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Certificate of Completion

This is to certify that

Aarupadai Veedu Institute of Technology (AVIT)
School of Arts and Science (SAS)
School of Architecture and Planning (SAP)

(Constituent College and Schools of Vinayaka Mission's Research Foundation)
AVIT Campus, Rajiv Gandhi Salai (OMR) Palyanoor, Kancheepuram (Dt), Tamilnadu

has Successfully Completed

Energy Audit

The study was completed by TULASI EOHS CONSULTANCY, CHENNAI

Dr.Vanisri Arunachalam **Er. C. Madhan Mohan**

For TULASI EOHS CONSULTANCY SERVICES

Date :19-11-2020

Place : Chennai

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VINAYAKA MISSION'S
RESEARCH FOUNDATION
(Deemed to be University under section 3 of the UGC Act 1956)

7.1.6_3. ENERGY AUDIT

B.AUDIT REPORTS

B. Jayaraman

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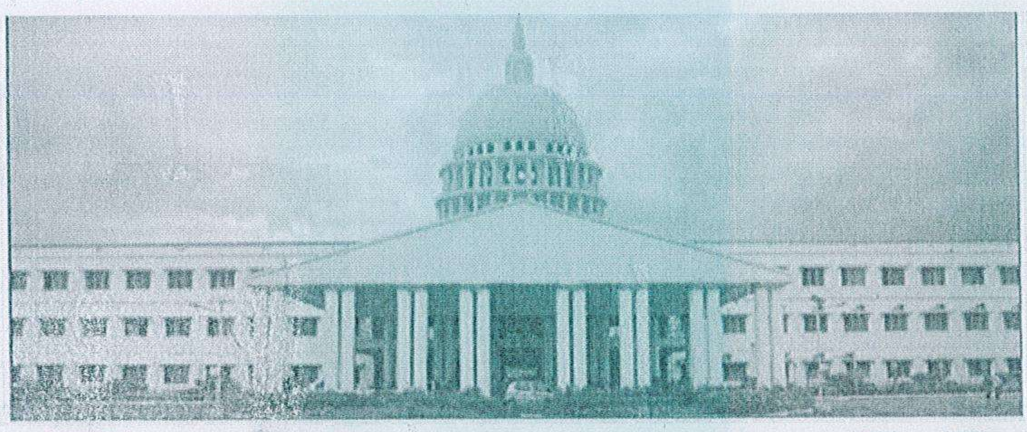
ENERGY AUDIT REPORT OF

Aarupadai Veedu Institute of Technology(AVIT), School of Arts and Science(SAP), School of Architecture and Planning(SAP) Kancheepuram

AVIT
AARUPADAI VEEDU INSTITUTE OF TECHNOLOGY



SAS
SCHOOL OF ARTS AND SCIENCE

SAP
SCHOOL OF ARCHITECTURE & PLANNING

Council of Architecture

Submitted By

TULASI EOHS CONSULTANCY SERVICES

Regd off: NO.18, SAKTHI NAGAR, LAKSHMI PURAM, WEST TAMBARAM, CHENNAI-600045
Mob: 9884624964, Email: chellamadhan@gmail.com, tulasieohsconsultancy@gmail.com

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This is to certify that the following utilities were carried out Energy audit in the month of October 2020.

Details of Facilities Audited: Main college building including: Laboratories, Libraries, Hospitals, All departments and Hostel and college Canteen.

Dr. Vanisri Arunachalam

Er. C. Madhan Mohan

Authorized Signatory

For TULASI EOHS CONSULTANCY SERVICES

Date : 30-10-2020

Place : Chennai

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TABLE OF CONTENTS

Separately Enclosed- CD with soft copies of

1. **Data recorded during specific load combinations**

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2. INTRODUCTION

An energy audit is an inspection, survey, and analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the output(s). In commercial and industrial real estate, an energy audit is the first step in identifying opportunities to reduce energy expense and carbon footprints.

The scope of an energy audit can comprise a detailed review of the energy performance of an organization, Significant Energy User(s), systems, energy-using processes and/or equipment. It is typically based on appropriate measurement and observation of actual energy performance for the defined energy audit scope.

Energy audit outputs typically include information on current energy consumption and energy performance, and they can be accompanied by a series of specific recommendations ranked by energy performance improvement or financial return on investment, based on analysis of specific site data and operating conditions.

In the present study, the Campus Comprising of College of Technology, School of Arts & Science, and School of Architecture Planning, an electricity audit has been done. In this study Admin buildings, laboratories, Classrooms and Service areas viz. laundry, kitchen, CSSD, Backup power supply, AC plant, Fans, air conditioners, Computers facilities, IT infrastructures, Digital Libraries, Hostel facilities etc.. were considered. We have studied total budget of the Institution, total economic investment of Institution on the electricity and total electricity generation from the solar unit. Also, we have studied total saving of "electricity" and the exact contribution of bulb, fans, computer, instruments etc., in the total requirement of electricity. We studied all the above said parts of energy audit by collecting exact details of the inputs through a survey.

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3. SUMMARY STATEMENT

The Director, Aarupadai Veedu Institute of Technology (AVIT) is located on Rajiv Gandhi Salai (Old Mahabalipuram Road) in a sprawling 24.11-acre land with a built-up area of 5.65 Lakhs Sq.ft requested to carry out Energy Audit at their campus. Energy and Power Quality Audit team had undertaken harmonic and other electrical parameter measurements on 13th October 2020 at their institute of **500 kVA capacity**.

The summary of the information are as follows:

The measurements were undertaken using Hioki, CLAMP ON POWER LOGGER Model: PW3360-21. The following parameters were recorded by the above instrument with 5 **minutes recording sample time over the 3 hours,**

(i) The following parameters were recorded

(a) 3 Phase voltage
(b) 3 Phase current
(c) Frequency
(d) % Voltage Unbalance
(e) % Current Unbalance
(f) Active Power in kW and reactive power in kVAR
(g) Power Factor
(h) % Voltage THD
(i) % Current THD

The parameters (a) to (i) are recorded for every 5 minutes period by the meter and they are averaged.

