **Type Of Sub-Stations**
- **The Presentation is applicable to Distribution Sub-stations.**
- **The Distribution voltage may vary , 11 KV onwards**
- **Substations can be Indoor, Outdoor, Pole Mounted, Plinth mounted, mobile, ring main Unit, multi-panel board,**
- **The sub station may be attended, unattended, locally actuated, remote-actuated.**
- **The breakers may be minimum oil, SF6, ACB**

# Sub-Station Earthing

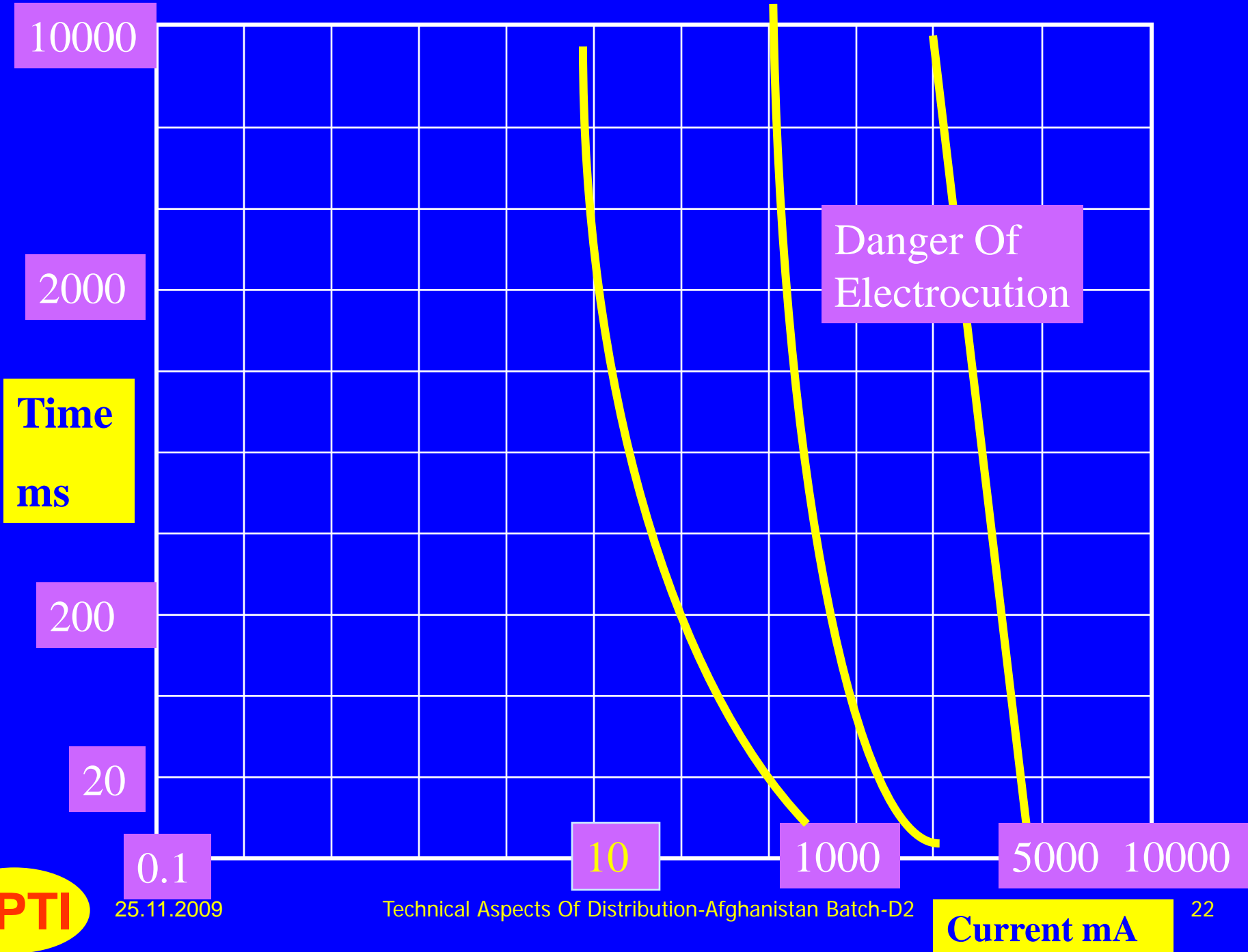
- **Grounding system Provides a low impedance path to ground for personnel and equipment.**
- **Withstand and dissipate repeated faults and surge currents.**
- **System to be capable to carry current under normal and fault conditions to earth.**
- **Earth path should be capable of handling magnitude and duration of current as per over-current protection of the system without any fire or flash or explosion or electrical shocks to persons and installations in the vicinity of earthed structures.**
- **All medium voltage equipment shall be earthed by two separate and distinct connections.**
- **All earth connections shall be visible for inspection.**

