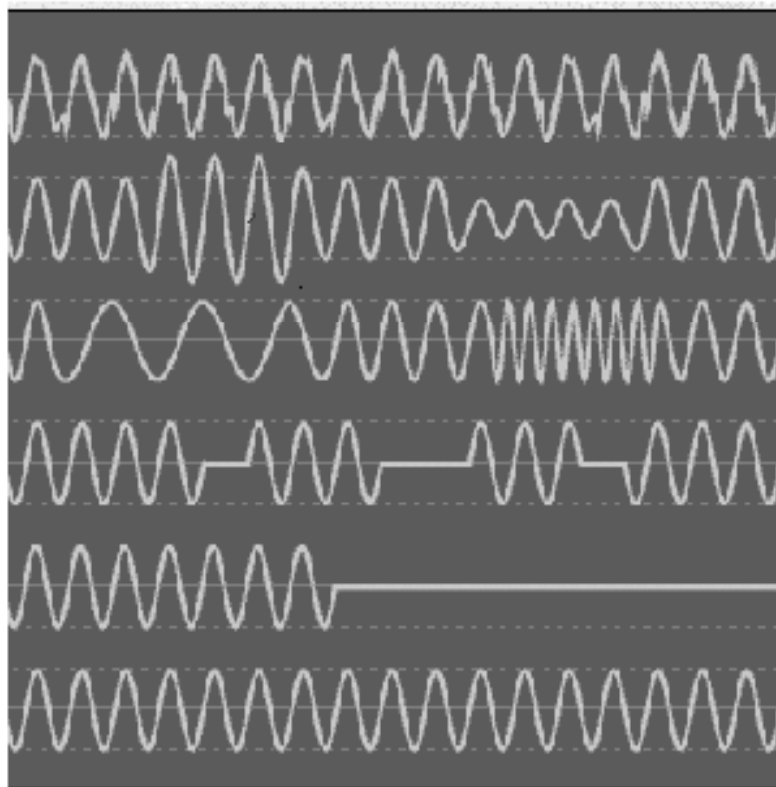


# **POWER QUALITY & SAFETY IN BUILDINGS**

**(HIGH RISE AND COMMERCIAL)**

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# WHAT IS POWER QUALITY ?



► **Transients - Harmonics**

► **Voltage fluctuations**

► **Frequency fluctuations**

► **Micro-cuts**  
(  $t < 10$  ms )

► **Power cuts**  
( short : 10 to 300 ms )  
( long :  $> 300$  ms )

► **Perfect power**

# WHY POWER QUALITY IS IMPORTANT IN HIGH RISE BUILDINGS ?

## TWO MAIN REASONS :

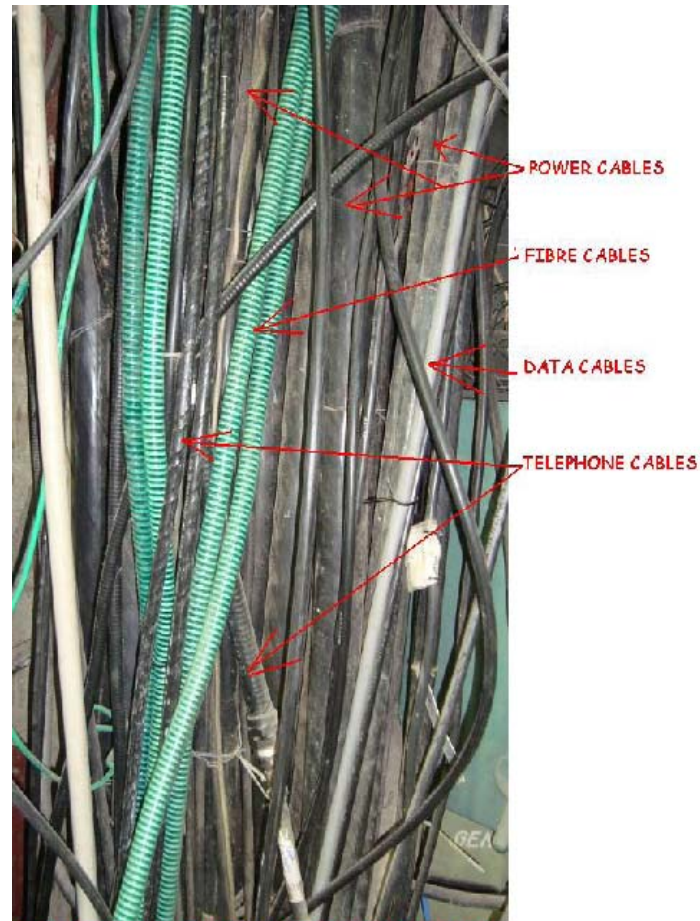
- HEIGHT → LONG LENGTH OF CABLES → HIGHER VOLTAGE DROP → HEATED CABLES
- HARMONICS → TYPES OF LOADS → NON LINEAR HARMONIC RICH “IT” LOADS IN SUCH BUILDINGS → LIKELY TO OVER HEAT THE TRANSFORMERS AND CABLES

