TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

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EDITORIAL

Dear Members, Fellow Professionals and Friends,

Greetings to All!

Was pondering over the number of road accidents and
Why it happens? &
How it can be reduced?

The analysis reveals in driving skills there are 3 parts

(a) Knowledge of the Vehicle.

(b) Knowledge to Drive the Vehicle.

(c) Road Sense.

Knowledge of the Vehicle, is knowing the Engine, Clutch pedal, Brake pedal, Accelerator, Gear shift etc., Knowledge to drive is knowing how to use the vehicle and run it. Road sense is all about knowing how to drive on the Road, where to maintain correct speed, using of signals, slowing down at corners, obeying traffic signals.

In our country, people lack road sense, that is the reason for number of accidents. If the Driving Schools / Parents / Schools / Colleges impart the knowledge of Road Sense, we would have safe and enjoyable motoring.

Usage of horns are the second important thing to be focussed, motorists should empathise on the road users and general public before using loud and continuous horns.

We thank all those members who have helped us by participating in the advertisement appearing for the issue June 2023 – 3SI Eco Power LLP, Ashlok Safe Earthing Electrode Ltd., E Power Engineering, Galaxy Earthing Electrodes (P) Ltd., Gravin Earthing & Lightning Protection System (P) Ltd., Global EPC India Private Limited, Pentagon Switchgear (P) Ltd., Power Cable Corporation, Power Cable Corporation Screened Separable Connection, RBB Electricals, Sakthi Transformers, Sri Bhoomidurga Marketing (P) Ltd., Supreme Power Equipment (P) Ltd., Value Engineers.

Editor

Electricity can transform people's lives, not just economically but also socially. – PIYUSH GOYAL

TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

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KNOW THY POWER NETWORK – 172

This month's topic – "Mapping / Shaping the profile of Modern Substation Equipment with a New Brush". "(Smart Digital Brush)"

In this brief, while having a close brush with the materials / components employed in Modern Sub-Station Equipment, the flight paths of materials employed in earlier equipment, now become obsolete are plotted and in addition some philosophical quotes/ thoughts on "Life" are also spelt out.

"LIFE"

(There is not much difference between a Human Life and Equipment Life)

(1) In life, there should be truth in thought, truth in speech and truth in action.

(2) Every new beginnings comes from the end of some other beginnings.

(3) We are not in a position to comprehend

- why we are here with a limited life span? (100 years or less)
- Why we are unable to lead effective and useful lives?
- Instead of effectively addressing the above two points, why we waste our time in thinking / planning how to make our lives more effective, beneficial and become infinitely happy and finally fail utterly in all our efforts and leave the scene silently. This is referred as Human / Equipment History.

While analyzing the journeys made by SS equipment, let us make these thoughts as the "Basic blocks of this technical brief". In addition, it is preferable to take guidance from our past experiences / events keep the present conditions in our focus / consideration and finally with these inputs map our future.

The S.S. equipments that are found in reference is listed below,

(1) EHT and HT Circuit Breakers

(2) HT Capacitors

(3) Surge arresters

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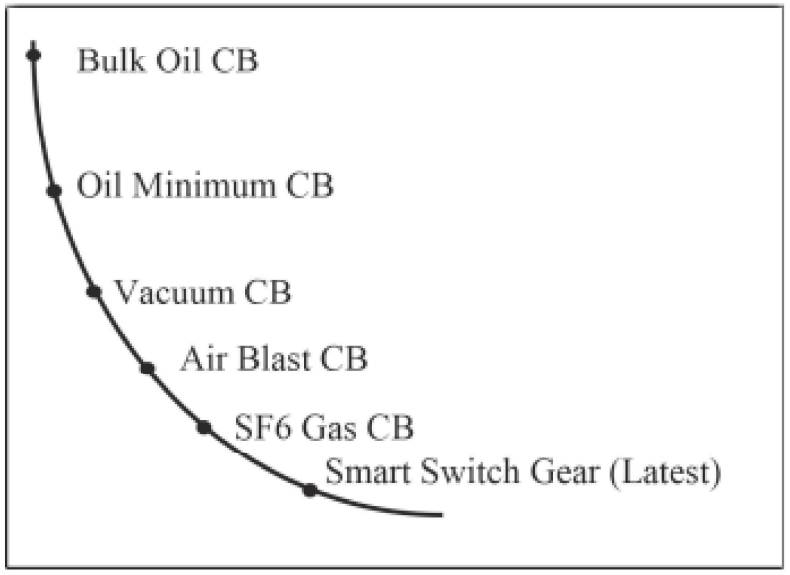


Fig 1 EHT and HT Circuit Breakers

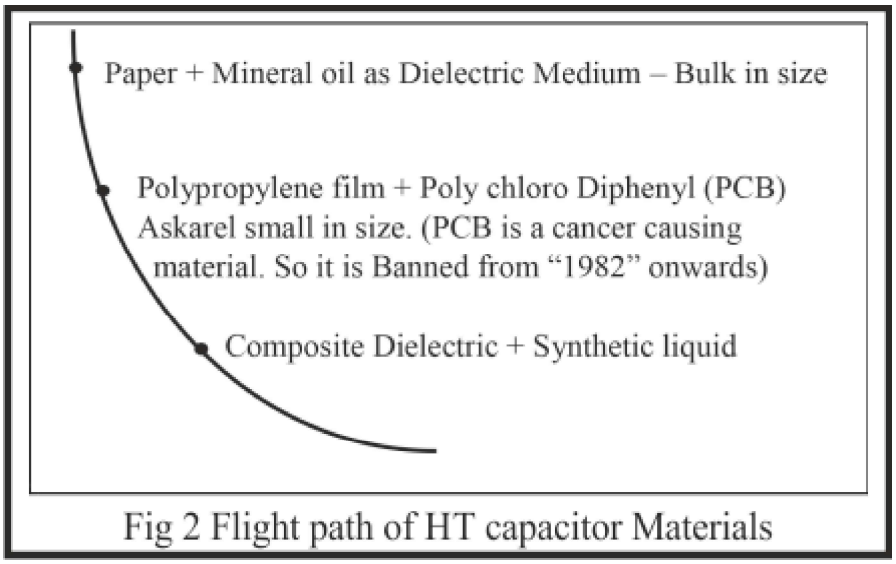


Fig 2 Flight path of HT capacitor Materials

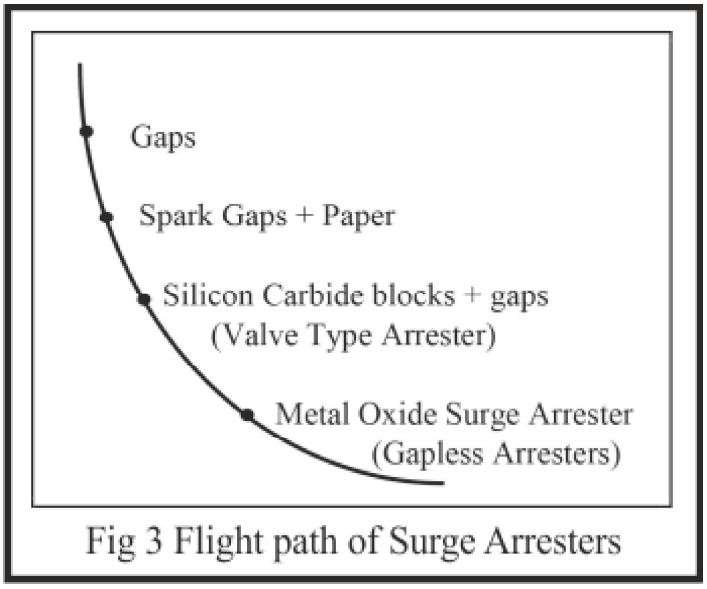


Fig 3 Flight path of Surge Arresters

(4) Sub-Station

(i) Air insulated SS (Outdoor and Indoor Sub-station)

(ii) SF6 Gas Insulated SS (GIS)

As regards, our future SS equipment, we have to catch up a lot of things. Among them are,

(i) Alignment with Nature – That is Building / creating an environment with zero tolerance pollution

(ii) Line losses are to be brought down from the present level to an acceptable level so as to safe guard/conserve the limited natural resources available with us.