*The definition of THD are provided at the end of this section

(ii) The trend recordings for various parameters (voltages, currents, powers and power factors) are also taken for the different periods of recording times.

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(iii) This is followed by the report of the recordings for the various combinations of equipment in operation to cover possible operational modes with the time stamp. For these periods, the recorded parameters are provided the corresponding THD figures and the calculated TDD values with 4500 kVA as the base are also provided.

(iv) The scrutiny of the data presented for the THD. The voltage THD figures are also well within the stipulated 1.6 % whereas the current THD is in the range between 3.07 % to 20.1% which is high as per the CEA.

(v) These values are not well within the IEEE 519-1992 stipulations which are internationally accepted values.

(vi) The extracts from IEEE regulations and CEA regulations are provided as annexure to this report.

(vii) **Definitions of THD and TDD :**

THD = Total Harmonic Distortion

The ratio of the root-mean-square of the harmonic **(voltage or current)** content to the root-mean-square of the fundamental quantity, expressed as a percent of fundamental. THD typically refers to instantaneous measurement of harmonic distortion at an individual piece of equipment or group of loads, based on the actual fundamental current that is flowing during the measurement. THD is the typical measurement made with a harmonic analyzing equipment which takes in 3 phase voltages and currents from which the same is extracted as per the following ratio.

$$THD = \sqrt{\frac{\text{sum of squares of amplitudes of all harmonics}}{\text{square of amplitude of fundamental}}} \quad 100\%$$

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TDD = Total Demand Distortion

The total root-sum-square harmonic current distortion, in percent of the maximum demand load current (15- or 30-minute demand).

$$TDD = \sqrt{\frac{\text{sum of squares of amplitudes of all harmonics}}{\text{square of maximum demand load current}}} \quad 100\%$$

When the point of common coupling (PCC) is considered at the service entrance or utility metering point, IEEE-519 recommends that the maximum demand load current (IL) be calculated as the average current of the maximum demand for the preceding 12 months. To calculate TDD for new construction, prior to installation of equipment, one may use good engineering judgments to estimate the expected maximum demand load current. A conservative approach is to use the summation of the FLA ratings of all motors.

4. MEASURING EQUIPMENT SPECIFICATION

Hioki PW3360-21 Power Demand Analyzer

Measurement line & number of circuits	50/60 Hz, Single phase 2 wires (1/2/3 circuits), Single phase 3 wires (1 circuit), Three phases 3 wires (1 circuit), Three phases 4 wires (1 circuit), Current only: 1 to 3 channels
Measurement items	Voltage RMS, current RMS, voltage fundamental wave value, current fundamental wave value, voltage fundamental wave phase angle, current fundamental wave phase angle, frequency (U1), voltage waveform peak (absolute value), current waveform peak (absolute value), active power, reactive power (with lag/lead display), apparent power, power factor (with lag/lead display) or displacement power factor (with lag/lead display), active energy (consumption, regeneration), reactive energy (lag, lead), energy cost display, active power demand quantity (consumption, regeneration), reactive power demand quantity (lag, lead), active power demand value (consumption, regeneration), reactive power demand value (lag, lead), power factor demand, pulse input. Harmonic voltage level, harmonic current

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	level, harmonic power level, content percentage, phase angle, total harmonic distortion (THD-F or THD-R), up to 40th order
Voltage ranges	600 V AC (Effective measurement range: 90.00 V to 780.00 V)
Current ranges	500.00 mA to 5.0000 kA AC (depends on current sensor in use), 50.000 mA to 5.0000 A AC (Leak clamp on sensor only)
Power ranges	300.00 W to 9.0000 MW (depends on voltage/current combination and measured line type)
Basic accuracy	Voltage: ±0.3% rdg. ±0.1% f. s Current: ±0.3% rdg. ±0.1% f.s. + clamp sensor accuracy Active power: ±0.3% rdg. ±0.1% f.s. + clamp sensor accuracy (at power factor = 1)
Display update rate	0.5 sec (except when accessing SD card or internal memory, or during LAN/USB communication)
Save destination	SD memory card, or internal memory at real time
Data save interval	1 sec to 30 sec, 1 minute to 60 minutes, 14 selections
Save items	Measurement value save: Average only / Average, Max./Min. value, [PW3360-21 only]: Harmonic data save: Average only / average, max./min. value in binary format, Screen copy: BMP form (saved every 5 min. at minimum interval time), Waveform save: Binary waveform data
Interfaces	SD/SDHC memory card LAN 100BASE-TX: HTTP server function USB 2.0: When connected to a PC, the SD Card and internal memory are recognized as removable storage devices, remote settings via communication program, data download Pulse output: proportional to active power consumption when measuring integral power consumption, Isolated open-collector signal
Functions	Connection check, Quick Set navigation guide, clock, pulse input