**BOTH REASONS INCREASE CHANCES OF FIRE !!**

# **FIRE SAFETY IN SUSTAINABLE HIGH RISE BUILDINGS**

- **FIRE SAFETY - UTMOST IMPORTANCE IN ANY HIGH RISE BUILDING**
- **TO REDUCE FIRE RISK –**
- **HIGH QUALITY DESIGN OF ELECTRICAL SYSTEM**
- **HIGH QUALITY MAINTENANCE**

# EXAMPLE OF A WRONG DESIGN OF CABLE DUCT IN A HIGH RISE BUILDING IN MUMBAI



RISER CABLE DUCT WITH POWER AND DATA CABLES

## **SOLUTION ??**

- **RISING BUS-DUCT IS A MUST FOR ANY HIGH RISE BUILDING**
- **DOES AWAY WITH MOST OF THE HEAVY CABLES**
- **IT IS MANDATORY IN MANY STATES**
- **SANDWITCH TYPE PREFERABLE OVER TRADITIONAL AIR-INSULATED TYPE**
- **USE OF COPPER BUS-DUCTS AND COPPER BUS-BARS TO REDUCE THE POWER LOSSES**



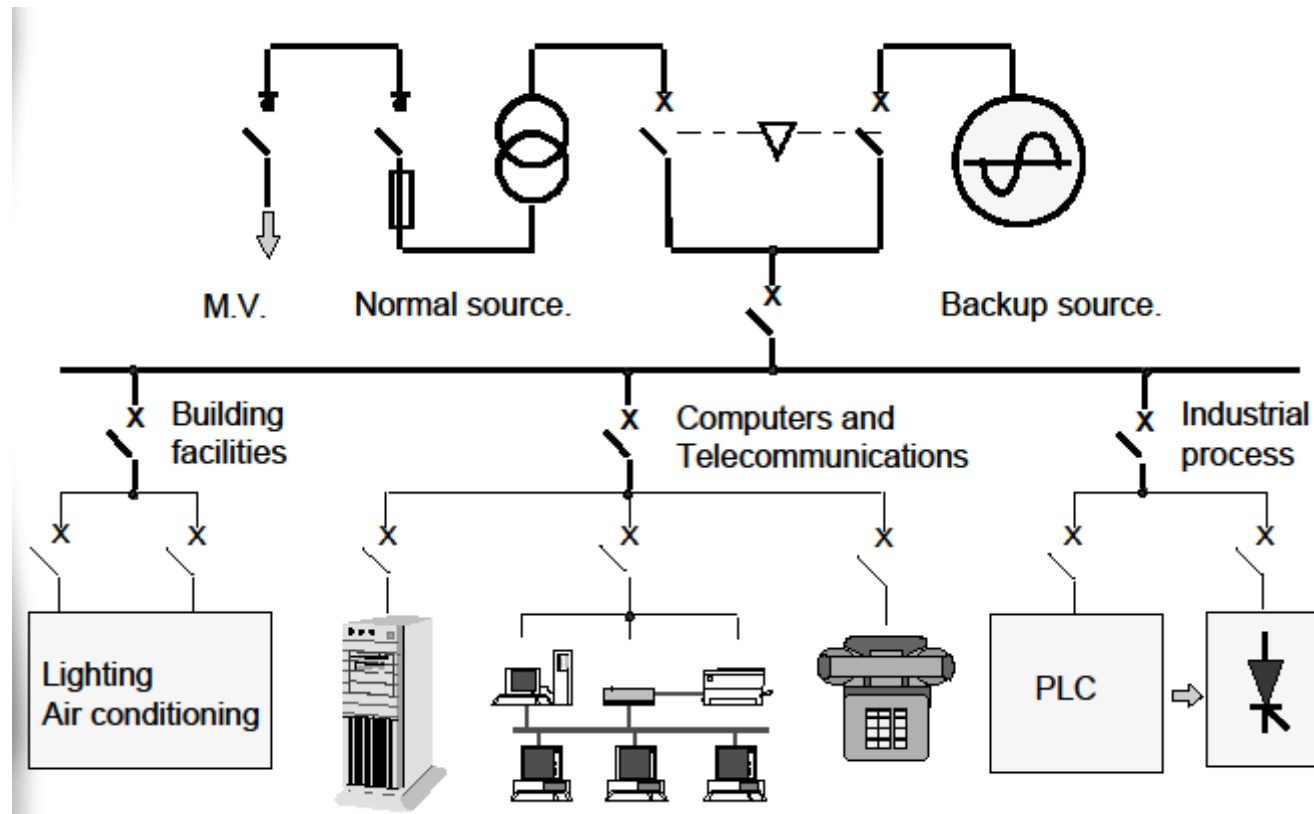
## **HOW TO OVERCOME POOR POWER QUALITY ?**

- **POWER CUTS – BY USING GENERATORS & UPS**
- **MICRO CUTS – NO ACTION NEEDED**
- **VOLTAGE FLUCTUATIONS – STABILIZERS, AVR**
- **FREQUENCY FLUCTUATIONS – BY USING UPS**