It is not out of place to mention here that earlier equipment were "phased out" because of,

1. Their higher maintenance needs
2. Higher pollution and losses they brought
3. Their performance is not up to expectations
4. Shortage of spares and fast development of advanced technologies. Further some of them brought adverse effects ((e.g) Capacitors with PCB as Dielectric Medium)

All these equipment "past their prime or past their sell - by - date".

Now it is time to go for Smart (Digital) Equipment.i.e. "Smart" is the key or buzz word employed in the power systems. Before delving deep into this topic, let us see what are the short comings noted with present SF6 gas and vacuum circuit breakers.

A. Vacuum Circuit Breakers

Its use is restricted to Medium Tension networks only. (upto 33KV). It is because of the limitations brought by its breaking chamber capacity to handle arcs (Max.65KA) and the limits on the number of chambers employed.

B. SF6 Gas Circuit Breakers

It suffers from

- Frequent gas leaks and drop in gas pressures
- Moisture Ingress
- Adverse impacts of its decomposition products i.e powdery material produced by SF6 gas while quench of arcs. These endanger our lives.(Poisonous gases are formed then).

The topic next in line is 'SCADA System' – Supervisory Control And Data Acquisition – a category of software applications for controlling sub-stations. It is mainly related to the gathering of data in real time from remote locations in order to control SS equipment and operating conditions. Now it is wildly employed in TANGEDCO and other power networks. In this system, coded signals over communication channels are used to control remote equipment.

While SCADA has many advantages, it has certain demerits also.

Among its disadvantages are

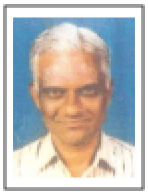
- Higher costs of installation.
- Skilled persons are required to maintain the SCADA system.
- This system enhances the unemployment rates of workers.
- It allows for the use of restricted soft wares and hard wares.

Now it is time for us to land on our main topic "Smart Switch Gears". Switch gears or circuit breakers that they make / play a critical role in todays' power system by Monitoring, Regulating, Protecting and Isolating Electrical Equipment throughout the grid.

These Medium and High Voltage, switchgears are made mainly by Digitalization (computer technology) and modern communication systems. They are Intelligent, Smart, Compact, Flexible, Reliable, easy to install and able to endure harsh environments. They facilitate smooth power transmission and distribution and their ability to remotely monitor the operating conditions enhance safely and productivity and this attribute is invaluable. Their enhanced connectivity and communication capability make it is easier to monitor to flow of current consumption and quality in real time.Through advanced data processing with the support from IoT, they can play the role of a technological vigilant agent by spotting errors and malfunctions beforehand, thereby preventing system failure and minimizing energy losses and costs. They also free the customers of hassles around maintenance. They can plan their maintenance schedule well in advance.

Let me continue this topic in next brief.

With this I sign off.



(To be continued)

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ELECTRICAL MAINTENANCE UNIT (QUESTION & ANSWERS) – 18

Switchgear

1. Mention the commissioning tests on breaker and bus bars.

Breaker

a. Milli volt drops test between the interrupting contacts and between the isolator contacts.

b. Closing and opening timing of the breaker for 5 times.

c. Checking whether the breaker trips or closes when the logics are fulfilled.

Bus bars

a. Milli volts drop test for the contact resistance value.

b. Tightness of the joints.

c. IR values between phase to phase and phase to ground.

2. Explain clearly the three positions in 415 V breaker.

a. Service position: Power connections and control connections are available to the breaker.

b. Test position: Power connections are cut off but control connections are available to the breaker and it can be tested.

c. Disconnect position or rack out position: This is for maintenance of the breaker and in this positions both the control and power connections are not available.

3. What do mean by trip free system in breaker?

In trip free the breaker is free to trip at any time. If both close and trip signal is present at same time (instant) the breaker will attempt to close and positively trip. When the breaker trips it will not close again even if closing signal exists because of anti-pumping feature.

4. What is the purpose of spring charging in 415 V breaker?

If the breaker is to be closed and tripped manually the closing time and tripping time would vary from person to person. Also it would not be very fast. So spring charging is provided. It gives uniform timings irrespective of the operator and its action is fast and closing and tripping time is very less.

5. What are the built in protections provided in 415 V breaker?

a. DINF (Making Current Magnetic Release)

This consists of a laminated magnetic circuit. This is placed under the lower current terminal pole. This is provided for all the three poles. It has a core that rotates in the air gap. It is held by spring. During protection the magnetic forces developed overcome the spring tension and the core is attracted. The mechanical force developed is used to trip the breaker. This protection acts during the closing of breaker if any fault exists. The current is set to 5 times the rated current.

b. DIRS (Short Time Magnetic Release)

The construction is same as DINF, but it has a mechanical timer, which can be set accordingly. This protection acts when any fault comes during breaker in service. The current rating is set to 3 to 8 times the rated current.

c. DIT – S (Thermal Over Load Protection)

This consists of a three bimetallic strip, which gets heated up when over loaded and trips the breaker by a lever. It is placed in front of the breaker. Setting range is 60% to 100%.

MCC

1. What are the advantages of MCC?
   a. Starters and contactors all will be a standard size.
   b. Spares inventory will be less.
   c. Cost of cables will be less because same size of cable is used for all capacity and gland holes can be provided beforehand.
   d. Maintenance and troubleshooting is easier in MCC.
2. What type of motor starting adopted in MCC?
   DOL (Direct On Line) starter.
3. What is the purpose of grounding secondary of the control transformer?
   To protect the operating personnel from high induced voltage.
4. Based on what factors will you select rating of components for a starter cell?
   Factors for selecting rating of components are,
   a. Capacity of load.
   b. Type of starting.
   c. Duty (continuous or intermittent).
   d. Type of protection.
   e. Nature of starting (acceleration time is slow or fast).
5. What maintenance checks you will do for an MCC cells and MCC panel?

   Maintenance checks on MCC cells

   a. Ensure that the load is tripped from control room and switch is in off position. Switch off the isolator at MCC cell.
   b. Open the door and rack out the cell into isolation position.
   c. Check the tightness of terminal of contactor, 3C, control transformer, control fuses, wipe in contacts, power cables, etc.
   d. Check the tightness of component mounted.
   e. Look for any charred components or terminals.
   f. Check the IR value of 3C, contactor, control transformer, isolator etc.
   g. Check the isolator double switch feature.
   h. Check the OLR and calibrate the OLR.
   i. Check the pick and drop out value of contactor, 3C.
   j. Check the fuses for healthiness and fuse carriers for proper contacts.
   k. Clean the arc-chutes of the contactor and clean all the components of the MCC cell properly.
   l. Check the resistances of control transformer, contactor, 3C etc.
   m. Check the tightness of control cable at main TB compartment.

   Maintenance on MCC panel

   a. Ensure the permit and all isolations.
   b. Open the bus bar chamber and discharge the bus bar.
   c. Disconnect the cables connected to bus bar and take the IR value of bus bar and cable individually. Connect it properly and tight it to proper torque.

d. Check the tightness of nut and bolts and cables connected to buses.
e. Open the main TB compartment and check the tightness of all cables and clean it.
f. See the tightness of power terminal compartment and clean it.
g. Check that cables are supported properly.
h. Do checks on CT, PT used for indication purposes.
i. Clean the entire MCC panel properly and take the IR value.
j. Carry the checks on relays, which are used in the MCC panel.
k. See for proper earthing connection and tightness of the earthing connections.
l. See for proper housekeeping.

6. What is the difference between an auto reset and manual reset overload relay?
   a. *Auto reset relay* closes its contacts when the bimetallic strip gets cooled. In *manual reset relay* we have to manually reset the relay because even though bimetallic strip cools its contacts are not closing without manual reset. L & T type OLR have only manual reset and siemens type has both manual and auto facility.
   b. *Auto reset over load relay* is reset by switching OFF the respective had switch and again switching it ON.
   c. *Manual over load relay* is resented by pushing the reset button provided on the MCC cell.