# Best Practices in Operation And Maintenance of Sub-station Equipment, And Auxiliaries

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## Lethal Current

- A let-go current of 10 mA for men and 8 mA for women are accepted as the limit.
- Currents of 100 mA and above are fatal.
- The effect of current passing through human body depends upon duration and magnitude of the current as shown in next slide.
- If a fault is rapidly cleared the chance of severe injury or fatality is reduced or even eliminated.



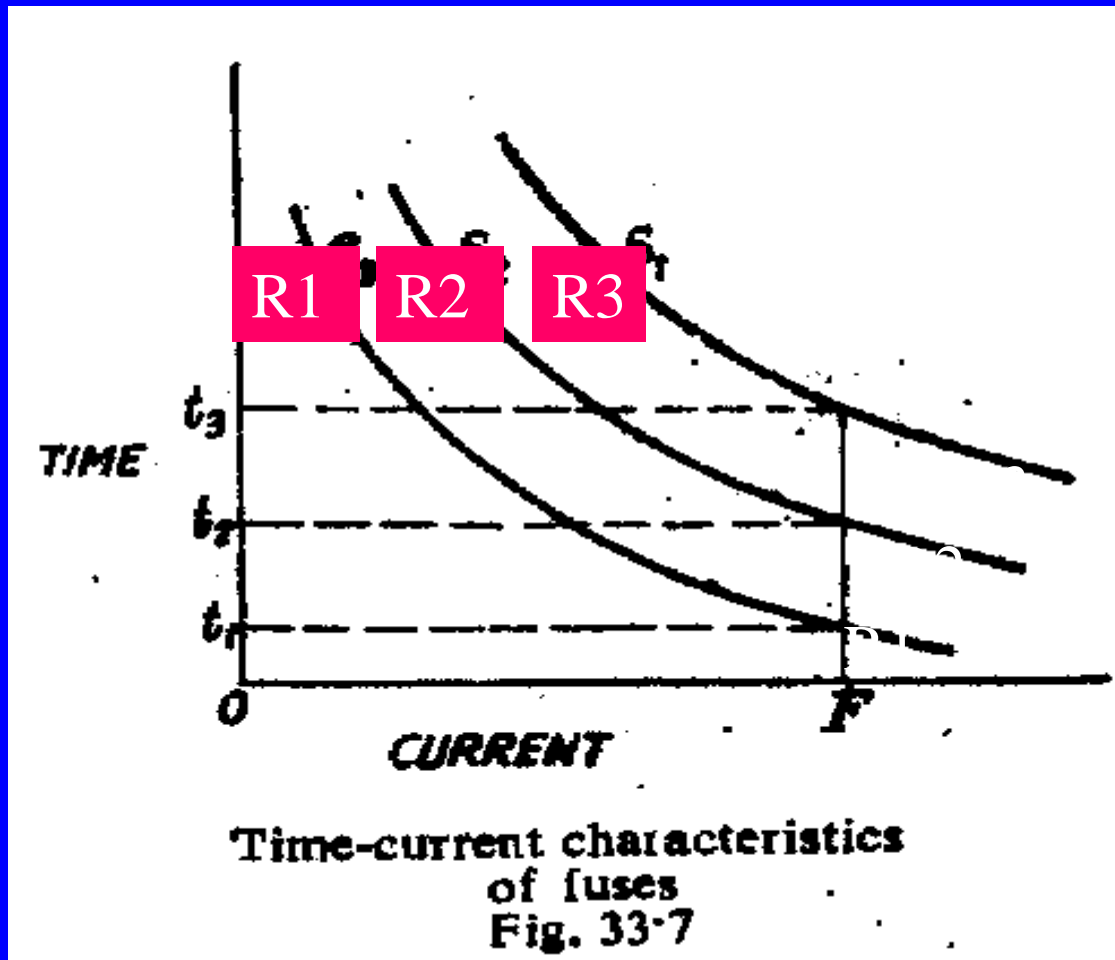
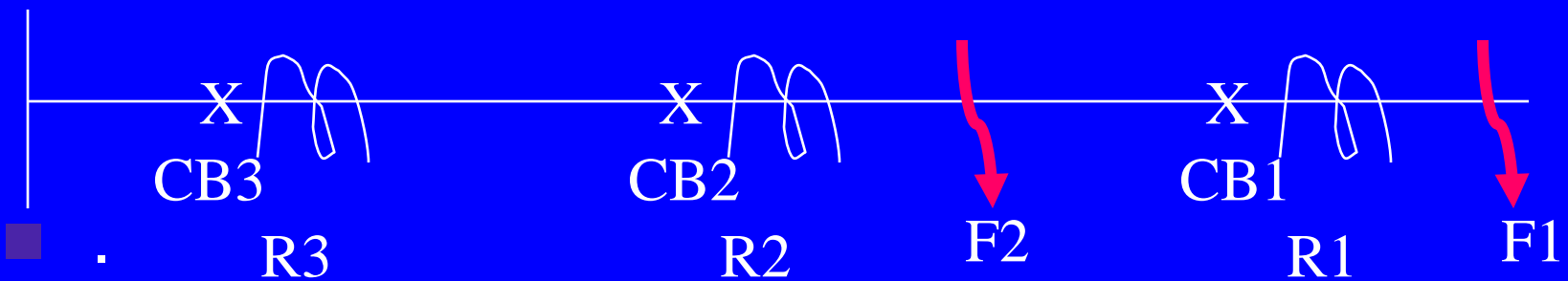
## Earthing Of Distribution Lines

