Power Quality Issues In Indian Power Distribution Utilities And Feasible Solutions

Narasimha Pandit, Dr. R.L.Chakrasali

Abstract: One important contributing factor to India's slow pace of development in general and relatively poor industrial growth in particular is the poor quality and reliability of the electrical power. Earlier, the consumers of electrical energy were mere acceptors. Interruptions and other voltage disturbances were part of the deal. But today, electric power is viewed as a product with certain characteristics which can be measured, predicted, guaranteed, improved, etc. which has become an integral part of our life. This paper gives insights on different Power Quality (PQ) problems experienced by the Indian electricity consumers, and the reasons for those problems. This paper proposes feasible solutions to assist in employing or implementing appropriate mitigation techniques with an optimism of an improvement in the field scenario as more and more investments are proposed in Generation, Transmission and Distribution Sectors, and stringent codes and standards are being imposed for those who do not maintain minimum PQ level in the field.

Key words: Distribution system, power quality, transformer, interruption, standards

1. INTRODUCTION:

Quality is a perception [3], and if consumers are happy with the things/service delivered to them, then one can say that things/service is of good quality. In respect of electric power, the consumers had less awareness and information 30 years ago. Now, as more and more people are using electrical gadgets, for various reasons, Power Quality is a major expectation from all section of people. Most of the consumers are worried about scheduled/unscheduled load shedding, low voltage, Flickering (Brownouts), High voltage and Transients. The interest in Power Quality (PQ) is related to all three parties concerned with the power i.e. utility companies, equipment manufacturers and electric power consumers, and involves huge loss to the utilities and consumers [2]. Since, mitigation of PQ problems requires huge investments in generation, transmission and distribution, the Government of India and the respective State Governments have already started investing in all these three sections in phased manner.

2. THE PROPOSED WORK:

The literature survey reveals that the research is in progress to clearly bring out the issues related to power quality and novel approaches to mitigate power quality issues. The proposed work is carried out based on facts and figures obtained from the field to indicate the severity of power quality problems and feasible solutions to address these problems. To get the gross root level information the work started with the basic concept of power quality.

2.1 What is Power Quality and Why Power Quality is important?

It is the devoir of the utilities to supply the power at specified voltage and frequency and if they fail to do so then it is termed as inferior power quality. It is important to note that the consumer appliances are to be operated as per specifications. If there is mismatch between the specified values and actual values beyond the tolerance limit then it will impair the functioning of the appliances leading to adverse effect to the extent of failure of the appliances. Hence, it is a must to maintain the voltage and frequency at specified values. The typical sources of power quality are [1]:

1. The power utilities, which create PQ problems, are also affected by it, in terms of financial loss as well as losing the consumer confidence.
2. Increased consumer awareness in the recent years, viz., earlier it was only 'Light On', now it is more.
3. Increase in Industrial automation and importance of productivity in a competitive global market.
4. Health of equipment and appliances

2.2 Classification and impact of Power Quality problems:

To make the study of PQ problems useful, the various types of disturbances need to be classified by magnitude and duration.

1. Complete interruptions : This is the major problem in India and the reasons are many:
   - Mismatch between Generation and Load, leading to scheduled and unscheduled load shedding. Many times, this happens because of overloading of transmission/distribution lines or power/distribution transformer and lack of redundancy in the infrastructure. Unscheduled load shedding is resorted to sudden drop in generation or technical problems in the local network. Frequent Local interruptions, the duration of which may be a fraction of an hour to 5-6 hours, occur due to line clear taken by local staff for line/transformer maintenance, tree trimming, system improvement works, etc. In such cases, industries and commercial establishments will face lot of inconveniences and suffer financial losses. The utilities themselves incur losses as they miss the opportunity to sell power during such interruptions. In India, no mechanism has been established to inform all the consumers affected in such cases regarding the possible duration of outage. They keep calling whatever number they have, only to get vague/no answers.
   - Since transmission lines and distribution lines are laid for long distances, environmental (like rain and wind) related damages can happen any time in the year. In villages, lines run for distances ranging from 5 KMs to 30 KMs in the fields, forests or hills, making it more prone to line faults and difficult to access for fast repairs. Few, semi-skilled staff,

accompanied by no or infrequent conveyance facility add further delay. In the city, congested roads, traffic and trees are the major impediments.