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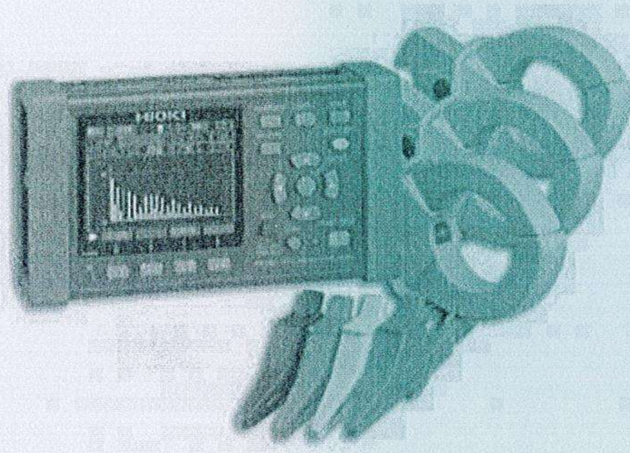
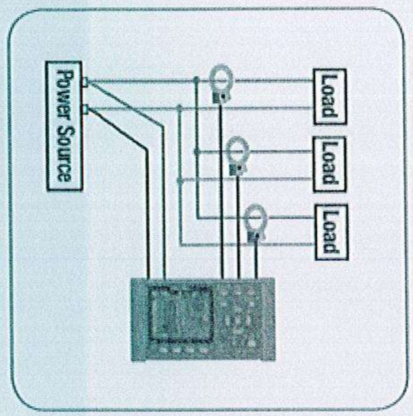
• **Equipment Connection Method**





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5. TOTAL AVERAGE RECORDINGS

5.1 Total Recordings for Three Hours Averaged over 5 min

S.No	3Phase Voltage			3Phase Current			Frequency	% Voltage Unbalance	% Current Unbalance	Active Power in kW	Reactive power in kVAr	Power Factor	% Voltage THD	% Voltage THD	% Voltage THD	% Current THD	% Current THD	% Current THD
	L1	L2	L3	L1	L2	L3							V1	V2	V3	I1	I2	I3
1	233.47	233.48	234.93	89.17	51.26	60.66	49.92	0.4	41.3	46.18	1.56	0.98	1.55	1.46	1.22	17.83	14.86	11.71
2	233.67	233.90	235.46	91.56	50.09	50.77	49.94	0.5	47.4	44.21	-1.01	0.98	1.49	1.37	1.18	17.14	14.44	13.97
3	234.15	234.35	235.76	92.33	53.15	59.22	50.01	0.4	42.7	46.96	2.28	0.98	1.34	1.13	1.03	17.2	11.76	11.05
4	234.86	234.92	236.11	86.08	54.59	67.13	50.01	0.3	34.4	47.69	3.08	0.98	1.25	0.98	0.94	18.42	10.48	9.27
5	235.11	234.99	236.30	79.41	51.35	61.76	50.02	0.4	35.3	44.47	2.03	0.98	1.25	0.98	0.92	19.88	11.05	9.7
6	235.37	235.16	236.69	77.93	51.83	54.25	50.03	0.4	40.1	42.55	1.59	0.98	1.23	0.95	0.91	20.1	10.74	11.21
7	235.39	235.28	236.70	86.06	56.30	60.01	49.93	0.4	38.4	46.58	2.72	0.98	1.2	0.93	0.94	17.13	9.91	10.51
8	234.46	234.19	235.66	97.51	68.48	81.10	49.93	0.4	37.8	55.96	4.90	0.96	1.22	0.94	0.93	15.26	8.75	7.62
9	234.73	234.87	235.79	135.03	79.11	121.36	50.03	0.3	28.0	75.92	7.19	0.96	1.2	0.9	0.86	10.68	7.67	4.69
10	234.46	234.62	235.14	146.12	98.28	157.59	50.03	0.2	17.0	90.24	10.78	0.96	1.22	0.85	0.84	10.1	5.96	3.51
11	233.77	234.20	234.53	167.52	101.65	169.77	50.03	0.2	15.5	98.65	11.60	0.96	1.21	0.85	0.81	8.78	5.66	3.12
12	233.74	234.20	234.49	176.90	100.22	171.01	50.06	0.1	14.8	100.81	11.45	0.96	1.19	0.83	0.79	8.29	5.78	3.07
13	233.13	233.81	234.04	186.29	97.98	168.43	49.98	0.2	16.2	101.80	11.20	0.96	1.19	0.86	0.82	7.94	6.06	3.14
14	233.31	233.89	234.31	183.92	100.24	163.65	49.95	0.2	20.2	100.94	10.54	0.96	1.19	0.88	1.07	7.86	6.14	3.6
15	231.96	232.63	232.99	195.98	107.28	169.91	49.89	0.2	19.9	105.30	11.67	0.96	1.35	1.23	1.25	7.64	7.39	4.46
16	231.67	232.35	232.58	198.61	111.19	176.03	49.90	0.2	16.3	107.72	12.46	0.96	1.51	1.51	1.22	8.03	8.04	4.67
17	233.13	233.88	233.90	203.08	107.82	189.93	50.07	0.1	11.3	111.58	13.80	0.95	1.56	1.51	1.15	7.98	8.51	4
18	233.84	234.48	234.63	198.33	111.10	186.16	50.09	0.1	13.4	110.68	13.70	0.95	1.49	1.53	1.21	8.13	7.74	4.01