- **TRANSIENTS - BY USING SPD OR TVSS**
- **HARMONICS – DO NOT GENERATE !!**

**GOOD DESIGN PRACTICE**



# TYPICAL POWER DISTRIBUTION IN A MODERN HIGH RISE OR COMMERCIAL BUILDING



# TYPICAL LOADS IN MODERN BUILDINGS

- MICROPROCESSOR BASED ELEVATORS AND ESCALATORS
- HVAC LOADS SUCH AS AHUs, PUMPS AND COMPRESSORS FITTED WITH VARIABLE FREQUENCY DRIVES (VFD)
- LIGHT FITTINGS WITH ELECTRONIC BALLASTS
- BMS SYSTEMS SUCH AS FIRE ALARM, CCTV, ACCESS CONTROL
- IT EQUIPMENTS SUCH AS DESK-TOP PCs, SERVERS & SWITCHES
- UPS AND DC POWER SUPPLIES
- AV EQUIPMENTS SUCH AS PROJECTORS, LCD TV, AUDIO-VIDEO SYSTEMS

**ALL ABOVE LOADS ARE HARMONIC RICH**

## EFFECTS OF HARMONICS ?

- HIGHER IMPEDENCE – OVER HEATED CABLES
- SKIN EFFECT - OVER HEATED CABLES
- HIGHER NEUTRAL CURRENT DUE TO HALF SIZE NEUTRAL ?
- HIGHER N-E VOLTAGE
- MALFUNCTIONING OF SENSITIVE ELECTRONICS
- DERATING OF TRAFOS & GENSETS
- EARLY AGING OF EQUIPMENTS
- HIGHER POWER FACTOR- TARIFF PENALTY