- Earthing of overhead lines and sub-stations is important for safety of personnel and livestock and for reducing communication interference by keeping earth potentials low.
- All metal supports of overhead lines and metallic fittings attached thereto, are permanently and effectively earthed.
- For this purpose a continuous earth wire shall be provided and securely fastened to each pole and connected with earth at three points in each km

# Protection Of Sub Station Equipment

- Protections in an electrical network are required to take care of following situations.:-
  - Anticipate hazards,
  - Minimum interruption in supply,
  - Isolate the section causing nuisance,
  - Overloading,
  - Short circuits,
  - Earthing and electric shocks,
  - Propagation of fire,
  - Bear transient disturbances for pre determined time.
  - Discriminate between faulty and healthy portions.

# Best Practices in Operation And Maintenance of Sub-station Equipment, And Auxiliaries



R=Relay

CB=Circuit Brkr

F=Fault

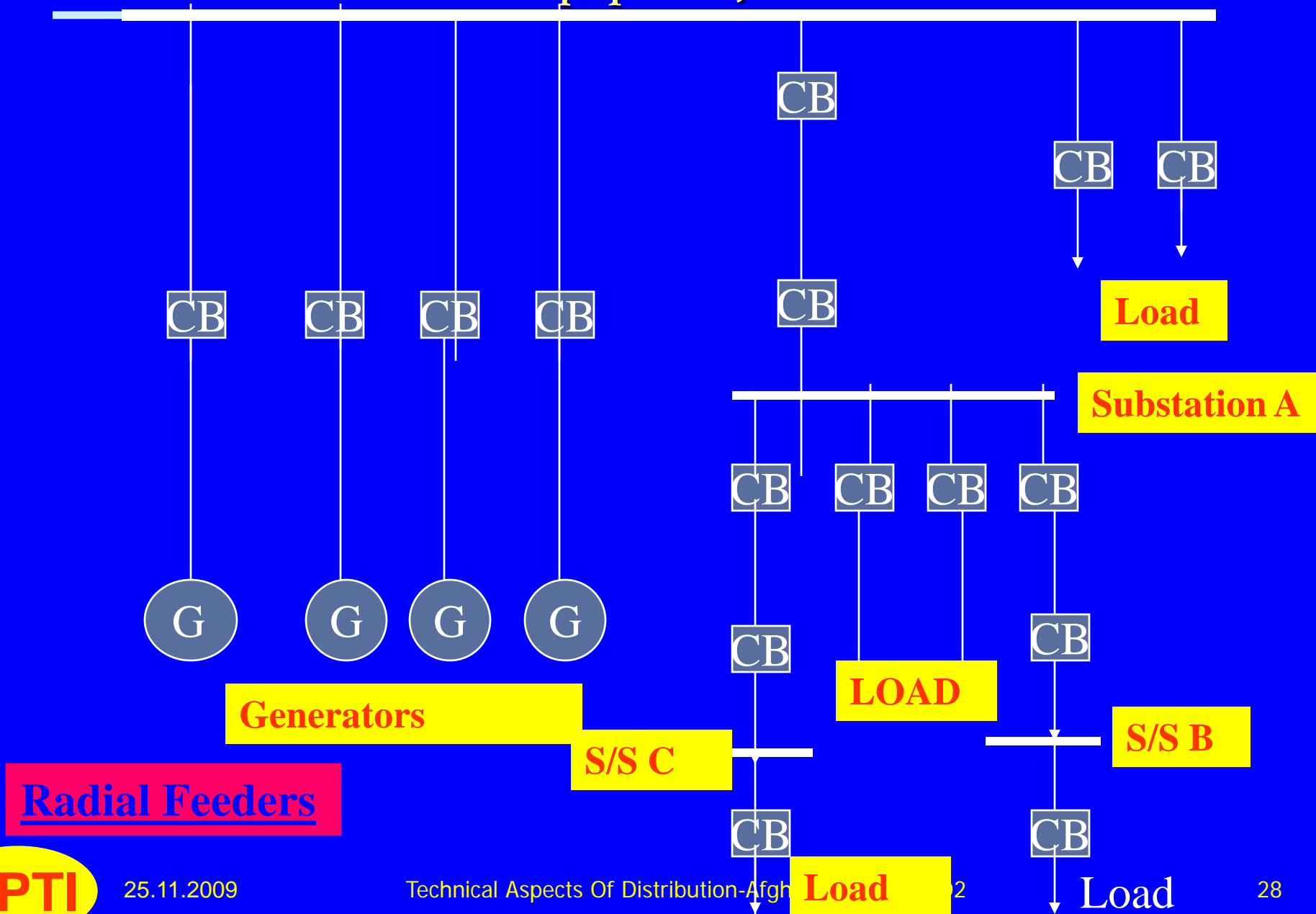
## Time Graded Scheme

- A fault at F1 would be sensed by Relay R1. It would open CB1 and isolate the fault.
- In case of failure of relay R1, the fault would be sensed by R2.
- Similarly fault F2, if failed to be detected by relay, R2 would have the back up of R3.

## Protection For Feeders And Auxiliaries

- **Distribution feeders are of three types:-**
  - **Radial Feeders.**
  - **Parallel Feeders.**
  - **Ring Main**
- **For deciding and adoption of protection philosophy it is essential to know significance of the feeder for maintaining supply.**

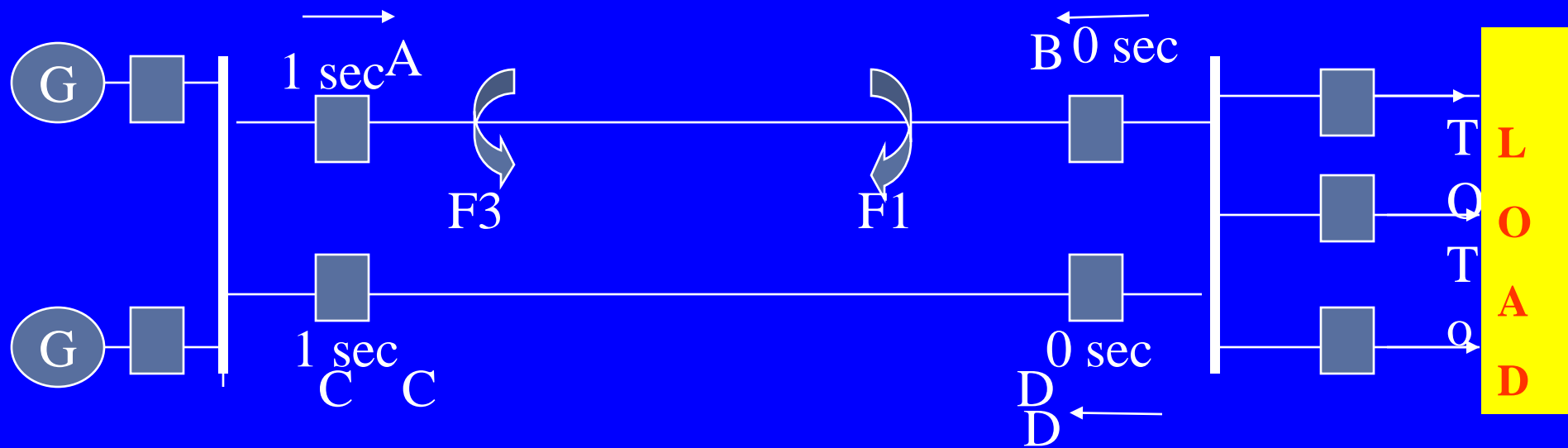
# Best Practices in Operation And Maintenance of Sub-station Equipment, And Auxiliaries