Batteries and charger

1. How you will prepare electrolyte for a lead acid battery?
   While preparing electrolyte for lead acid battery sulphuric acid is added to distilled water.
2. How battery capacity is expressed?
   Always battery capacity is expressed in *Ampere – hour.*
3. What is the instrument used to measure the specific gravity?
   The instrument used to measure the specific gravity is called *Hydrometer*.
4. What you mean by SCR?
   SCR is meant for silicon controlled rectifier.
5. Define specific gravity and mention the specific gravity of a fully charged lead acid battery?
   Specific gravity of a substance is the comparison of density of the substance with the density of pure water.
   Specific gravity = Density of the substance / density of pure water.
   $= kg / cm^2$
   kg / cm^2
   = (No unit)
   Specific gravity is only number. It has no unit.
   Specific gravity of pure water is one.
   Specific gravity of fully charged lead acid battery is 1.215. Specific gravity should always be corrected to 27^oC.
   Corrected specific gravity is equal to indicated specific gravity $\pm$ (t - 27^oC)*0.0007.
   Indicated specific gravity = 1.205 and 't' means electrolyte temperature.
6. What are the parts of the battery?
   Parts of the battery are
   a. Battery container.
   b. Battery cover.

c. Positive plate (Pb o_2).

d. Negative plate (Pb).

e. Cell connector.

f. Grid.

g. Cell separator (porous material).

h. Sediment chamber.

i. Positive and negative terminals.

j. Vent plugs.

k. Dilutes sulphuric acid (electrolyte).

7. What are the indications of a fully charged cell?

a. The colour of the +ve plates will be dark brown. This can be seen only if the battery has transparent cover.

b. Voltage per cell will be a 2.15 volts.

c. Gassing in the will electrolyte will indicate. But the current is splitting up water to H_2 and O_2. Because the positive and negative plates are fully converted to their original constituents.

8. What are the difference between primary cell and secondary cell?

Primary cell: The electrolyte in primary cell is chemically irreversible. That is once the cell is discharged it cannot be recharged. It should be replaced with a new cell. The cells can supply only low currents and have low efficiency. They supply intermittent current. Their internal resistance is more. These cells are comparatively cheap.

Secondary cell: These cells are chemically reversible. They can be discharged and charged. They can supply large currents because their internal resistance is less. These have high efficiency compare to primary cells. These can supply constant current. These are comparatively costly.

9. What do you mean by sulphation? And what are the effects of sulphation?

Sulphation: During normal discharge of battery Pb so_4 is formed. This Pb so_4 is chemically reversible by passing current. These split up to their original constituents. But under certain condition crystalline lead sulphate is formed (Example: under charging after some time without trickle charging). This Pb so_4 is chemically irreversible. So if the sulphation occurs the battery life decreases. Efficiency decreases and the active material starts falling off the grid.

10. Write down the equation for Nickel cadmium battery.

Equation for Nickel cadmium battery.

$Ni(OH_4) + Cd + 2\,kOH \longrightarrow Ni(OH_2) + Cd\,OH_2 + kOH$ (during charging)

(Nickel hydrate + cadmium + potassium hydroxide $\longrightarrow$ Nickel hydroxide + cadmium hydroxide + potassium hydroxide.)

$Ni(OH_2) + Cd\,OH_2 + kOH \longrightarrow Ni(OH_4) + Cd + 2\,kOH$ (during discharge)

We see that there is no change in electrolyte. It just acts as a catalyst. So there is no need to change the electrolyte.

11. Write down the theory of lead acid battery.

A simple lead acid battery consists of positive and negative electrodes Immersed in an electrolyte. The positive electrodes are Pbo_2 (lead oxide) and the negative electrodes are Pb (spongy lead). The electrolyte is dilute sulphuric acid.

On discharging the battery

$Pbo_2 + Pb + 2\ H_2\ so_4 \longrightarrow Pbso_4 + Pbso_4 + 2\ H_2o$

Lead acid is converted into lead sulphate. Spongy lead is also converted into lead sulphate and $H_2\ so_4$ used up in the process. Only water is remaining. So the specific gravity of the cell comes down.

On charging the battery

$Pbso_4 + Pbso_4 + 2\ H_2o \longrightarrow Pbo_2 + Pb + 2\ H_2\ so_4$

Here the products are converted to their original constituents and the acid is released. So the specific gravity rises as the cell is charged. How much ever larger be the cell the voltage of each cell will be approx. 2.15 V when fully charged.

The positive plate is made of a paste lead oxide, lead sulphate that is fitted in a mesh like material and is connected to grid. All positive plates are made common and connected to a grid.

The negative plate is made of spongy lead also it is in mesh and connected to grid. These are also grouped together.

These plates are separated by a micro porous separator for the diffusion of electrolyte.The electrolyte is prepared by adding sulphuric acid to distilled water drops by drop and stirring it until the reasoned specific gravity is attained.

Everything is placed in a container of hard rubber. The cells of a battery are connected by a cell connector. The container is leak proof.

12. What are the parts of a 48V DC charger?

***Main transformer*:** This steps down the 3Φ 415V supply to the require value of voltage.

***Synchronizing transformer for phase sequence*:** This gives the synchronizing signal to the firing card. That is, the pulses from this card if fed to the firing card. The firing card gives pulses to the SCR of R or Y or B depending upon which phase is positive maximum.

***Half control module*:** This has a diode and a SCR for each phase. The firing card controls the firing angle of SCR.

***Firing card*:** This gives the firing pulses to SCR depending on phase sequence and the feedback from output.

***Controller card*:** This card monitors the output and gives signal to firing card to conduct at certain angle to maintain constant output voltage.

***Power supply card*:** This gives power supply for the controller card, firing card and protection.

13. Explain the operation of 48 V battery charger.

The supply for the charger is from MCC. The supply is tapped for power supply to control card, PF correction capacitor. LC filter is used for suppressing surge voltage. The main supply is stepped down and given to the half control rectifier module. The SCR conducts only when gate gets positive pulse. This pulse is given by pulse transformer, which gets pulses from firing card. Firing card gives pulse to the respective RYB SCR only when their phases are positive maximum. The freewheel diode is incorporated to protect the SCR and diodes from back emf when supply to coils is cut off due to collapsing magnetic field.

The filter is provided to smoothen the ripple output and the bleeder is used for voltage regulation. It gives improved voltage regulation and acts as a minimum load. Also it keeps the SCR in conducting state by drawing the minimum current which is higher than the SCR holding current. Thus there is always output voltage irrespective of load.

DC CT is used for limiting output current. It works on principle of magnetic amplifier. There is also provision for smooth rising of output voltage.

14. What is purpose of freewheeling diode and DC filter circuit in the charger?

Freewheeling diode is used to protect the semiconductor components used in the charger from the back emf, which is induced in the inductive coils of relays when the supply to the relays is cut off. The magnetic field in the relays collapses and induces high voltage in reverse direction. This emf is shunted by the freewheeling diode, which is connected in reverse bios with the output.

DC filter is used to smoothen the output, which has ripple. Ripple frequency is same as system frequency for half wave rectifier and 2 times of system frequency for full wave rectifier. The filter, which is a capacitor, will oppose any change in voltage. Thus the ripple will not be allowed to come to zero.

(To be continued)

Courtesy:https://www.scribd.com/document/244623258/Question-and-Answers-Electrical-Maintenance-Unit

BY 2025-END, DELHI TO ADD 4K ELECTRIC BUSES IN PHASES

The Delhi transport department is set to add nearly 4,000 electric buses to its fleet in a phased manner by the end of 2025, according to senior officials. The first lot of 100 buses is expected to be delivered by September this year.

While 1900 vehicles will be bit 12-metre buses, 2080 will be smaller nine-metre buses. They will be supplied by three companies. PMI Electro, Switch Mobility and JBM – Delhi Transport Corporation managing director Shilpa Shinde said.