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19	233.90	234.58	234.83	201.28	108.60	180.40	49.98	0.2	16.7	109.43	13.52	0.95	1.48	1.41	1.15	7.98	7.94	4.4
20	235.59	236.41	236.43	200.40	111.45	184.90	50.02	0.1	12.1	111.66	13.78	0.95	1.44	1.31	1.15	8.06	7.38	4.1
21	236.14	237.05	236.98	209.26	108.38	187.69	50.02	0.1	13.8	113.91	13.88	0.95	1.46	1.39	1.19	7.69	7.94	4.05
22	235.91	236.63	236.83	199.66	110.82	177.22	50.03	0.2	15.8	109.79	13.18	0.95	1.51	1.43	1.23	7.99	7.72	4.48
23	235.54	236.28	236.49	204.65	107.85	181.18	50.05	0.2	16.4	110.89	13.60	0.95	1.57	1.52	1.27	7.75	8.35	4.41
24	234.63	235.55	235.50	204.79	110.69	188.88	50.06	0.1	13.7	113.04	13.90	0.95	1.57	1.53	1.28	7.83	8.07	3.92
25	235.46	236.23	236.31	203.58	108.80	186.82	50.00	0.1	13.1	112.00	13.90	0.95	1.59	1.54	1.27	7.97	8.43	4.05
26	234.78	235.56	235.79	201.49	111.95	177.38	49.94	0.2	17.5	109.85	13.14	0.95	1.51	1.48	1.29	7.87	7.94	4.72
27	235.13	235.93	236.15	203.43	110.70	178.63	50.00	0.2	17.5	110.44	13.33	0.95	1.53	1.48	1.27	7.85	7.98	4.59
28	234.49	235.34	235.67	207.59	108.01	184.26	50.06	0.2	21.4	111.75	13.19	0.95	1.52	1.49	1.27	7.6	8.22	4.25
29	234.05	234.77	235.06	202.05	110.67	186.86	50.01	0.2	18.4	111.53	13.52	0.95	1.53	1.51	1.31	7.77	7.98	4.17
30	234.43	235.40	235.58	204.32	106.13	183.04	50.00	0.2	18.8	110.22	13.82	0.95	1.44	1.37	1.22	7.59	7.91	4.14
31	234.52	235.36	235.63	200.09	107.92	180.70	49.99	0.2	19.5	109.15	13.73	0.95	1.4	1.25	1.14	7.75	7.24	4.08
32	233.53	234.61	234.80	205.82	102.42	180.70	49.96	0.2	20.7	109.01	13.50	0.95	1.45	1.34	1.18	7.45	7.77	4.09
33	233.94	234.95	235.23	201.57	105.10	176.58	49.93	0.2	22.2	108.00	12.98	0.95	1.5	1.35	1.18	7.81	7.51	4.2
34	232.86	233.82	234.19	203.23	105.54	176.87	49.88	0.2	24.2	108.20	12.79	0.95	1.54	1.47	1.25	8.03	7.89	4.35
35	232.55	233.51	233.79	198.42	102.56	176.84	49.91	0.2	21.7	106.10	12.88	0.95	1.55	1.5	1.26	8.21	8.34	4.34
36	233.27	234.19	234.47	206.94	105.99	178.12	50.04	0.2	21.0	109.68	13.20	0.95	1.51	1.46	1.25	7.69	7.96	4.39
37	232.81	233.57	234.01	187.89	97.99	162.23	50.06	0.2	23.4	99.42	12.29	0.95	1.54	1.54	1.33	8.53	9.1	5.36

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6.Annexure

1. **EXTRACTS FROM IEEE 519-1992**
2. **CEA Regulations- Extracts**

   i. Technical Standards for Connectivity to the Grid
   ii. Central Electricity Authority (Grid Standards) Regulations 2010 [New]

1. EXTRACTS FROM IEEE 519-1992

Voltage Distortion Limits.

The recommended voltage distortion limits (see Table 11.1) are concerned with the follow indices:

THD: Table (RSS) Harmonic voltage distortion in percent of nominal fundamental frequency voltage.

The limits listed in Table 11.1 should be used as system design values for the "worst case" for normal operation (conditions lasting longer than one hour). For shorter periods, during start-ups or unusual conditions, the limits may be exceeded by 50%.

Voltage Distortion Limits

Bus voltage at PCC	Individual voltage Distortion (%)	Total voltage Distortion THD (%)
69 kV and below	3.0	5.0
69.001kV through 161kV	1.5	2.5
161.001 kV and above	1.0	1.5

Note: High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user.

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CURRENT DISTORTION LIMITS FOR GENERAL DISTRIBUTION SYSTEMS

(120V THROUGH 69 000V)

Maximum Harmonic Current Distortion in Percent of I_1						
Individual Harmonic Order /odd Harmonics/						
I_{sc}/I_L	**<11**	**11≤h<17**	**17≤h<23**	**23≤h<35**	**35≤h**	**TDD**
<20	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Current Distortion Limits for General Sub transmission Systems

(69 001 V through 161 000 V)

Maximum Harmonic Current Distortion in Percent of I_L						
Individual Harmonic Order (odd Harmonics)						
I_{sc}/I_L	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20	2.0	1.0	0.75	0.3	0.15	2.5
20<50	3.5	1.75	1.25	0.5	0.25	4.0
50<100	5.0	2.25	2.0	0.75	0.35	6.0
100<1000	6.0	2.75	2.5	1.0	0.5	7.5
>1000	7.5	3.5	3.0	1.25	0.7	10.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Current distortions that result in a de offset, e.g., half-wave converters, are not allowed.

*All power generation equipment is limited to these values of current distortion, regardless of action I_{sc} / I_L

Where

I_{sc} = maximum short-circuit current at PCC. I_L = maximum demand load current (fundamental frequency component) at PCC.

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These limits are recommended for low-voltage systems in which the notch area is easily measured on an oscilloscope. It should be noted that the total voltage distortion factor is related to the total notch area, A_N, by the equality given in Eq 8.20.

Fig 10.1 defines notch depth and area.

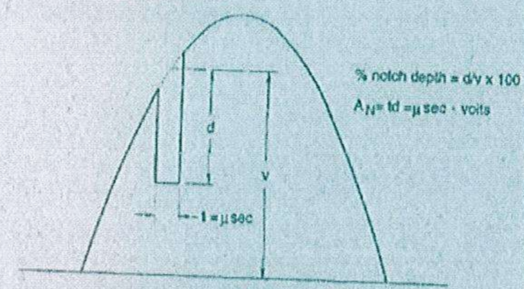

Fig 10.1
Definition of Notch Depth and Notch Area

10.4 Current Distortion Limits. Ideally, the harmonic distortion caused by a single consumer should be limited to an acceptable level at *any* point in the system; and the entire system should be operated without substantial harmonic distortion anywhere in the system. The harmonic distortion limits recommended here establish the maximum allowable current distortion for a consumer. The recommended current distortion limits are concerned with the following indice:

TDD: Total demand distortion (RSS), harmonic current distortion in % of maximum demand load current (15 or 30 min demand) *

The limits listed in Tables 10.3, 10.4, and 10.5 should be used as system design values for the "worst case" for normal operation (conditions lasting longer than one hour). For shorter periods, during start-ups or unusual conditions, the limits may be exceeded by 50%.