# HOW TO AVOID HARMONICS ?

## DESIGN FEATURES :

- MINIMIZING AT SOURCE
- ISOLATING & ARRESTING
- FILTERING AND/OR ABSORBING
- OVERSIZING CABLES & EQUIPMENTS

# MINIMIZING HARMONICS AT SOURCE

## PROPER SPECIFICATION & SELECTION OF EQUIPMENTS

- UPS & VFD : THD < 5%, PF > 0.95
- SERVERS : THD < 3%, PF > 0.99  
(IEC 1000-3-2 COMPLIANT)
- DESK TOP PC : BRANDED
- ELECTRONIC BALLAST : THD < 10%
- TV, AV EQUPT. ETC : BRANDED

# ISOLATING & ARRESTING HARMONICS AT SOURCE

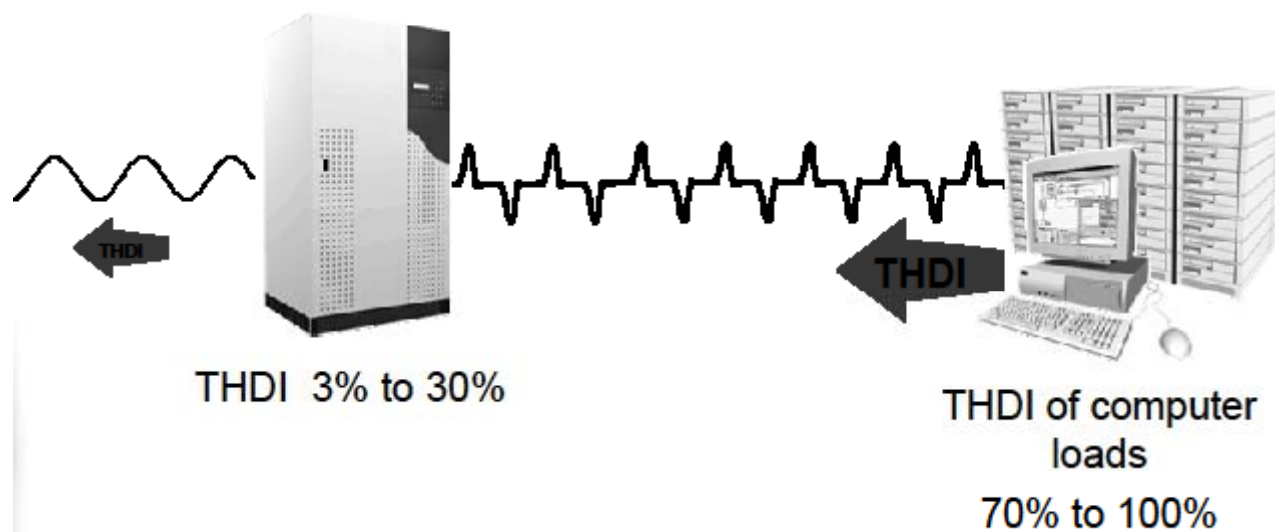
## USE OF SPECIAL EQUIPMENTS -

- UPS
- PDUs WITH DELTA-STAR ISOLATION TRANSFORMER (K-20 RATED)
- ZIGZAG / PHASE SHIFTING / HARMONIC CANCELING TRANSFORMER
- DUAL/QUAD OUTPUT TRANSFORMER
- PASSIVE AND ACTIVE HARMONIC FILTERS

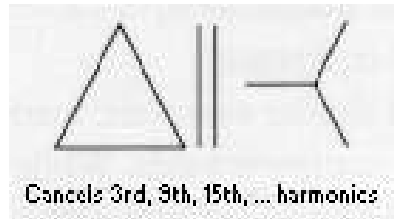
# USE OF UPS - ALSO ACTS AS FILTER ! ( IF SELECTED PROPERLY )