## Parallel Feeders

- As illustrated in next Slide , two parallel feeders AB and CD feed the Sub Station from the Plant.
- Assume a fault in the feeder AB at point F1.
- Fault F1 would be fed via both the feeders.
- Feeder AB would feed the fault via AF1, while Feeder CD would feed via CDF1.
- Thus when the fault is in one feeder, both the feeders are affected.
- Current in Section BF1 is flowing in direction opposite to the normal power flow.
- Directional relay at S/S B acts instantaneously and isolates the faulty feeder from the healthy one

# Best Practices in Operation And Maintenance of Sub-station Equipment, And Auxiliaries

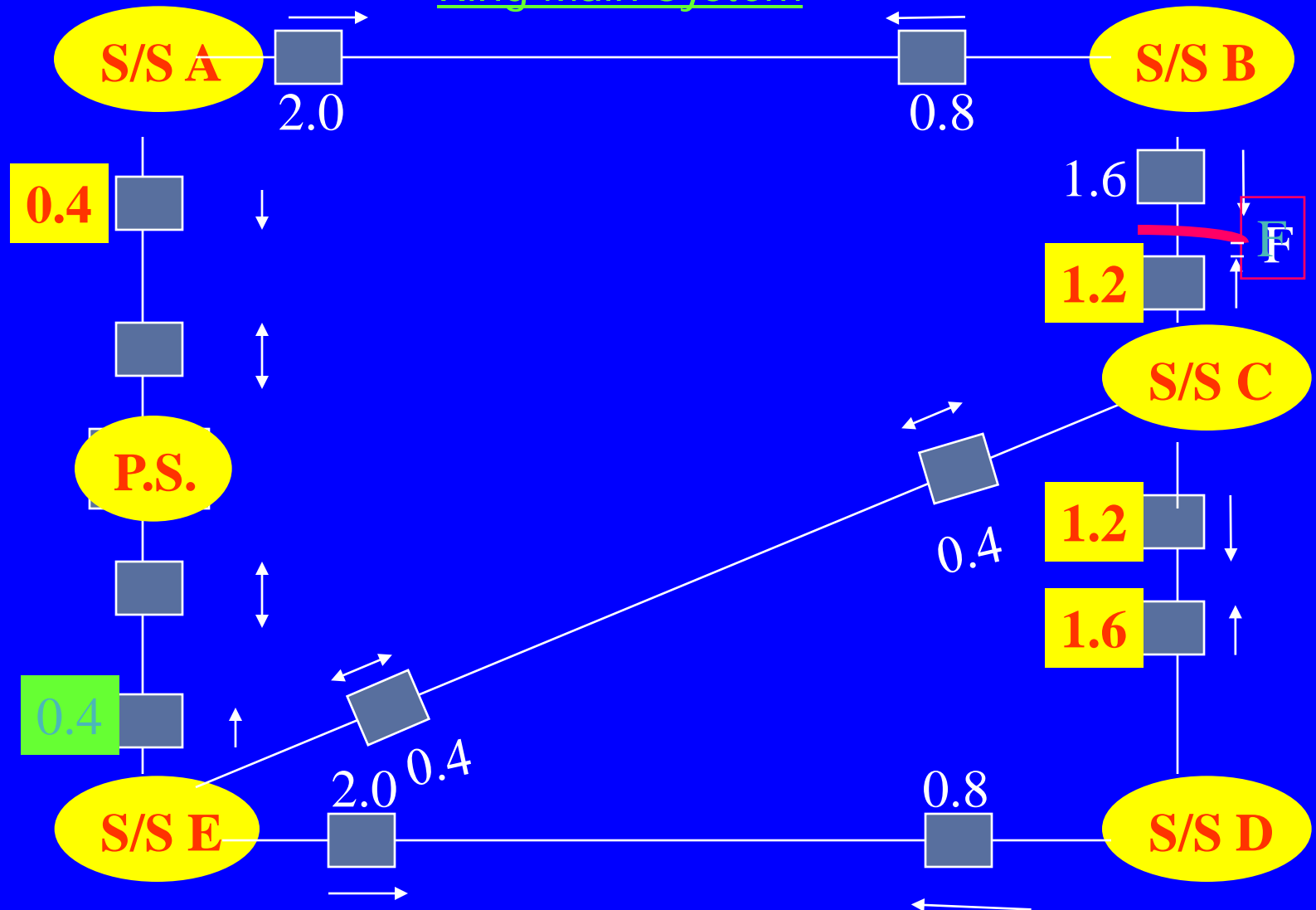


## Ring Main Distribution System

- A conceptual configuration of Ring Main Network is shown in the following Slide.
- Time graded Directional and Earth Fault Relays are used.
- A power station is connected to five substations with an interconnector between C and E.
- Power is never to flow to PS Bus bars.
- In order to decide about time grading feeders E-PS and A-PS should trip in 0.4 sec for flow of power in reverse direction from E&A towards PS.
- Other relays are graded with a difference of 0.4 sec.