The buses will be added to both the DTC and the mohalla service fleet, according to transport minister Kailash Gahlot. "It will serve the dual purpose of enhancing public transport as well as bringing down pollution levels. Delhi has so far been a leader in the EV segment and with these buses, carbon emission will be reduced".

PMI Electro chairman Satish Jain said his firm had been entrusted with the responsibility of delivering 2026 electric buses to Delhi government.

PMI will operated and manage these buses, and provide the citizen of Delhi with reliable services. Our team will also help the Delhi government with regular maintenance of the buses to ensure zero downtime". Jain added.

The buses will have real-time monitoring system (RTMS) and CCTV cameras to ensure passenger safety. They will also be equipped with automatic pneumatic wheel chair ramps for persons with disabilities. Transport department officials said the new buses would have a higher charging capacity and a fully charged vehicle would be able to run for two shifts.

According to senior officials, procurement of buses has been a challenge. Last year, DTC had signed an agreement with a private company to procure 1,500 12-metre low-floor AC electric buses. However, the department has received only about 100 so far, said an official.

"There are different safety protocols to be followed and testing exercises that need to be done, but we hope to induct the buses by the end of the year," he added.

Delhi has nearly 7,000 buses under DTC and Delhi Integrated Multi-Modal Transit System Limited (DIMTS) as well as 300 electric buses. With the number of e-buses likely to grow in the next few years, a comprehensive plan for electrification of all bus depots in the city is being prepared, the official said. As part of the initiative, a total of 62 bus depots will be electrified.

With 3.3 million people using buses for commuting every day, it is the most popular form of public transit in Delhi.

Courtesy: The Times of India

NTPC BEGINS INDIA'S FIRST GREEN HYDROGEN BLENDING OPERATION IN PNG NETWORK

NTPC Kawas Green H_2 Blending project having electrolyser, H_2 storage and blending skid…

India's largest power generator, NTPC Ltd has commissioned India's first green hydrogen blending project. Green hydrogen blending has been started in the Piped Natural Gas (PNG) network of NTPC Kawas township, Surat. The project is a joint effort of NTPC and Gujarat Gas Limited (GGL).

The first molecule of green hydrogen from the project was set in motion by P. Ram Prasad, Head of Project, Kawas in presence of other senior executives of NTPC Kawas and GGL. After the start of the blending operation, NTPC Kawas held awareness workshops for township residents with help of GGL officials.

NTPC and GGL have worked relentlessly towards achieving this milestone in record time after its foundation stone laid by the Prime Minister of India on 30th July 2022. This set-up is geared up to supply H_2-NG (natural gas) to households of Kawas township at Adityanagar, Surat. Green hydrogen in Kawas is made by electrolysis of water using power from an already installed 1 MW floating solar project.

Petroleum and Natural Gas Regulatory Board (PNGRB), the regulatory body has given approval for 5% vol./vol. blending of green hydrogen with PNG to start with and the blending level would be scaled phase wise to reach 20%. Green hydrogen when blended with natural gas reduces CO_2 emissions keeping net heating content same.

This feat is achieved only by a few select countries like the UK, Germany, and Australia etc. This would bring India at the centre stage of the global hydrogen economy.

Courtesy: Electrical India

When used as an Energy source, Hydrogen produces no emissions besides Water. Zero polluting emissions, an amazing advance over the current sources of Energy ... – BRAINY QUOTES

HARMONICS IN POWER SYSTEM & MITIGATION - 1

Harmonics in Power System & Mitigation

Power Quality is one of the major concerns & emerging issues in the present era. With increasing quantities of non-linear loads due to power electronics being added to electrical system it has become necessary to investigate the Power Quality issues.

One of the major Power Quality issue is **HARMONICS**

Harmonics are the alternating components having frequencies other than fundamental present in voltage & current signals. It is a distorted wave form which frequency is higher than the fundamental frequency. It is an integral multiplication of fundamental frequency.

Origin of Harmonics

Origin of harmonics is non-linear loads. When current wave form is not proportional to the voltage wave form the load is classified as non-linear load. Wherever AC to DC conversion is involved in the equipment's it is non-linear load.

The non-linear loads are current source. Hence the harmonics generated is only current harmonics. When the harmonic current travels through the system impedance Voltage Harmonic occurs.

Type of non-linear loads

1. Electronic lighting ballast/controls
2. Variable Frequency Drives
3. Battery charger
4. Arc Furnace
5. Welding equipment's
6. UPS
7. Solid state industrial rectifiers
8. Saturated inductors & Transformers

Indication of Harmonics Problem

1. Severe lamp flicker
2. Excessive equipment heating
3. Electrical interference
4. Transformer neutral over loading
5. Frequent tripping of Circuit Breakers & Fuse Blowing
6. Capacitor Failure
7. Power factor problem

Harmonic Order

The order of Harmonics is based on the rectifier pulse number & number of rectifiers in the circuit. Normally the pulse numbers will be 6,12,18 & 24. The harmonic frequency number is derived as follows

Hn = K x Pn plus or minus 1

Wherein Hn = Harmonic order number

K = the integral number

Pn = Rectifier pulse number

Type of Harmonics

Even Harmonics

The numbers which is divisible by 2 are Even Harmonics

Example: 2,4,6,8,10,12 ……..

Normally EvenHarmonics will not present in the system since positive half cycle & negative half cycle will cancel each other. If there is a firing angle difference in the 3ph full wave bridge rectifier in the circuit Even Harmonics will exist which creates the unbalance current in the circuit.

Odd Harmonics

The numbers which is not divisible by 2 is Odd Harmonics. Odd Harmonics will present in the system since positive half cycle & negative half cycle will not cancel each other.

Categories of Current & Voltage Harmonics

There are three categories of Voltage & Current harmonic which are

1. Positive Sequence Harmonics 1 + 3k
2. Negative Sequence Harmonics 2 + 3k
3. Zero Sequence Harmonics 3 + 3k

   Wherein k is the integral number 0 to 30

Effect of Sequence of Harmonics

1. **Positive Sequence** (Same phase sequence as fundamental R-Y-B)
   a) Causes additional heat Transformers, Conductors, Circuit Breakers and Panels in the power system
   b) Produces a forwarding rotating field in the motors that adds up to the torque
2. **Negative Sequence**(Opposite phase sequence of fundamental R-B-Y)
   a) Same effect of positive sequence in the power system
   b) Produces reverse rotating field in the motors & hence the torque of motor is reduced. To maintain the rated torque the motor will draw more current than actuals that results in excessive heat
3. **Zero Sequence** (Do not produce rotating field in either direction)
   a) Causes components & system heating
   b) Do not cancel but add together in the neutral conductor of 3ph 4 wire system
   c) In case of Delta winding zero sequence component will rotate in the phase winding

Interpretation of Ohm's Law in Harmonic Spectrum

As per Ohms Low Voltage = Current x Resistance

The same is applicable in the case of harmonic spectrum as harmonic current travels through the system impedance it will create a Voltage Distortion.

The level of voltage distortion is the function of harmonic current of various frequencies & system impedance within the circuit.

The voltage at Point of supply will be less since the impedance at that point is only source impedance.

The voltage THD at load point will be high comparing to point of supply since the system impedance at load point is the cumulative total of all impedances between the load & the source including source impedance

Relation Between Source Impedance & Harmonics

There are two type of sources namely Stiff Source & Weak Source

Stiff Source

When the available short circuit current is high the source is called **Stiff Source**. In this the system impedance will be low. The voltage will not be affected and will unchanged due to variation of load.

Hence if a non-linear load is connected to a stiff source, though the Total Demand Distortion (ratio of RMS value of all harmonic currents to Demand current) is high the Voltage THD will be less.

Weak Source

When the available short circuit current is low the source is called **Weak Source**. Voltage at connecting point will vary based on load.

Hence if a non linear load is connected to a weak source though the Total Demand Distortion is low Voltage THD will be high.