## ► Reduction of harmonic currents upstream of the installation

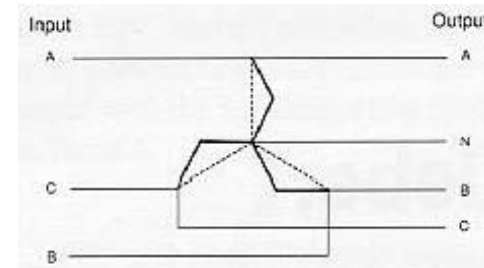
> A double-conversion UPS acts as a filter



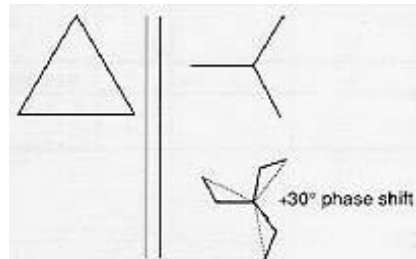
# USE OF SPECIAL PURPOSE TRANSFORMERS



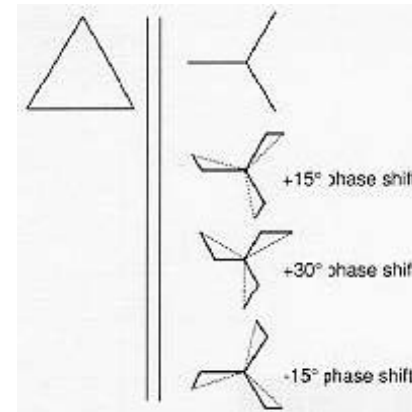
**ISOLATION (DELTA-STAR)**  
(ARRESTS ALL TRIPLIN )



**AUTO TRAF0 - ZIGZAG**  
(CANCELS ALL TRIPLIN)



**ISOLATION (DUAL OUTPUT)**  
(TRIPLIN + 5<sup>TH</sup>, 7<sup>TH</sup>, 17<sup>TH</sup>, 19<sup>TH</sup> )

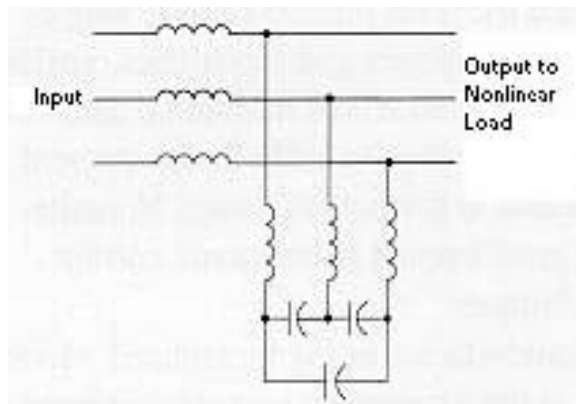


**ISOLATION (DUAL OUTPUT)**  
(TRIPLIN + 5<sup>TH</sup>, 7<sup>TH</sup>, 11<sup>TH</sup>, 13<sup>TH</sup>, 17<sup>TH</sup>, 19<sup>TH</sup>, 29<sup>TH</sup>, 31<sup>ST</sup>)

