Aspects of Power and Risk Management in Deregulated Power Supply

Harsh Sahu[#1], Gaurav Mishra[#2] ,Mehul Singh[#3] ,Surendra Kumar Tripathi[#3]
[#]Department of Electrical and Electronics Engineering,
KIET Group of Institutions, Ghaziabad

***Abstract* — This paper addresses the complex challenges of risk management and pricing in deregulated power systems and proposes regulatory solutions. In this context, a uniform framework for risk management is recommended to ensure the safe and reliable operation of the power system in a competitive market. The framework is generic and adaptable to any power market structure. The paper reviews several approaches to managing risk in the deregulated market environment and presents a systematic overview of the current risk management practices of a Distribution System Operator (DSO) as an integral part of its network planning process. The paper defines the concept of risk, examines the impact of various incentives on risk management, and discusses the simulation of power quality disturbances.**

***Keywords* — Risk management, Deregulated power supply, power management, management tools, Distribution System, Risk Analysis, Risk Methods,power quality.**

I. INTRODUCTION

In the past few years, the power system has changed from a vertically integrated and monopolistic paradigm to one that is autonomous and competitive. The government controls all segments of the vertical system, including the generation companies (GenCos), transmission companies (TransCos), and distribution companies (DisCos). In the restructured model, new engineering disciplines in operation and planning are raised by the bilateral contracts between the players in the power market managed by the Independent System Operator (ISO).

Markets for energy are evolving. Energy prices are currently more volatile than they have ever been since the earlier decades of the 20th century due to a number of variables. Utility firms are confronting a new day after being previously protected by the regulatory process from significant worries about profitability, fuel costs, generation additions, and delivery system expansions.

These significant adjustments include:

1. extraordinary load growth
2. significant gasoline price increases and supply uncertainties
3. Environmental constraints make it difficult to add new sourcing and delivery methods.
4. Insolvencies, a decline in investor confidence, and significant utility restructuring
5. Deregulation in some retail and wholesale sectors

In order to contribute to the ongoing work of developing risk management principles, this paper's goal is to analyze, assess, and systematically describe the work with risk management at a distribution system operator (DSO). The direction of the on the basis of this initial stage and a review of the proposals through implementation, following steps of the application study will include a more extensive list of recommendations for improvements in risk management. The long-term objective is to create a risk methodology that is based on both practical industrial experience and more scholarly approaches.

The direction of the on the basis of this initial stage and a review of the proposals through implementation, following steps of the application study will include a more extensive list of recommendations for improvements in risk management

1. Conduct a thorough risk assessment: The first step in improving risk management in a high voltage distribution system is to conduct a comprehensive risk assessment. This involves identifying all potential hazards and evaluating

the likelihood and consequences of each hazard.

2. Develop a risk management plan: Once potential hazards have been identified and assessed, a risk management plan should be developed. This plan should outline strategies for reducing the likelihood of each hazard occurring, as well as strategies for minimizing the consequences should a hazard occur.
3. Train personnel: Properly trained personnel are essential for effective risk management. All personnel who work with the high voltage distribution system should receive training on risk management strategies, as well as on the safe use of equipment and procedures.
4. Implement safety procedures: Safety procedures should be put in place to ensure that all work with the high voltage distribution system is performed in a safe and controlled manner. These procedures should be regularly reviewed and updated to ensure they are effective.
5. Conduct regular inspections and maintenance: Regular inspections and maintenance are essential for identifying potential hazards and addressing them before they become a problem. This includes inspecting all equipment, conducting regular tests, and performing routine maintenance.
6. Use protective equipment: Protective equipment, such as safety glasses, gloves, and helmets, can help minimize the risk of injury or death in the event of an accident. All personnel working with the high voltage distribution system should be provided with the necessary protective equipment and trained on its proper use.
7. Monitor performance: Regular monitoring of the system's performance is essential for identifying potential risks and addressing them before they become a problem. This includes tracking equipment performance, measuring system reliability, and analyzing safety data.
8. Establish emergency procedures: In the event of an emergency, it is important to have established procedures in place to quickly and safely respond to the situation. This includes having emergency response teams trained and ready to respond, as well as establishing procedures for evacuating personnel and addressing equipment failures.