(To be continued)

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6.8 PROBLEM LOADS

6.8.1 Arc Furnaces

Electric arc furnaces are considered as being one of the worst source of fluctuations on a power supply system. The load cycles of arc furnaces vary widely, depending on size and metallurgical requirements. The first part of the cycle consists of melt-down period when the solid charge is melted and the main energy input needed. The later part of the cycle is known as the refining period; in this, energy supplied has only to make good the heat losses. A considerable movement of the charge occurs during the melt-down period with consequent variations in the arc lengths on each phase. The two main causes of fluctuation are believed to be first, the movement of the arcs as flexible conductors in a magnetic field and in some cases their extinction and restricting; secondly, the short circuiting of the graphite electrodes by scrap movement.

When the fluctuating currents pass through the power supply network impedance, a corresponding fluctuation is set up in the supply voltage at the point of common coupling with other consumers (p.c.c.). Visible light flicker is due to power system voltage fluctuation. The fluctuations in the three phases are, moreover, unbalanced. During melting period, the arc furnaces also create harmonics. Arc furnaces are designed to operate at low power factor say 0.7 and 0.8. When the electrode is usually driven into the scrap metal, it produces a dead short circuit on one phase. During arc furnace short-circuit, arc furnace demands larger reactive power from the electricity supply, in turn a larger voltage dip is produced on the system.

To reduce harmonic injection into the system, to improve the power factor of the arc furnace during melting, to support the power supply system for VAr compensation during arc furnace short-circuit, and to balance the three-phases, a reactive VAr compensator is needed. The static VAr compensator should be capable of supporting the system for the dynamic reactive VAr swing requirement due to arc furnaces swing from open circuit to short circuit.

6.8.2 Electric Welding

There are a wide variety of applications for electric welding. The method used can broadly be divided into a) arc welding and b) resistance welding. The control of the welding in both cases can be automatic or manual. Welding is mostly controlled by thyristor control. Most welders operate at low power factor around 0.3 – 0.4 lagging. The welding load employs bursts of power and so creates voltage disturbances and produces harmonic currents, but is generally of smaller magnitude than the other types of fluctuating load considered here.

6.8.3 Mine Winders

Mine winders (e.g. in the coal industry) are driven by thyristor-fed D.C. drive motors. The duty imposed on the a.c. power supply system is severe due to the varying power demand of the D.C. drives. Every time a winder accelerates it demands a very high amount of reactive power from the system. Because of the thyristor-fed drive, it also generates harmonic currents which need filtering.

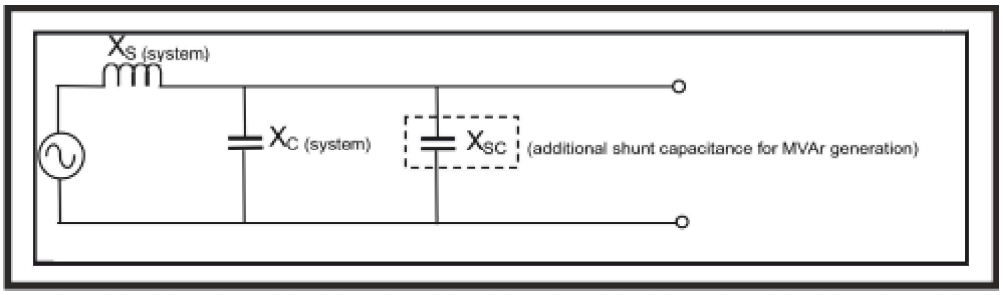
6.8.4 Rolling Mills

Rolling mills are driven by D.C. motors fed from thyristor converters. Every time the rolls reverse a large change in reactive power demand occurs in a few cycles. This change in reactive power demand occurs in a short period during acceleration. When compared to an arc furnace, however, overall duty on the power supply system is less severe (as in the case of mine winders) both because the rate of change is slower and the load in the three phases is balanced.

6.8.5 Shunt Capacitor Bank

Shunt capacitor banks are mainly installed to provide capacitive reactive compensation/ power factor correction. Because they are relatively inexpensive, the use of capacitor banks has increased. Shunt capacitor banks are composed of capacitor units mounted on the racks. They can be easily and quickly installed virtually anywhere

in the network. Its installation has 68 beneficial effects on the system such as improvement of the voltage at the load, better voltage regulation and reduction of losses.



Mechanically switched capacitor bank (shunt connected) may be installed on transformer tertiaries or connected directly to 132kV, 275kV, 400kV, 500kV or higher grid system. In the case of back-to-back switching of Mechanically Switched Capacitor banks, these shunt capacitor banks are to be connected to grid system via damping reactors (in series with capacitor banks).

Shunt capacitor banks can be arranged in different forms i.e.

a) Phase to Neutral - Double Wye,
b) Phase to Neutral - Single Wye,
c) Ungrounded Wye-connected Banks,
d) Delta-connected Banks and
e) H connected-configuration Banks.

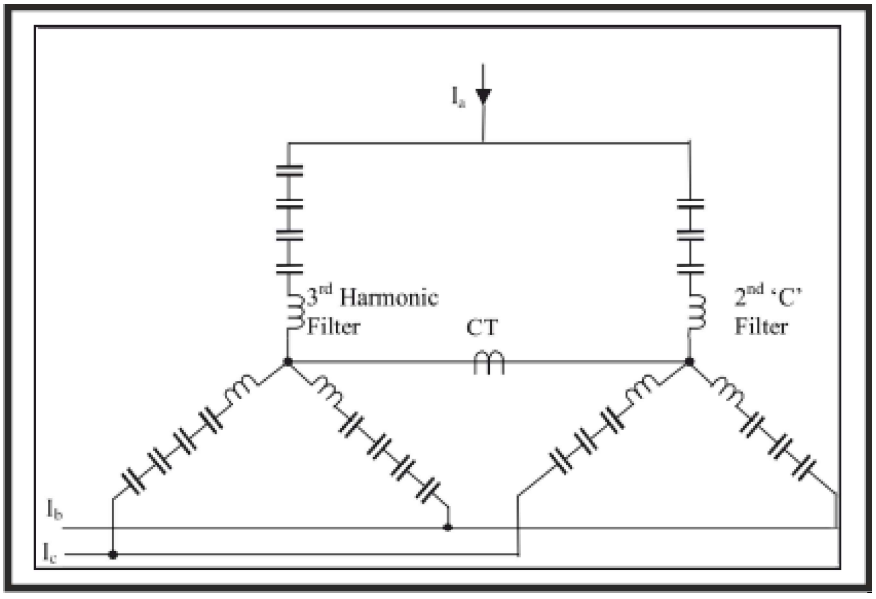
a) Phase to Neutral – Double Wye

Capacitor units with external fuses can be arranged to make up the bank.

When a capacitor bank becomes too large for the maximum 4.5MVAr per group, the bank may be split into two Wye sections, to prevent the parallel energy of a series group becoming too great (above 4500kVAr) for the capacitor units or fuses.

Capacitor Unbalance Calculations

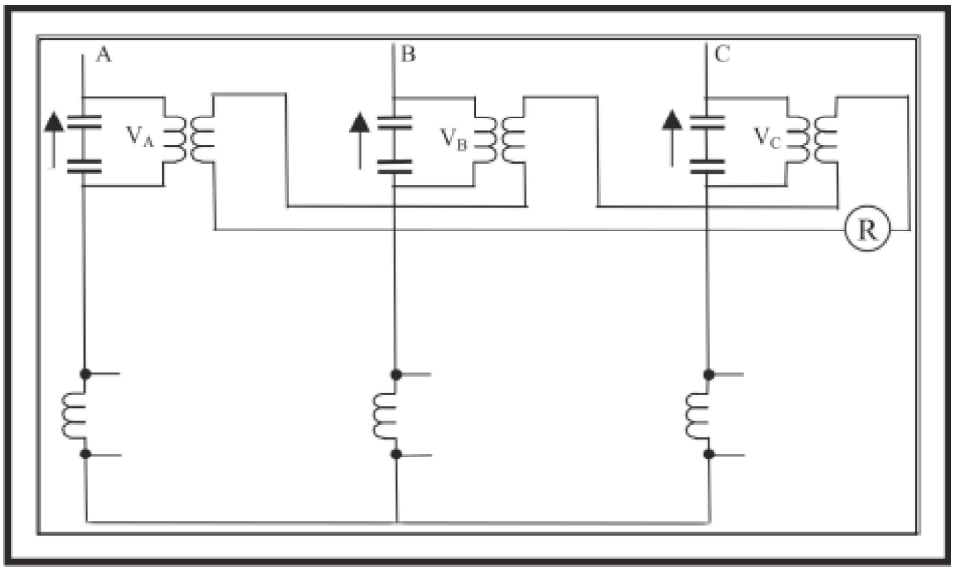
For split-star banks, the unbalance current in the CT interconnecting the star-points is to a first approximation



Where V_{II} is system line to line voltage and ΔY is the change in admittance of the faulty half phase.

b) Phase to Neutral – Single Wye

Capacitor units with external fuses, internal fuses or fuseless can be arranged to make up the bank.