# Best Practices in Operation And Maintenance of Sub-station Equipment, And Auxiliaries

## Ring Main System



# Circuit Breakers

- Circuit breaker is a protection device capable of making and breaking all currents, both under normal and short circuit conditions.
- Actuations of CBs are governed by relays ranging from instantaneous to time delays.
- Closing and opening operations are through solenoids, manual/motorized springs or pneumatically.
- CBs have high sense of discrimination so as to isolate faulty link from the healthy ones, thus minimizing the interruption.
- It is capable of sustaining transient over currents without actuation.

# CAUSES OF FAILURES OF TRANSFORMERS

**Failure due to repeated faults.**

**Failure due to bad protection.**

**Failure of insulation between LV winding and tank.**

**Displacement of LV and HV coils.**

**Displacement of spacers.**

**Failure due to bad loading conditions.**

**Bad design**

**Sub-standard material.**

**Repetitive closing on fault.**

# Good O&M Practices

- Adequate housekeeping
- Provide Cable trench covers
- Panel doors shut properly.
- Cables & equipment in good condition
- Adequate sizing of all equipment
- Protections and relays are functional
- Load balancing
- Safety of men and material.
- Work-to-permit&Data Logging
- Infra red cameras for inspections of o/h lines & Substation bus bars for hot spots.
- Live line washing for cleaning overhead lines and open terminal substation insulators

- **Robust connections with secondary of transformer:**
- **Earth wire to be clamped and terminated correctly.**
- **LV cables are supported on cleats and there is no stress on Transformer terminals**
- **Bushings are not having any oil leakages. Gaskets are in proper position.**
- **GO switch knife blades are properly inserted in the female contacts.**
- **To avoid bi-metallic action between copper and aluminum, the bus bar should be bi-metallic or provided with a bi-metallic strip between the bus bar and the cable lugs.**
- **Painting and corrosion protection**
- **Lubrication of moving parts of circuit breakers**
- **Oil levels**
- **Quality of SF6 gas for humidity, pressure or density**
- **Verification of correct operating sequence**
- **Closing and opening times**