II. DEREGULATED POWER SYSTEM

A deregulated system contains multiple generating units that provide power to the consumers and made the system which is more reliable then the traditional systems with large generation capacity as .If one generating unit fails the others will keep the system working giving this system edge over any another system developed in the past. It is not over to say that this system is the system of the future as due to this system the competition in the market have been increased which helped the consumers to avail the power at lower rate.This competition also made them to improve constantly.

With the improvement of the deregulated system, various new components were introduced. various type of converters are one such example which made it possible to bind and co-existence of multiple generating stations. These Components introduced various possible risks for the system along with the possibilities to improve for the Future.

Deregulated power supply refers to the process of removing government regulations on the production and distribution of electricity. In a deregulated power market, power generation and retail sales are opened up to competition, allowing multiple suppliers to offer electricity to consumers.

Deregulation aims to increase competition and efficiency in the electricity market, leading to lower prices for consumers and greater innovation in the industry. The idea is that by allowing multiple suppliers to compete, the market will determine the price of electricity, rather than the government regulating prices.

In a deregulated power market, the generation of electricity is separated from the distribution and retail sale of electricity. This allows for independent power producers to generate electricity and sell it to retail suppliers or distributors, who in turn sell it to consumers.

The benefits of deregulation include lower costs, increased innovation, and greater consumer choice. However, it can also lead to increased volatility in pricing and reduced reliability, as there may be less government oversight of the electricity grid.

Deregulation of power supply is a complex process that involves significant changes to the structure of the electricity industry. It requires careful planning and implementation to ensure that consumers are protected and that the electricity grid remains reliable and efficient.

Benefit of deregulated power system:

Customers and private businesses alike can benefit from the competitive climate in a number of ways. According to various claims, some of the major advantages of deregulating the power industry would be:

a. The cost of electricity will decrease: It is generally accepted that competitive pricing is lower than monopolist rates. In a highly competitive market, the producer will aim to sell the power at its marginal cost.
b. Customers will have the option of choosing their retailer. Retailers will compete on the other services supplied to customers as well as the price they are willing to offer. These can include improved strategies, dependability, quality, etc.
c. Customer-focused service: Retailers would offer superior service to the monopolist.
d. Regulation and a lack of competition prevented electric companies from innovating or taking chances on novel concepts that would raise customer value. Under a deregulated environment, the electric company would constantly seek to innovate something to improve service, reduce costs, and increase profit.
e. The original power industries developed into regulated monopoly utilities. Figure 2.1 depicts the organization of a typical vertically integrated utility. The chart clearly shows that the customer only had to deal with one utility. Thus,In the power industry, there were only two players: the client and a monopolist utility.

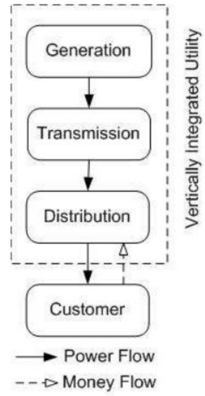

Fig 2.1

f. Figure 2.2 depicts the deregulated electricity system's representative structure. It is clear that there are numerous additional routes along which the money flows as opposed to the vertically integrated utility system. In addition to the vertically integrated utility and the customers, it is obvious that there are many more other companies present. It should be emphasized that deregulated structures can take many different forms.

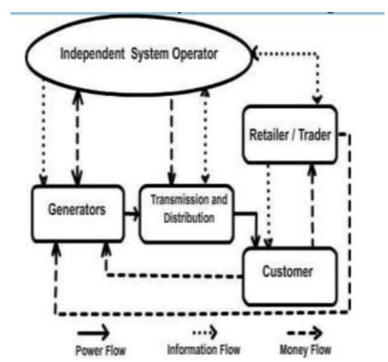

Fig 2.2

Need for risk management:

A rising demand for transmission services is being fueled by the environment of competitive marketplaces in the electricity system. Few significant transmission reinforcements have been undertaken deliberately to strengthen the bulk transmission system; instead, most transmission system additions have been done to locally strengthen the network in response to demand growth or to connect capacity resources. In addition, open transmission access has enhanced electricity transfers across greater distances in ways and to an extent that were unanticipated when the current transmission lines were designed and built. As a result of the increasing electrical transfers, the transmission system is often pressured, causing several transmission interfaces to frequently be loaded at or close to their security limitations. As a result,protection in operating procedures are being used increasingly frequently by system operators and security coordinators to maintain the transmission network.

Benefit of risk management:

Special protection systems are extremely reliable since they frequently take important redundancy into account while designing them. It is common practice to use monitoring and self-check functions to find and warn when important functions or essential components fail.