$\overline{V_a}, \overline{V_b}, \overline{V_c}$, are the capacitor phase voltages and I_a is the current in the faulty phase; if there is an impedance unbalance of ΔX in one of the phases,

The unbalance voltage is

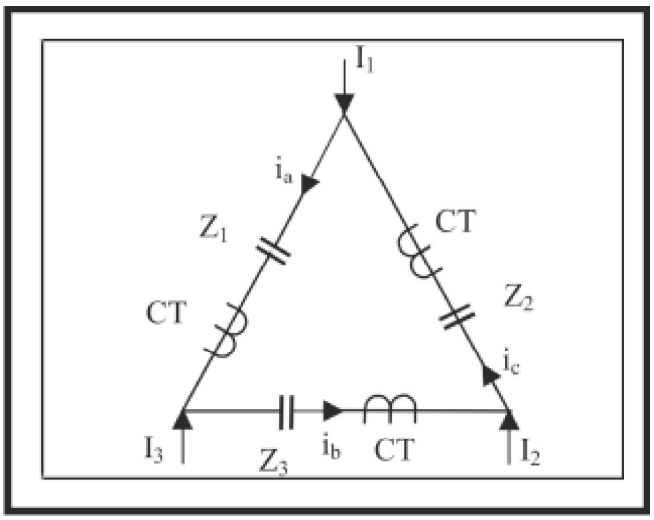
$$\therefore \overline{V_a} + \overline{V_b} + \overline{V_c} = \Delta X \overline{V_a}$$

c) Ungrounded Wye-Connected Banks

Capacitor units with internal fuses can be arranged to make up the bank. Ungrounded Wye banks do not permit zero sequence currents, third harmonic currents, or large capacitor discharge currents during system ground faults to flow.

d) Delta-Connected Banks

70 Capacitor units with internal fuses can be arranged to make up the bank. These banks are generally used at distribution voltages and slope correction for saturated reactor compensators. Capacitors are configured with a single series group of capacitors rated to line to line voltage. As there is only one series group of capacitor units, no voltage stress occurs across the remaining capacitor units from the isolation of a faulted capacitor unit.



Let the nominal impedance of each mesh phase be Z and the unbalance in one phase be ΔZ.

Unbalance current $= \bar{I}_a + \bar{I}_b + \bar{I}_c$

$$= \frac{\bar{V}_a}{Z} + \frac{\bar{V}_b}{Z} + \frac{\bar{V}_c}{Z+\Delta Z}$$

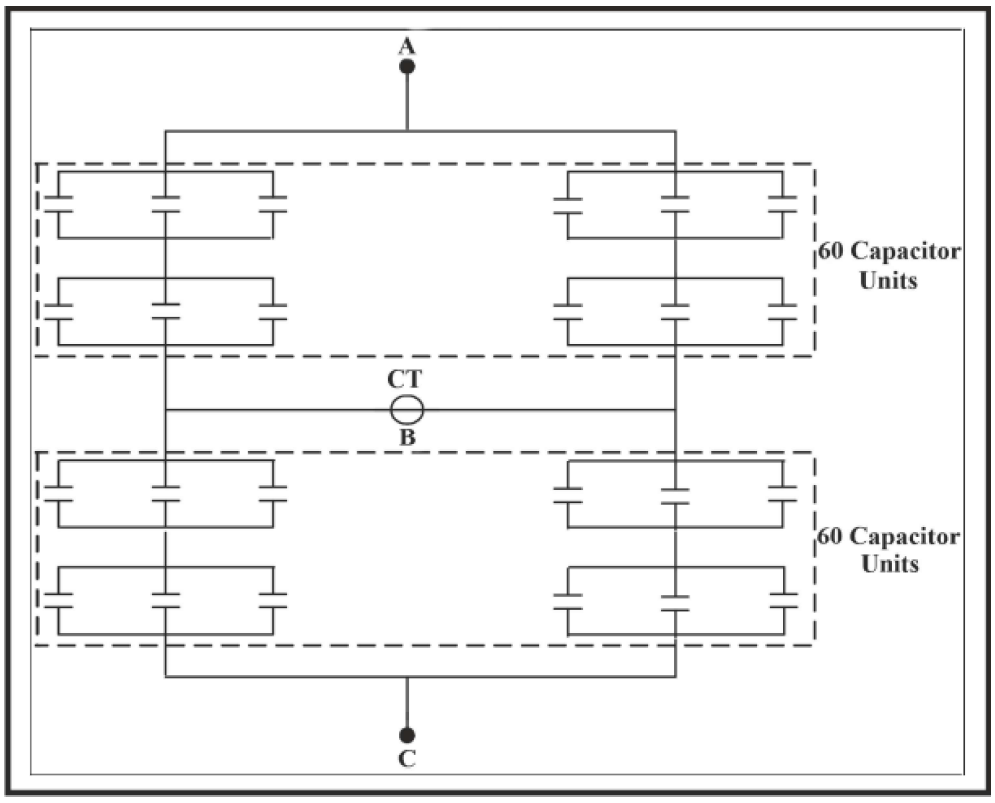
$$= \frac{(\bar{V}_a + \bar{V}_b)(Z + \Delta Z) + \bar{V}_c Z}{Z(Z + \Delta Z)}$$

$$= \frac{\bar{V}_a + \bar{V}_b + \bar{V}_c}{Z} - \frac{V_c \Delta Z}{Z(Z + \Delta Z)}$$

$$= I_c \frac{\Delta Z}{Z}$$

$$since \left(I_c = \frac{V_c}{Z + \Delta Z} \; and \; \bar{V}_a + \bar{V}_b + \bar{V}_c = 0 \right)$$

e) H–Configuration Banks Capacitor units with internal fuses or fuse-less can be arranged to make up the 'H' bank. An 'H' configuration capacitor bank will have in each phase with a current transformer connected between the two legs to compare the current down in each leg. As long as all capacitors are normal, no current will flow through the current transformer. If a capacitor element or elements of a capacitor units fails (i.e. open circuited) some current will flow through the current transformer. This 'H' arrangement is used on large banks with many capacitor units in parallel.



Single Phase 'H' Type Capacitor Bank

(To be Continued)

Courtesy: V. Ayadurai, Bsc, C. Eng, FIEE
Engineering Expert

WASTEFUL ACTIONS - MITIGATION MANAGEMENT

All industries generate waste. The general understanding once we say waste is the amount of scrap generated, packaging waste, food waste, etc. in day-to-day world it means "*of no use*" or "*discarded*". But there is more science to the term "*waste*".