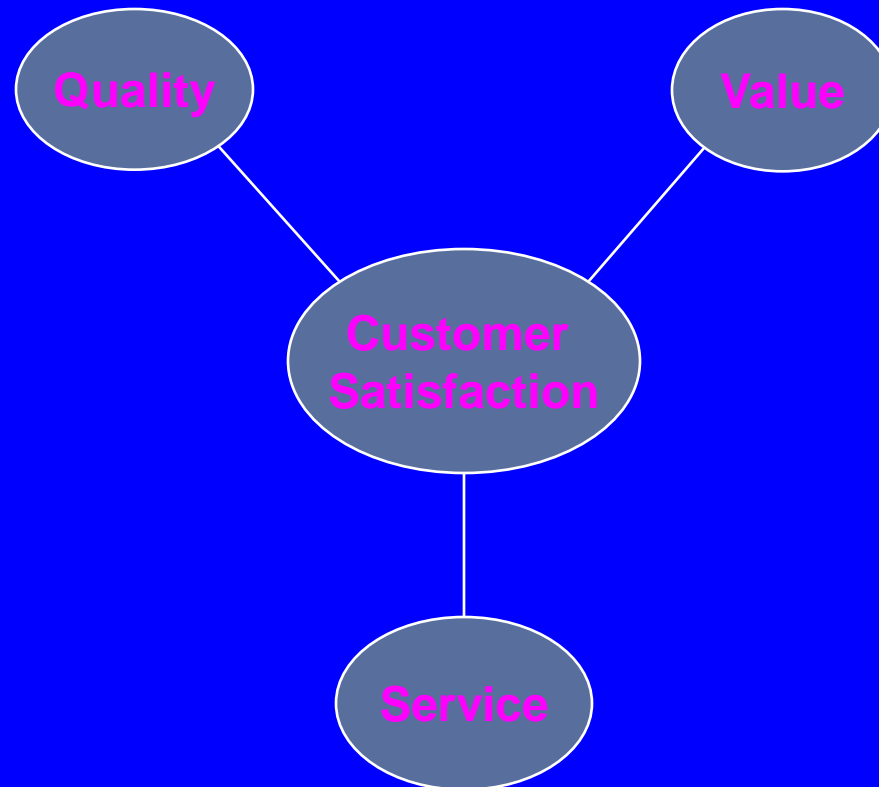
# Safety

- Lay down procedures for PTW (Permit to work) to ensure safety of the personnel and the public.
- Procedure for cancellation of PTW and issue of “line clear”.
- Cable live terminals are properly insulated.
- Do not Provide two parallel ACBs for one transformer.
- Do not Provide one isolators for two transformers.
- Handle to switch On/OFF the Breaker is in place
- Arc chute is existing
- Cover plate is in place.
- Termination of the cables is in proper condition with the provision of plate washer, socket, plate washer, spring washer, nut and self-locking check nut, in that order.

# METER TO MONEY CONVERSION

1. Consumer Data Updation
2. Consumer Survey
3. Consumer feeder/Transformer wise Indexing
4. Meter Management System
5. Meter Reading
6. Consumer Billing
7. Bill Distribution
8. Revenue Collection
9. Revenue Account updation
10. Disconnection of Defaulting Consumers
11. Surveillance on Disconnected consumers
12. Updation of consumer ledgers
13. Commercial policies
14. Regulatory Directives / Issues
15. Energy Accounting / Auditing
16. Power Purchase Billing
17. Theft Prevention