2. Flickering (over voltage fluctuations), spikes and surges i.e., Brownouts: the main causes are loose connections in the transformer bushings or line jumpers. Poor workmanship, overload on staff(less staff, more work) or starting of a large inductive load (welding machine). Frequent tripping can also be included in this category. Frequent tripping occur when line is faulty and, the Master Unit Sub Station(MUSS) staff informs the O&M staff keeps on isolating bit by bit and the line trips again. During the testing of last bit, either the line gets charged or declared as permanently faulty, wherein the consumer will experience full restoration of power or complete darkness, respectively.
3. Low Voltage: This occurs during the overload of transmission line or distribution line. Most of the lamps and electrical gadgets do not operate during low voltage. Single Phasing also can be included in this category, which occurs when a line jumper is cut or a High Tension (HT) side fuse is blown in the transformer.
4. High Voltage: The consumer experiences high voltage when one phase in a 3 phase system fails , or when there is a loose connection in one bushing of the transformer, leading to severe unbalanced supply of 440 volts (instead of 230 volts) to few consumers. Many electrical gadgets will be damaged during such time.
5. Transformer Failure: Usually a minimum of 10% of the distribution transformers will fail every year in any utility. The number of consumers affected depends upon the capacity of transformer, viz., higher the capacity, more consumers are affected. The replacement may take 5 hours to 24 hours or more, depending upon the availability of staff/ crane, number of transformer failed on that day/ availability of good/ repaired good transformers, and time of transformer failure (if it has failed in night time, the replacement initiation itself may start on the next day morning). Sometimes, power transformer may fail, which is rare compared to distribution transformer failure, leading to interruption to a larger area.

The interruption of any form manifests itself in the form of consumer complaints. The number of complaints received, by a typical Power Distribution Company, in its Urban, Semi Urban and rural areas, in one year, are tabulated as follows:

Complaint details of Category A, B, & F:
A : complete interruption, B: Voltage problem,
F: Transformer Failure

	Category	Urban	Semi urban	Rural	Total
January	**A**	47826	2529	948	**51303**
	B	1206	54	41	**1301**
	F	22	197	501	**720**
February	**A**	52218	3691	1019	**56928**
	B	1124	62	47	**1233**
	F	14	199	424	**637**
March	**A**	1443	5698	1692	**8833**
	B	147	92	49	**288**
	F	30	247	487	**764**
April	**A**	78464	5372	2402	**86238**
	B	1509	98	37	**1644**
	F	16	202	432	**650**
May	**A**	112038	10058	2965	**125061**
	B	2010	111	31	**2152**
	F	66	225	493	**784**
June	**A**	103900	8638	2395	**114933**
	B	2412	141	41	**2594**
	F	57	403	657	**1117**
July	**A**	78475	6043	2404	**86922**
	B	1780	122	39	**1941**
	F	60	464	887	**1411**
August	**A**	77962	7432	3391	**88785**
	B	1759	115	48	**1922**
	F	91	839	823	**1753**
September	**A**	93054	8813	3532	**105399**
	B	2166	118	50	**2334**
	F	129	972	1164	**2265**
October	**A**	96787	9195	3934	**109916**
	B	1790	87	22	**1899**
	F	155	1011	1073	**2239**
November	**A**	71361	8473	2524	**82358**
	B	1301	92	33	**1426**
	F	127	864	1104	**2095**
December	**A**	63088	6955	3078	**73121**
	B	1202	74	51	**1327**
	F	121	856	1409	**2386**

From the above table it is clear that:

1. More interruptions have occurred due to rain/wind leading to more complaints.
2. Though rural areas suffer more interruptions during such times, due to lack of communicating procedural aspects, they refrain from complaining to the concerned authority and are 'Used to it'. But the transformer failure complaints in rural areas are more as they need power for agricultural purpose.