Unless the Special Protection System has been adequately proved, system studies must be done to determine the effects of Special System protection failure. Failure cannot be believed.

1. Minimize the risk of damage

Poor power quality can cause damage to sensitive equipment. Without clean, uniform power, your facility is more prone to premature equipment failures or outages.

2. Reduce energy costs

Poor power quality can lower productivity and drive up energy costs. Power quality improvement solutions can reduce heat, vibration, and noise in AC motors. The result is a reduction in energy expenses, improved machine performance, reliability, and longer life expectancy.

3. Improve equipment lifespan

Poor power quality also shortens the life of machinery, resulting in higher costs for upkeep and replacement of depreciating assets.

4. Ensure the safety of electrical installation

Poor power quality can impair the safety of electrical installations. If power is not properly provided, machines run the risk of overheating. When machines overheat, they can break down or even catch fire.

5. Increase operational efficiency

When you have an interruption of power, your service, and your machines, stops, even if only briefly. When you suffer these interruptions, your output, in turn, suffers as well.

Protection system Risk Assessment Process:

The chances and consequences are objectively evaluated in order to calculate the risks. The process that was adopted comprises of a few key components:

1. Gather information first

   To commence the SPS dependability assessment, it is essential to have a general understanding of the physical structure of the SPS, working logic, duties of each physical component, location, success criteria, integrated software information, and maintenance and test methods. Data on system working circumstances, human interaction procedures, and human dependability should also be gathered. This is a critical stage in SPS risk evaluation, and it is frequently repeated in subsequent steps as needed.

2. Identify the risk factor

   An initiating event is typically a disruption such as a power failure, generator tripping, load lowering, and so on. A collection of initiating events must be recognised in this phase. If the primary goal is to evaluate system risk with SPS to system risk without SPS. Only the starting occurrences that trigger SPS must be included. If the goal is to compute the overall risk of the system using SPS, then all potential system disturbances must be evaluated.

   SPS is intended to mitigate the effects of abnormal conditions following significant disruptions. The four major causes of SPS risk are as follows.

   1) hardware failure.
   2) faulty design logic.

3) software failure
4) human error

3. Carry out SPS reliability testing

In order to determine availability of SPS in the future, which is essential for SPS risk evaluation. Some techniques for assessing SPS dependability must be used. It is proposed that.Markov modelling is well adapted for SPS reliability evaluation because of its flexibility, which allows it to account for a wide range of SPS characteristics. Specifically, Markov modelling can account for both isolated and common cause failures, as well as partial and complete repairs, upkeep, and diagnostic coverage. Most significantly, it stipulates that all of these characteristics can be modelled as a product of time. In comparison, probability techniques produce steady-state findings and are only reliable for brief repair periods and low failure rates.

4. Conduct an impact analysis

In this stage, the financial damages caused by SPS failure must be calculated, i.e. the overall cost connected with the SPS failure. The consequences can include apparatus harm, outage, load disruption, and fines. Estimates can be derived from historical statistics, surveys, or the views of specialists.

5. Consider risk.

The system risk, which includes SPS reliability information, is calculated in this phase. To evaluate, the system risk without SPS should be calculated as well.

6. Make a decision

The system operator can decide based on the findings of the risk calculation.Decisions linked to SPS to enhance system security. One of these choices is when to activate the SPS. In current industry practice, independent of arming time, the SPS arming point is determined deterministically based on the worst-case situation. It is conceivable that the likelihood of the worst-case scenario is so low that the system risk with SPS is greater than the risk without SPS. The arming threshold in this research is determined by risk.

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III. CLASSIFICATION RISK ASSESSMENT

1.Classification using a hierarchy of evaluations:

There are numerous categorization methods for risk assessment of the power system in use today, which, in accordance with the classification of evaluation hierarchy, can be separated into component level and system level. some conducted component-level analyses. The risk level and significance of each system component are determined using a risk assessment approach for the power system based on risk theory and five different types of risk indicators. However, more research should be done to determine how many risk indicators affect the evaluation outcomes.

2. Grouping based on evaluation category:

According to the evaluation category, the research on risk assessment in the power system can be divided into three categories: power generation, transmission, and distribution. Utilizing both the Monte Carlo method and the total probability calculation, the researcher evaluates the dependability of the power producing system. The calculation was considerably streamlined in order to keep the reliability index near to the desired value.