These tables are applicable to six-pulse rectifiers and general distortion situations. However, when phase shift transformers or converters with pulse numbers (q) higher than six are used, the limits for the characteristic harmonic orders are increased by a factor equal to

$$\sqrt{\frac{q}{6}}$$

provided that the amplitudes of the noncharacteristic harmonic orders are less than 25% of the limits specified in the tables. See 13.1 for an example.

Table 10.3 lists the harmonic current limits based on the size of the load with respect to the size of the power system to which the load is connected. The ratio I_{sc}/I_L is the ratio of the short-circuit current available at the point of common coupling (PCC), to the maximum fundamental load current. It is recommended that the load current, I_L, be calculated as the average current of the maximum demand for the preceding 12 months. Thus, as the size of the user load decreases with respect to the size of the system, the percentage of harmonic current that the user is allowed to inject into the utility system increases. This protects other users on the same feeder as well as the utility, which is required to furnish a certain quality of voltage to its customers. *

All generation, whether connected to the distribution, subtransmission, or transmission system, is treated like utility distribution and is therefore held to these recommended practices.

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2. Extracts from CEA regulations

i. Technical Standards for Connectivity to the Grid

रजिस्ट्री सं. डी. एल.-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY

भाग III—खण्ड 4
PART III—Section 4

प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 58] नई दिल्ली, शुक्रवार, मार्च 9, 2007/फाल्गुन 18, 1928
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विद्युत मंत्रालय
(केन्द्रीय विद्युत प्राधिकरण)
अधिसूचना
नई दिल्ली, 21 फरवरी, 2007

सं. 12/एक्स/एस. टी. डी. (कॉन)/ग्रिप्र/के. वि. प्रा.—जबकि विद्युत (पूर्व प्रकाशन के लिए प्रक्रिया) नियमावली, 2005 के नियम 3 के साथ पठित विद्युत अधिनियम, 2003 (2003 का 36) की धारा 177 की उप-धारा (3) द्वारा यथा अपेक्षित केन्द्रीय विद्युत प्राधिकरण (ग्रिड के संयोजन के लिए तकनीकी मानक) विनियम, 2006 के मसौदे को प्रकाशित किया गया था।

अतः अब, केन्द्रीय विद्युत प्राधिकरण विद्युत अधिनियम, 2003 की धारा 177 की उप-धारा (2) के साथ पठित धारा 7 और धारा 73 के खण्ड (ख) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए ग्रिड के संयोजन के लिए तकनीकी मानकों के विनियमन के लिए एतद्द्वारा निम्नलिखित विनियम तैयार करता है, नामतः :-

1. अल्प नाम तथा प्रवर्तन

(1) इन विनियमों को केन्द्रीय विद्युत प्राधिकरण (ग्रिड के संयोजन के लिए तकनीकी मानक) विनियम, 2007 के नाम से जाना जाएगा;

(2) ये सरकारी राजपत्र में उनके प्रकाशन की तिथि से लागू होंगे।

2. परिभाषाएं

इन विनियमों में जब तक कि संदर्भ में अन्यथा अपेक्षित न हो,

(1) "अधिनियम" से अभिप्राय विद्युत अधिनियम, 2003 (2003 की सं. 36) से है;

(2) "उपयुक्त भार प्रेषण केन्द्र" से अभिप्राय है राष्ट्रीय भार प्रेषण केन्द्र (एनएलडीसी), क्षेत्रीय भार प्रेषण केन्द्र (आरएलडीसी) अथवा राज्य भार प्रेषण केन्द्र (एसएलडीसी) अथवा क्षेत्र भार प्रेषण केन्द्र, जैसा भी संदर्भ हो;

(3) "क्षेत्र भार प्रेषण केन्द्र" से अभिप्राय है राज्य के एक विशेष क्षेत्र में भार प्रेषण एवं नियंत्रण के लिए राज्य द्वारा यथा-स्थापित केन्द्र;

(4) "उपयुक्त संचारण यूटिलिटी" से अभिप्राय है केन्द्रीय संचारण यूटिलिटी अथवा राज्य संचारण यूटिलिटी, जैसा भी संदर्भ हो;

(5) "स्वचालित उत्पादन नियंत्रण" (एजीसी) से अभिप्राय कुल विद्युत संयंत्र उत्पादन, टाई-लाइन विद्युत प्रवाह और विद्युत प्रणाली आवृत्ति के संदर्भ में चुनिन्दा इकाइयों के विद्युत उत्पादन को विनियमित करने की क्षमता से है;

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Part-II

Gird connectivity standards applicable to the generating Units

(2) The Short-Circuit Ratio (SCR) for generators shall be as per IEC-34.

(3) The generator transformer windings shall have delta connection on low voltage side and star connection on high voltage side. Star point of high voltage side shall be effectively (solidly) earthed so as to achieve the Earth Fault Factor of 1.4 or less.

(4) All generating machines irrespective of capacity shall have electronically controlled governing system with appropriate speed/load characteristics to regulate frequency. The governors of thermal generating units shall have a droop of 3 to 6% and those of hydro generating units 0 to 10%.

(5) The project of the requester shall not cause voltage and current harmonics on the grid which exceed the limits specified in Institute of Electrical and Electronics Engineers (IEEE) Standard 519.