3. FEASIBLE SOLUTIONS

1. Investments: Investment in Generation, Transmission and Distribution is required. More attention is required on the latter two, as most of the major interruptions are because of non-availability of corridors to take available power from various parts of the country (Transmission), and lack of redundancy, and poor infrastructures (Distribution). Man Power: Recruitment of adequate

number of skilled labor and extending necessary state of the art training to them is required, as lot of distribution problems remain unaddressed due to overloading of staff and lack of skill.

2. Use of latest technology: Lot of IT initiatives are required[6] whereby all consumers can individually be informed well in advance regarding scheduled load shedding. Further, all affected consumers should be informed regarding unscheduled load shedding, immediately after the interruption occurs, with probable time of restoration. Technology initiatives are required to attend the complaints fast, replace the transformers, clear the tree branches, maintain lines, etc.
3. Educating the Consumers: Messages through various means, viz., Media, street play, booklet, visit to school, etc. should be arranged to create awareness to consumers regarding Demand Side Management. Switching over to solar light/ heater and usage of robust equipment [1] could be alternatives for facing PQ problems.
4. R&D, the need of the hour: As most of the power transmission and distribution sectors are state owned, that 'Government Mindset' lingers long in the mind of officers. Deep research on the possible solutions, at less cost, is necessary. No utility is thinking on harmonic distortions and effect of harmonics on transformers/ consumer equipment. Detailed thinking is need of the hour in every aspect of Transmission and Distribution.

4. DEVELOPMENT OF CODES AND STANDARDS

With ongoing regulatory policy and structural changes in Indian Electricity Industry, following the Electricity Act 2003, the issue of PQ has become a figure-of-merit amongst the competing distribution utilities [5]. Some measures have been taken to regulate the minimum PQ level that utilities have to provide to the consumers. The Karnataka Regulatory Commission, for example, has issued the following Standards of Performance on PQ related issues. It states that The Standards of Performance specified shall be the minimum standard of service with reference to quality, continuity and reliability of services that a licensee shall achieve in discharging the duty which is an obligation of a licensee, and consumers are eligible for payment of an amount in the manner provided in the Schedule I in case the Licensee fails to adhere to the Standards of Performance.

Nature of Service	Standards of Performance (Indicative Maximum time limit for rendering service)	Amount payable to affected consumer
1. Normal Fuse-off Cities and Towns Rural areas	Within 6 hours Within 24 hours	Rs.50 in each case of default Rs.50 in each case of default
2.Line Breakdowns Cities and Towns Rural areas	Within 6 hours (10 hrs if poles are broken down) Within 24 hours in all cases	Rs.50 to each affected consumer Rs.50 to each affected consumer
3. Distribution Transformer Failure Cities and Towns	Within 24 hours Within 72 hours	Rs.50 to each affected consumer
4. Period of Scheduled outages Maximum duration in a single stretch Restoration of supply	Not to exceed 12 hours By 6 PM on any day	Rs.50 to each affected consumer Rs.50 to each affected consumer
5. Voltage Variations Opening of neutral and neutral voltage exceeding 2% of supply voltage	Within 6 hours in Cities Within 24 hours in Rural Areas	Rs.50 in each case of default

5. CONCLUSIONS

Indian Power Utilities are now facing whole lot of consumers who are demanding Quality Power at any cost. The utilities have the onus of investing huge money in Generation, Transmission, Distribution, Manpower training, Modernizing, and more. The Central Government has timely come out with Integration Power Development Scheme (IPDS) to strengthen the transmission and distribution network. If the consumers and the employees of the utilities participate in this huge and important task, then Quality Power is always realizable. The advent in technology provides modernization opportunities to be explored to achieve the objectives of power quality.

References:

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