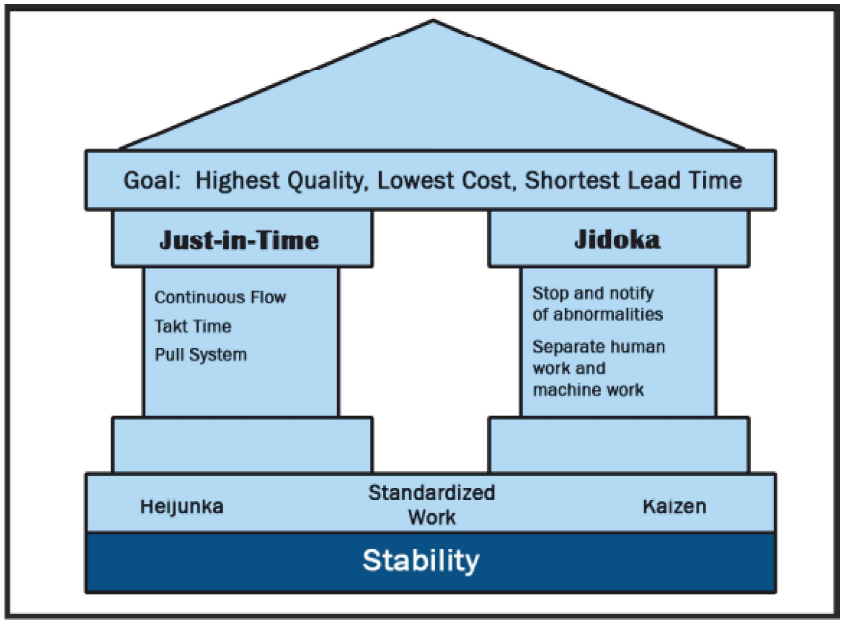
In Industrial parlance, **Waste is broadly defined as anything that adds to the cost of the product without adding value to it**.

In Industries, allocation of resources including human resources, defining processes and procedures play a very crucial role in their progress. Any wrong or inefficient handling of these will show adverse impact on the respective companies.

Toyota of Japan initiated some techniques later developed as Lean Principles. Their aim is simple – to give a perfect valued product to their customers. This will be achieved through processes and resources that have zero waste.

A brief peek into genesis of wasteful actions mitigation:

"*Jidoka*" and "*Just-in-Time*" are the two concepts the Toyota Production System (TPS) established. *"Jidoka"* means that when a problem occurs, the equipment and process stop immediately, preventing defective products from being produced. The problem should be solved immediately by the concerned team or else the whole production will suffer. This helps the problems to be highlighted to all and suitable Root Cause Analysis (RCA) would be found out and suitable action would be applied so that the problem will not recur.



Toyota production System "House"

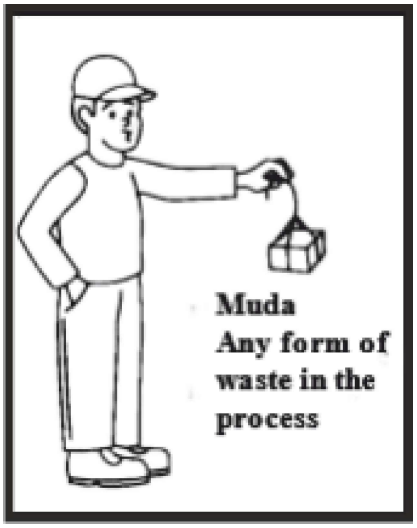
"Just-in-Time" is the concept in which each process produces only what is needed by the next process in a continuous flow without any wait time. This helps the industry "what is needed", "when it is needed" and "the amount needed". This will solve many inventory issues, maintenance issues, etc.

Now with the above concepts, some wasteful actions are identified. Wastes are broadly classified into Muda, Mura & Muri.

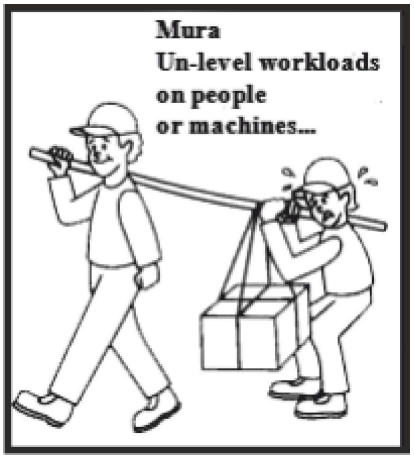
Muda: Any activity that consumes resources without creating value for the customer. These wastes are classified into 8 types:

1. **Over-production waste**: Just because there is capacity, it is not good to do over production which is not consumed/delivered.
2. **Waiting-time waste**: All the processes and workflow should be in such a way that there should be no waiting period for each process. This includes raw material availability and maintenance of machinery on time.
3. **Processing waste**: Repeated processing of same data through different data capture systems, additional processes carried out unnecessarily to be avoided.
4. **Transport waste**: Movement of people or resources unnecessarily adds up the process time, risk of losing or placing in wrong locations. This should be avoided.

5. **Defect**: Any process errors, paperwork errors, quality issues are considered as waste.
6. **Inventory waste**: The planning should be in such a way that right from raw materials to each process output to FG, there should be no stagnant product. Even the FG should be dispatched on time. Otherwise, it is not only waste of money and resources but also need additional space to store them.
7. **Motion waste**: The machinery and workflow should be designed in such a way that any excessive motion like tool fetching, or material fetching will increase the process time.
8. **Skills**: Identify the talent and skills of each individual and keep the right person in right place at the right time to do the right thing.

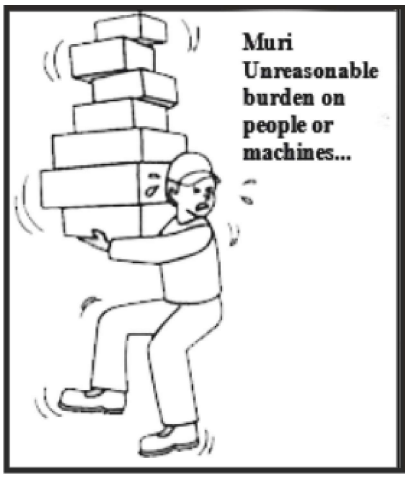


Mura: It means unevenness or irregularity in an operation.



Mura leads to Muda. Because of Mura we can see Muda. For example, to reach the Finished Goods stage, the raw materials will undergo different phases at different workstations. If one workstation or one process has more processing time, there will be lot of accumulation of over production at different stages, waiting time, etc. These wastes are nothing but Muda. Unevenness often can be eliminated by managers through level scheduling and careful attention to the pace and place of work. Using Kanban system will help in levelling the workflow. Here comes the "*Just-in-Time*" concept. It is like producing the right part in right amount at right time.

Muri: It means overburden.



Often overburdening equipment or operators by requiring them to run at a higher or harder pace for a longer period of time than the equipment is designed for is not good for the company. Also, the appropriate workload to be performed by the operators for a longer duration repeatedly will cause Muri. Untrained operators, improper or unclear work instructions, lack of correct tools or equipment, machinery without proper maintenance, no proper reporting hierarchy, operator health monitoring, etc; may lead to Muri.

Standardize work can help avoid Muri by designing the work processes to evenly distribute the workload and not overburdening any employee or equipment.

Conclusion:

In any industry it may not be possible to find an optimal solution involving the above wasteful action mitigation actions. Neither it is easy. Even in a well laid industry these may fail at certain times because of dynamic changes in customers' needs, technology upgradation for some processes, etc. Emphasizing on certain areas of Muda or Mura or Muri is not sufficient. One leads to other. Considering the impacts of the three M concepts we should plan and strategize the production line up and reap the benefits of mitigating the wasteful actions.

Courtesy: Suresh Dendukuri,
Managing Partner
3Si Eco Power LLP

ESTIMATING ELECTRICAL POWER REQUIREMENTS FOR FIRE FIGHTING PUMPSETS IN RESIDENTIAL BUILDINGS - PART 1

THE BRIEF

1. Electrical Engineers are now noticing that firefighting systems are being made mandatory in buildings and it is being indicated that firefighting pumpsets should be installed.
2. The electrical engineers immediately understand that connected and demand load should be properly considered for the firefighting pumpsets.