(6) Generating Units located near load centre, shall be capable of operating at rated output for power factor varying between 0.85 lagging (over-excited) to 0.95 leading (under-excited) and Generating Units located far from load centres shall be capable of operating at rated output for power factor varying between 0.9 lagging (over-excited) to 0.95 leading (under-excited). The above performance shall also be achieved with voltage variation of ± 5% of nominal, frequency variation of +3% and –5% and combined voltage and frequency variation of ±5%. However, for gas turbines, the above performance shall be achieved for voltage variation of ±5%.

(7) The coal and lignite based thermal generating units shall be capable of generating up to 105% of Maximum Continuous Rating (subject to maximum load capability under Valve Wide Open Condition) for short duration to provide the frequency response.

(8) The hydro generating units shall be capable of generating up to 110% of rated capacity (subject to rated head being available) on continuous basis.

(9) Every generating unit shall have standard protections to protect the units not only from faults within the units and within the station but also from faults in transmission lines. For generating units having rated capacity greater than 100 MW, two independent sets of protections acting on two independent sets of trip coils fed from independent Direct Current (DC) supplies shall be provided. The protections shall include but not be limited to the Local Breaker Back-up (LBB) protection.

(10) Hydro generating units having rated capacity of 50 MW and above shall be capable of operation in synchronous condenser mode, wherever feasible.

(11) Bus bar protection shall be provided at the switchyard of all generating station.

(12) Automatic synchronisation facilities shall be provided in the requester's Project.

(13) The station auxiliary power requirement, including voltage and reactive requirements, shall not impose operating restrictions on the grid beyond those specified in the Grid Code or state Grid Code as the case may be.

(14) In case of hydro generating units, self-starting facility may be provided. The hydro generating station may also have a small diesel generator for meeting the station auxiliary requirements for black start.

(15) The standards in respect of the sub-stations associated with the generating stations shall be in accordance with the provisions specified in respect of 'Sub-stations' under Part III of these Standards.

2. Existing Units

For thermal generating units having rated capacity of 200 MW and above and hydro units having rated capacity of 100 MW and above, the following facilities would be provided at the time of renovation and modernization.

(1) Every generating unit shall have Automatic Voltage Regulator. Generators having rated capacity of 100 MW and above shall have Automatic Voltage Regulator with two separate channels having independent inputs and automatic changeover.

(2) Every generating unit of capacity having rated capacity higher than 100MW shall have Power System Stabilizer.

(3) All generating units shall have standard protections to protect the units not only from faults within the units and within the station but also from faults in transmission lines. The protections shall include but not limited to the Local Breaker Back-up (LBB) protection.

Part III

Grid Connectivity Standards applicable to the Transmission Line and Sub-Station

The transmission lines and sub-stations connected to the grid shall comply with the following additional requirements besides the general connectivity conditions under these regulations and General Standards for Connectivity to the Grid as specified in Part I of the Schedule.

(1) Bus bar protection shall be provided on all sub-stations at and above 220 kV levels for all new sub-stations. For existing sub-stations, this shall be implemented in a reasonable time frame.

(2) Local Breaker Back-up (LBB) protection shall be provided for all sub-stations of 220kV and above.

(3) Two main numerical Distance Protection Schemes shall be provided on all the transmission lines of 220 kV and above for all new sub-stations. For existing sub-stations, this shall be implemented in a reasonable time frame.

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(4) Circuit breakers, isolators and all other current carrying equipment shall be capable of carrying normal and emergency load currents without damage. The equipment shall not become a limiting factor on the ability of transfer of power on the inter-state and intra-state transmission system.

(5) All circuit breakers and other fault interrupting devices shall be capable of safely interrupting fault currents for any fault that they are required to interrupt. The Circuit Breaker shall have this capability without the use of intentional time delay in clearing the fault. Minimum fault interrupting requirement need be specified by the Appropriate Transmission Utility. The Circuit Breaker shall be capable of performing all other required switching duties such as, but not limited to, capacitive current switching, load current switching and out-of-step switching. The Circuit Breaker shall perform all required duties without creating transient over-voltages that could damage the equipment provided elsewhere in the grid. The short circuit capacity of the circuit breaker shall be based on short-term and perspective transmission plans as finalized by the Authority.

(6) Power Supply to Sub-Station Auxiliaries, shall:

(a) for alternating current (AC) supply (Applicable to new sub-stations) :

220 kV and above: Two high tension (HT) supplies shall be arranged from independent sources. One of the two high tension supplies shall be standby to the other. In addition, an emergency supply from diesel generating (DG) source of suitable capacity shall also be provided.

66 kV and below 220 kV: There shall be one HT supply and one diesel generating source.

33 kV and below 66 kV: There shall be one HT supply.

(b) *for direct current (DC) Supply (Applicable to new sub-stations):* Sub-stations of transmission system *for 132 kV and above and sub-stations of all generating stations:* There shall be two sets of batteries, each equipped with its own charger.

For sub-stations below 132 kV: there shall be one set of battery and charger.

(7) Earth Fault Factor for an effectively earthed system shall be not more than 1.4.

Part IV

Grid Connectivity Standards applicable to the Distribution Systems and Bulk Consumers

The following additional requirements shall be complied with, besides the connectivity conditions in these regulations and general Standards for Connectivity to the Grid given in Part-I and those applicable to transmission lines and sub-stations in Part -III.

1. Under Frequency/df/dt Relays

Under frequency and df/dt (rate of change of frequency with time) relays shall be employed for automatic load control in a contingency to ensure grid security under conditions of falling grid frequency in accordance with the decision taken in the Regional Power Committee.

2. Reactive Power

The distribution licensees shall provide adequate reactive compensation to compensate the inductive reactive power requirement in their system so that they do not depend upon the grid for reactive power support. The power factor of the distribution system and bulk consumer shall not be less than 0.95.

3. Voltage and Current Harmonics

(1) The total harmonic distortion for voltage at the connection point shall not exceed 5% with no individual harmonic higher than 3%.