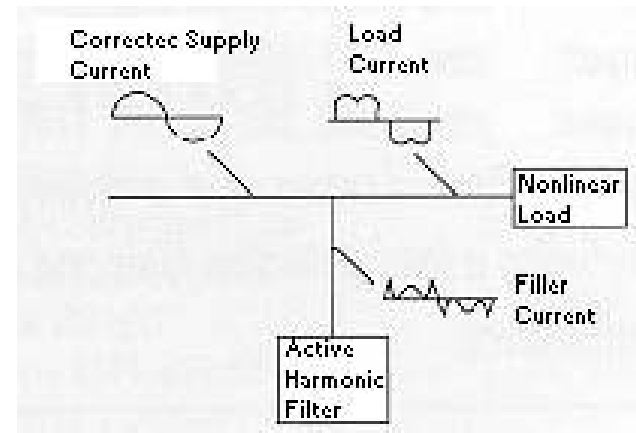


# FILTERING AND/OR ABSORBING HARMONICS

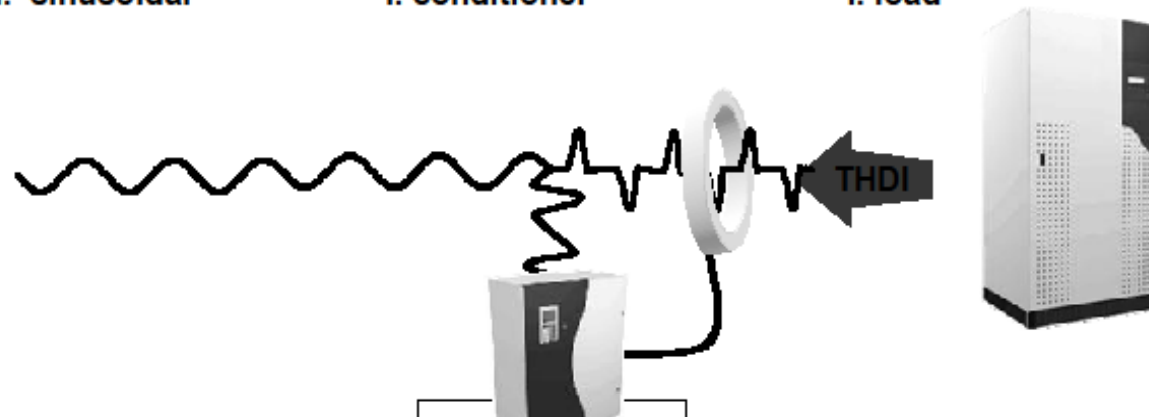
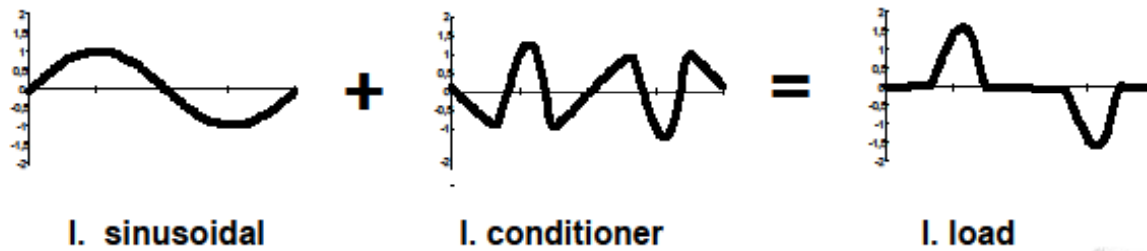
## PASSIVE FILTER



## ACTIVE FILTER



# USE OF ACTIVE FILTER



# OVERSIZING CABLES & EQUIPMENTS

- FULL SIZE OR DOUBLE NEUTRAL
- DERATING OF CABLES
- DERATING OF TRANSFORMERS
- DERATING OF GENERATORS
- USE OF COPPER CABLES AND BUS-DUCTS
  - TO OPTIMIZE THE COSTLY BUILDING SPACE
  - NO NEED OF BIMETALLIC CONTACTS AS MOST SWITCHGEAR COMES WITH COPPER TERMINALS
  - REDUCED CHANCES OF FIRE IN THE BUILDING DUE TO LESSER HEATING OF TERMINALS

# POWER FACTOR

- ALWAYS MAINTAIN NEAR UNITY POWER FACTOR
- LESSER SIZE OF CABLES NEEDED
- LESSER COST OF CABLES
- LESSER HEATING OF CABLES
- THE NEW ELECTRICITY TARIFF STRUCTURE ACROSS THE COUNTRY CONSIDERS KVAH AS A UNIT INPLACE OF KWH !
- MAINTAINING NEAR UNITY POWER FACTOR WILL RESULT IN DIRECT SAVING IN ELECTRICAL BILL EVERY MONTH.

# STANDARDS GOVERNING HARMONICS

- IEEE 519-2
- IEC 555-2, IEC 1000-3-2
- IS - 17036 (Voltage)
- IS - ?? (Current)

**THANKS**

**QUESTIONS .....**