However, the Electrical Engineers faces several important situations:

a. They understand that the electrical load for the firefighting pumpsets could be quite substantial. However, proper data is not furnished to the electrical engineers,or one is not sure whether approximately the data furnished is right.

b. Depending on the height of the building, local Fire NOC and building use (car parking in stilt area, refuge area protection, etc.), projects may have hydrant system, sprinkler system, draft curtain system, etc.

c. Again, depending on the height of the building, pumpsets may be located only in the terrace, or in ground level and booster pumpset in terrace etc.

d. Specific rules of electrical power connection are indicated for the power supply to the firefighting pumpsets in Indian Standards and Electricity Rules which need to be adhered.

e. Proper data is not given to the electrical engineer, but he is expected to estimate the power requirement for the pumpsets properly and load the main and standby power supplies accordingly.

Given this onerous situation, in this and the next few parts of the journal we will cover the following please:

1. The minimum requirements as per the National Building Code
2. The general prescriptions as per No Objection Certificates as per the Local Statutory Authorities
3. The Rule-of-the-Thumb calculation for calculating the electrical load are being furnished.

Please note that the power requirement will depend entirely on a case-to-case basis, but the rule-of-the-thumb calculations and data will help to review the inputs and also ask the right questions and get the right answers.

Reference to the tabular column below:

1. This Tabular Column is extracted from National Building Code 2016 Table 7. Additional details are available in Table 7.
2. The tabular column is split into convenient portions for printing and viewing purposes.
3. The reference numbers (for example refer 4, 5 etc.) are kept unchanged so that the association to the full table 7 of NBC is retained.

Sr. No.	Type of building occupancy	Type of Installation				
		First Aid Hose reel	Wet Riser	Down comer	Yard hydrant	Automatic Sprinkler system
1	2	3	4	5	6	7
	RESIDENTIAL BUILDING (A)					
a)	Lodging and Rooming (A-1) (see Note 3)					
1)	Less than 15 M in height					
	i) Up to 15 rooms	NR	NR	NR	NR	R (see Note 4)
	ii) More than 15 and up to 30 height rooms.	R	NR	NR	NR	R (see Note 4)
	iii) More than 30 rooms	R	NR	NR	NR	R (see Note 4)
b)	One or Two Family Private Dwellings (A-2) (see Note 3)	NR	NR	NR	NR	NR
c)	Dormitories (A-3) and Apartment Houses (A-4)					
1)	Less than 15 M in height	R	NR	NR	NR	R (see Note 4)
2)	15 m and above but not exceeding 35m in height	R	NR	R	NR	R (see Note 4)
3)	above 35m but not exceeding 45m in height	R	R	NR	NR	R (see Note 4 & Note 9)
4)	above 45m in height but not exceeding 60m in height	R	R	NR	R	R
5)	above 60m in height	R	R	NR	R	R

Furthering Note:

The first part of the NBC requirement namely 'Type of Installation' is covered above.

The rest of the NBC requirement namely 'water supply requirement', 'Pump requirement' and 'Commentary' will be covered in the next Journal.

With fires in residential buildings increasing, Electrical engineers hold the key to understanding the safety systems and providing suitable electrical systems to protect Life and Property Safety.

We will do the best for the world with our commitment to safety.

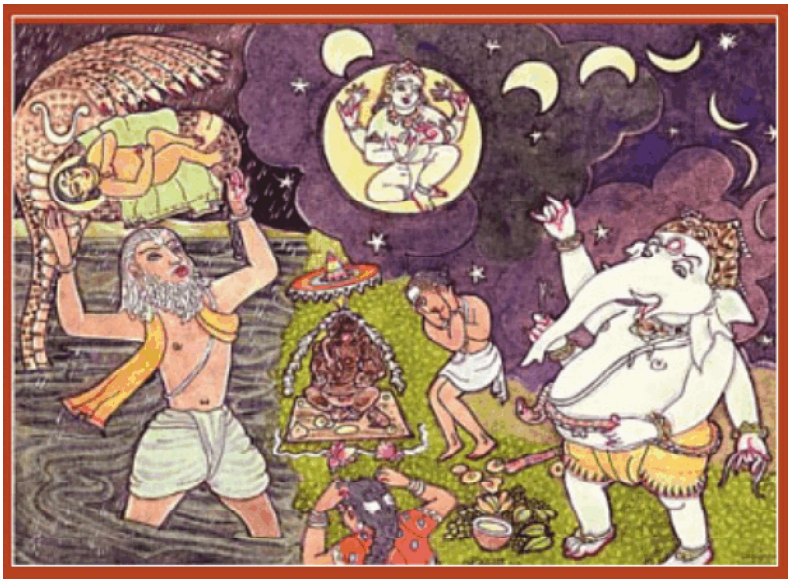
Mr. Muthukrishnan Kalyanasundaram, M.E.
Proprietor – M/s HKM ENGINEERS AND CONSULTANTS
Services - Fire and Life Safety Consultancy
Email id - mr.k.muthukrishnan@hkmconsultants.com
Contact Number - 9930265069
(Son of Mr. H.Kalyanasundaram – Ex. Best and Crompton Engineering Limited)

An electrical engineer makes his life miserable when he performs a function and the system becomes UnStable...!!!...

– PRIYANKA

HOME FESTIVALS - 8

ஆவணி - AVANI (August/September)



This is a busy month, with two major festivals celebrated both at home and at the temple. Krishna Jayanthi, the birth of Lord Krishna, comes first. In the painting at right is the rescue of the baby Krishna, who was born in a prison. His father carries him across a swollen stream while the seven-headed serpent, AdiSeshan, protects the incarnation of Lord Vishnu from the storm. In the Home, offerings of butter and yoghurt are made to Krishna's image, and footprints made with red powder reveal his path from the home's front door to the shrine room, suggesting that Krishna has come to participate. Ganesha Chathurthi is a mammoth festival across all of India, ten days in celebration of His manifestation. Shown in the centre of the painting is a statue of Lord Ganesha and a devotee offering obeisance by pulling his ears and bobbing up and down, a practice called *thopukarnam* in Tamil, done only for Ganesha – one explanation being that it is to make the Baby Ganesha laugh. The icon of Ganesha is made by the devotees from river clay and painted and decorated. At festival's end is the Visarjana or departure, when the clay icon is placed into the river the Deity is bid farewell. In North India Visarjana is celebrated by millions of people. At far right in the art is depicted the story of Ganesha consuming so many sweet offerings that He had to tie a snake around his belly to keep it from bursting. Ganesha chastised the Moon for laughing at His predicament, and as penance the Moon has ever since waxed and waned through the month instead of remaining constantly bright.

HOME FESTIVALS - 9

புரட்டாசி - Purattasi (September/October)

Navaratri ("nine nights") is the principal festival this month. The Goddess is worshipped in Her many forms, and on the ninth day, Sarasvati (centre of the painting) is invoked to bless musical instruments, account books, agricultural instruments and home tools (upper left). On Vijaya Dasami, the day following Navaratri, Goddess Durga is invoked as children are given their first instruction, worship their school books and honour their teacher. A decorated display of dolls is displayed through the nine days, then dismantled and stored on the tenth day. **Vijaya Dasami is also the birthday of Lord Venkateshwara**, presiding Deity of Tirupati temple in Andhra Pradesh, India's wealthiest temple.

(To be continued)

EC meeting on 29.7.2023 at Esakki Highview Resorts, Courtallam

TECHNICAL SEMINAR

on 5th August 2023 at Hotel Harrisons, Chennai

Dignitaries

Inauguration - Lighting of Traditional Lamp

TNEIEA honouring **Mr. A. Srinivasan,** B.E., MIE, CE(I), FIV, PE(I)
Clean Energy Solutions, Harmonics Auditors & Mitigation Providers
(Technical Speech)

TNEIEA honouring
M/s. Perfect House Pvt. Ltd., Chennai.

TNEIEA honouring
M/s. Apar Industries Ltd, Chennai.

TNEIEA honouring
M/s. Great White Electricals, Chennai.

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M/s. Power Cable Corporation, Chennai.

Lucky Draw Winners

Mr. S. Shanawaz,
M/s Jupiter Electricals, Chennai

Mr. S. Gopalakrishnan
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Display the Product

EC meeting on 5.8.2023
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