(2) The total harmonic distortion for current drawn from the transmission system at the connection point shall not exceed 8%.

(3) The limits prescribed in (1) and (2) shall be implemented in a phased manner so as to achieve complete compliance not later than five years from the date of publication of these regulations in the official Gazette.

4. Voltage Unbalance

The Voltage Unbalance at 33 kV and above shall not exceed 3.0%.

5. Voltage Fluctuations

(1) The permissible limit of voltage fluctuation for step changes which may occur repetitively is 1.5%.

(2) For occasional fluctuations other than step changes the maximum permissible limit is 3%.

(3) The limits prescribed in (1) and (2) above shall come into force not later than five years from the date of publication of these regulations in the Official Gazette.

6. Back-energization

The consumer shall not energize transmission or distribution system by injecting supply from his generators or any other source either by automatic controls or manually unless specifically requested by the Transmission or Distribution Licensee.

BIJOY KUMAR MISRA, Secy.

[ADVT-III/IV/Exty/187G/06]

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ii. Central Electricity Authority (Grid Standards) Regulations 2010 [New]

Table 5

S.No.	System Voltage (kV rms)	Total Harmonic Distortion (%)	Individual Harmonic of any Particular Frequency (%)
1	765	1.5	1.0
2	400	2.0	1.5
3	220	2.5	2.0
4	33 to 132	5.0	3.0

Provided that the standard on Harmonic Distortion shall come into force concurrently with clause 3 of Part IV of the Schedule to the Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.

Explanation: For the purpose of this regulation, Total Harmonic Distortion (V_{THD}) expressed as percentage, shall be calculated as under,-

$$V_{THD} = \sqrt{\sum_{n=2}^{n=40} \frac{V_n^2}{V_1^2}} X100$$

'1' refers to fundamental frequency (50 Hz)

'n' refers to the harmonic of n^{th} order (corresponding frequency is 50 x n Hz)

Operation Planning - The Regional Power Committee shall periodically review the performance of the grid for the past period and plan stable operation of the grid for the future, considering various parameters and occurrences such as frequency profile, voltage profile, line loading, grid incident, grid disturbance, performance of system protection schemes and protection coordination.

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7. TOTAL POWER REQUIERMENT OF VARIOUS EQUIPMENT

Department/Infrastructure	CFL BULBS	LED BULBS	FANS	A/C	TUBE LIGHTS	COOMPUTERS	PHOTOCOPIER	TV	CCTV	NVR	DVR
Full college/ Admin/ Hostel / other	250	500	2591	153	2932	627	10	10	159	4	1
POWER CONSUMPTION(KWh) in units per annum	**9180**	**21600**	**413235**	**207144**	**8444**	**213336**	**6969.6**	**4320**	**20606.4**	**1555.2**	**103.68**

Electrical Power conserved through renewable energy sources

Type of renewable energy sources	**Renewable energy source**	**Energy Conserved Per Year Considering 250 Days**
Bio energy	-	-
Solar Energy	Power grid-126KWP	182500

By using Solar water heater, the electric power conserved by 182500 units

Consumption of Electricity per year

Sl No	Year	Consumption in Kw-Hr
1	**2015-2016**	**632260**
2	**2016-2017**	**656133**
3	**2017-2018**	**711236**
4	**2018-2019**	**705675**
5	**2019-2020**	**798798**
	TOTAL 5 YEARS	**3504102**

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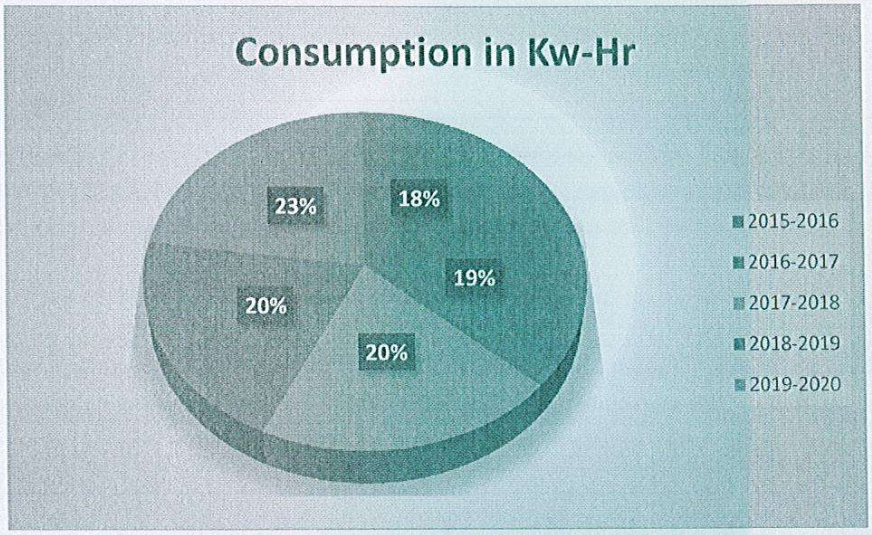
Consumption of Electricity per year



POWER CONSUMPITON OF EB

MONTH	CONSUMPTION in kW-hr
Jan-19	**40100**
Feb-19	**63431**
Z eMar-19	**67214**
Apr-19	**74551**
May-19	**76830**
Jun-19	**53605**
Jul-19	**61722**
Aug-19	**71968**
Sep-19	**78830**
Oct-19	**63145**
Nov-19	**68331**
Dec-19	**68922**
Total Power Consumption in Yearly in Kw-hr	788649
Average power consumption in kW-hr	65720