# Customer Requirements



# Consumer priorities

Payments  
Convenience

Redressal  
Management

Consumer  
Relationship

Billing

Ownership  
Change /  
Addition /  
Reduction of  
Load

Meters  
Reading

Fault  
Management

New  
Connection

Power  
Reliability  
Quality

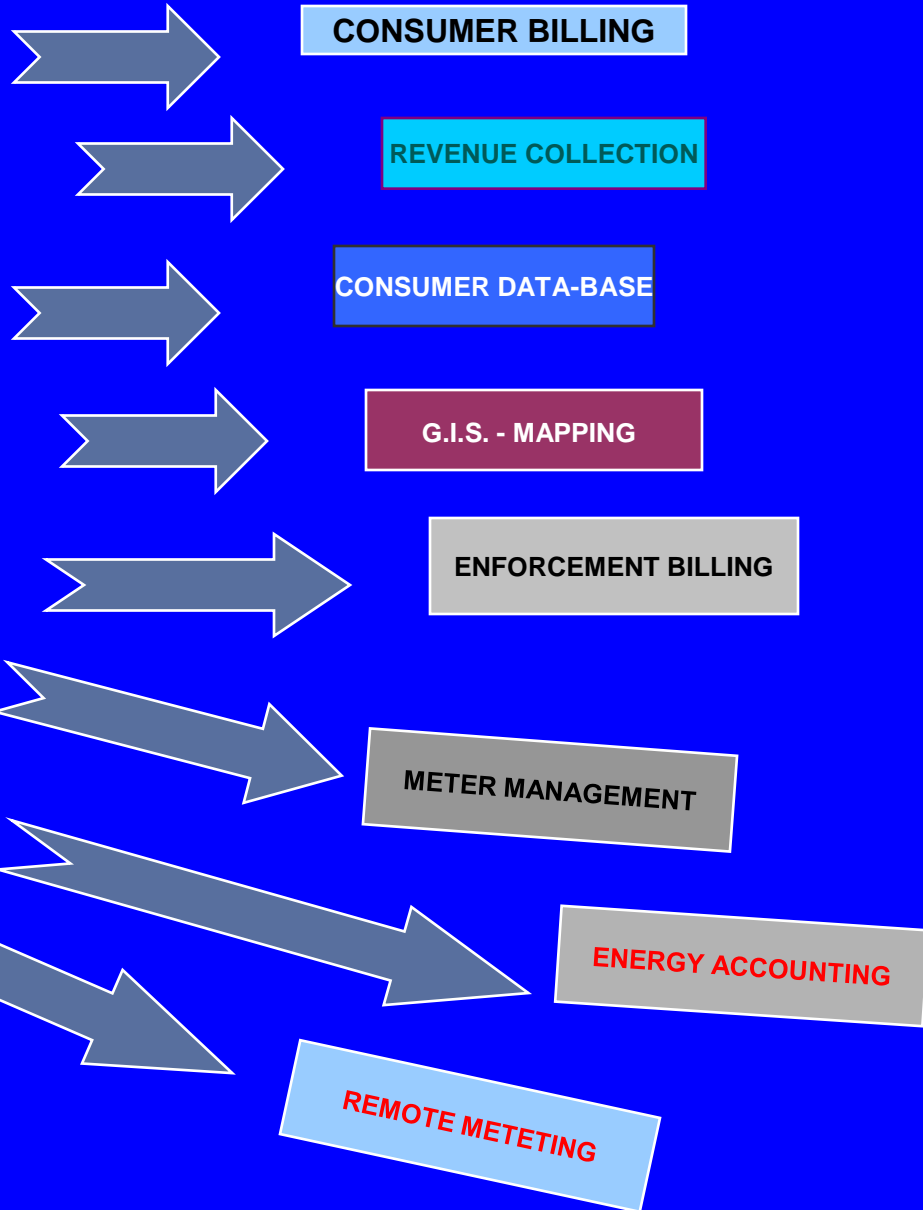


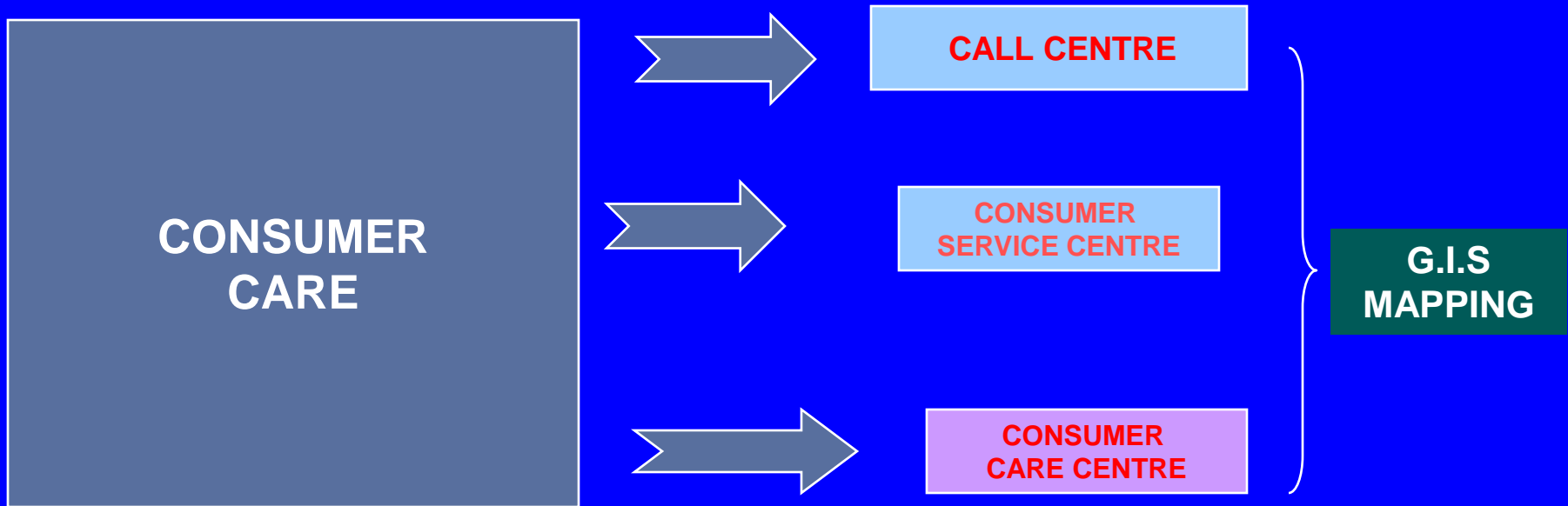
# Consumer Interface

- Prolonged Disputes.
- Connivance.
- Non reading or incorrect readings of meters.
- Hard procedures for new consumers.
- Frequent churning of existing customers.
- Rampant corruption or favors.
- Lack of commercial approach.
- Even honest consumers harassed.
- Long chain for dispute resolutions.
- Avoidable litigations.
- Erratic Reconciliation.
- Single window on paper only.
- Insufficient payment mechanism.
- No business thrust.
- Non-friendly commercial policies.

# Consumer Aspirations

- **Consumer expects that utility efficiently invokes traits as :-**
  - **Billing management.**
  - **Client management.**
  - **Consumer comfort**
  - **Friendly collection services.**
  - **Transaction and remittance services.**
  - **Promptness in new connections, load enhancements.**
  - **Single window redressers.**
  - **Least monopolistic overtures.**
  - **Minimum customer churning.**





# Enhancing Consumer Convenience

## *Consumer Care and Communication*

Fully networked consumer care centers launched