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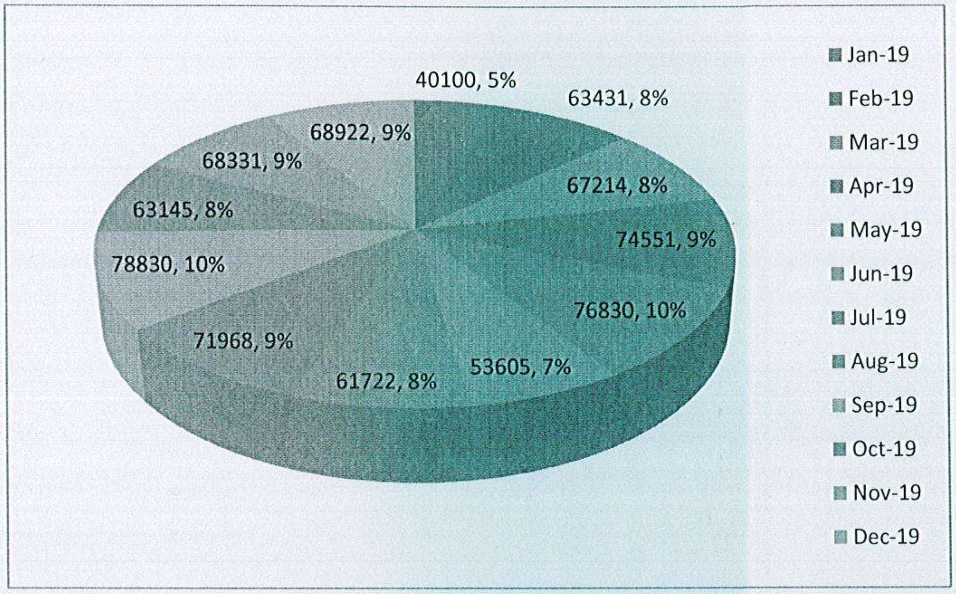

"The college uses energy efficient lights of 500 numbers, which consumed only 20 percentage of power compared to normal lights. So savings is attained almost 80 percentages."

BUILDINGS AND ENERGY EFFICIENT EQUIPMENT

SL NO	CATEGORIES	QTY	POWER CONSUMPTION-in units per annum
1	Energy Efficient LED Lights	500 No's	21600 kW-hr
2	Capacitor Bank of different capacities	2 No's (100 KVR + 150 KVR)	0.96
3	Energy Efficient Ceiling Fans	NA	NA
4	VRF Air Conditioners	2 No's (12 ton + 21 ton)	52000 kW-hr

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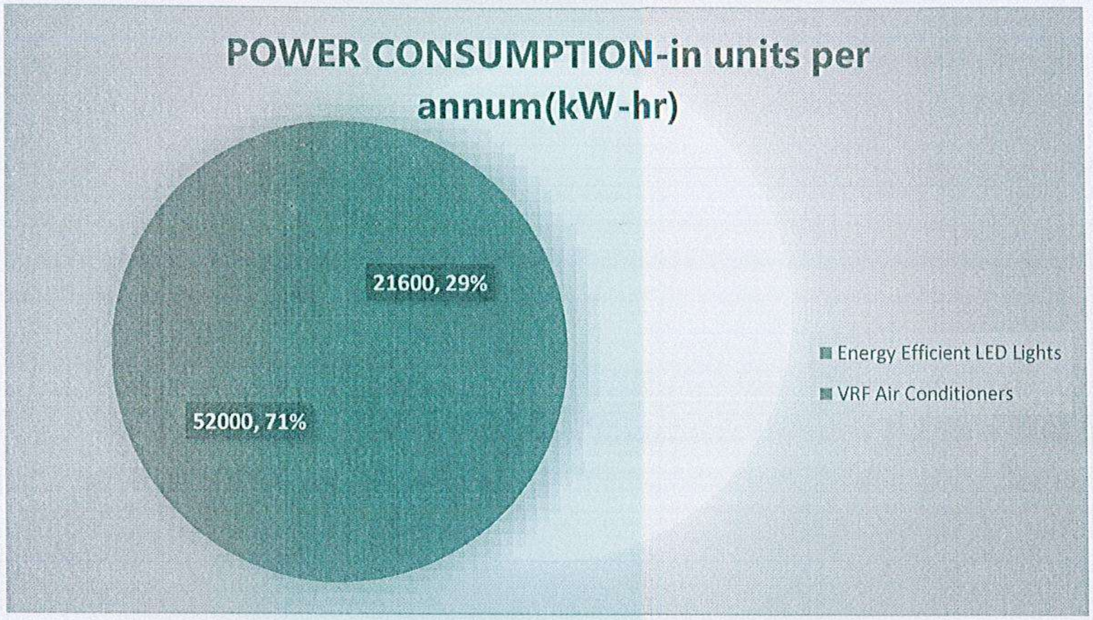

8. RECOMMENDATION/CONCLUSION

- Non inverter Air conditioners can be replaced by inverter based 5 Star rating for Eco friendly, Power consumption, Energy Savings, Sound, Longer life and fast cooling/heating.
- Number of solar streetlights can be increased to get more power conservations.
- Library /Auditorium can have their own roof top panels to generate their power to meet their demand.
- Proximity/ Motion sensor can be introduced in the rest room and storage room.
- Small wind mills can be established for pumping water at the bore well places.
- Percentage current THD of each phase is different and it varies between 3.07 % to 20.1% which is high as per CEA. To overcome this , distribute the load equally in all phases and still % current THD values more than 8% than it is better to add Harmonic filters in the corresponding phases.

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Positive points:

Some of the positive points mentioned here which is already in practice, and shall recommend following the same.

- Percentage voltage THD Value is less than 1.6 %
- From the total average recordings, the power factor is maintained above 0.9 for different load conditions.
- The Tungsten lights have been replaced with compact fluorescent lights/LED which conserves energy.
- During the day, lights are switched off to make use of daylight.
- All air conditioners are with local control and are used only when necessary. They are set to a comfortable 25 degrees.
- The use of renewable energy is highly recommended to sustain the same.

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