3.Classification using a model of evaluation:

Deterministic and stochastic models can also be used to categorize studies on risk assessment in the power system. Without relying on historical data, a model of risk assessment for typhoons based on a measurable index has been presented. However, combining historical data with simulation was necessary since history data contained the potential under comparable circumstances, which could foretell the contingency. To obtain the average impact of the simulation findings directly from the wind map, a probabilistic model was put forth. The accuracy of the wind map, however, could not be guaranteed because the database was not full. In order to make up for this, it is necessary to use the database of other landmasses or areas with the similar latitude or environmental factors for the discontinuity of wind map.

4.Grouping according to power system status

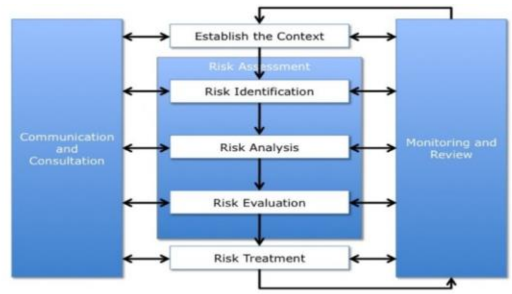
The risk assessment can be classified into static, dynamic, and transient assessments depending on the status of the power system. The motor output probability model was simplified in static risk assessment, and the correlation model was not ideal. The assessment was more accurate and timely thanks to the dynamic procedure. The drawback was that it failed to accurately classify risk since it divided the risk interval on average. The risk should be categorized in accordance with its mathematical distribution. The transient evaluation method increased the safety of wind power operation. However, the system's overall stability could not be achieved, and there was a significant computational cost. . Utilizing the risk theory, utility theory, and Monte Carlo method, a risk assessment methodology was developed. The fact that three risk indicators were identified was advantageous. As a result, the outcome was more complete than a single risk signal. The drawback was that the possibility of two or more wires short-circuiting at once was not taken into account.

5.Sorting based on time

According to time, the risk assessment can be divided into short-term and long-term assessments. A. T. Degaetano provided a short-term prediction model of line icing using the improved Ramer precipitation algorithm. The prior model's flaws, which overestimated the icing, were fixed by this one. The results were unstable, which was a drawback.

6.Simulated classification algorithm

Using the Monte Carlo approach, the consequences of cyclone monitoring and prediction errors on a storm model were examined. The sample was too tiny, which had the drawback of leaving no room for persuasion. It will be important to investigate what data the customers find most helpful in the future. The probabilistic storm model and simulation of the data were established using a simplified sequential Monte Carlo approach. It successfully illustrated the effects of disaster. However, it condensed the input data using the empirical model. As a result, the model's accuracy was Comparison of risk assessment techniques for power systems.



IV . COMPARISON OF RISK ASSESSMENT TECHNIQUES

There are two types of risk assessment techniques: deterministic and probabilistic. The reliability level of the system under the anticipated fault was studied using the deterministic technique.

It cannot account for the risk of accidents and was only effective for fault categories with fewer defects. The results of probabilistic methods were more thorough than those of deterministic approaches, and they were used to determine the probability of various events using risk indicators and various statistical variables.

V. RISK EVALUATION

These days, as the electric power system becomes more intelligent and complicated, its uncertainty also grows. The assessment and control of the power system's risks are now faced with new difficulties. Since over 50 years ago, approaches for determining the risk of a power system have evolved from deterministic to probabilistic, local to global, simple to complicated research methodologies. However, the power system risk assessment has its own unique traits and relative independence.

RISK MANAGEMENT DUE TO THE VOLTAGE LEVEL

The EDS is made up of local systems (0.4-24 kV) and regional systems (>24 kV). In terms of operation, risk management, and network planning, these systems vary considerably. Regional systems emphasise specific components (such as electricity transformers) and the N-1 criterion, which is sometimes augmented by probabilistic measures, whereas local systems emphasise dependability (such as SAIDI) and volume. (number of customers).

While regional distribution systems adopt a more forward-thinking strategy, pondering what would happen if the system remained in its present state, local systems use previous outages as a crucial input for project selection. Local delivery networks are typically operated radially, but this is not always the case.

Fortum Distribution employs three types of risk management for its EDS, depending on the voltage level:

S.no	Voltage level	Range
1.	Low Voltage (LV)	0.4kV
2.	Medium Voltage (MV)	1.0 - 24kV
3.	High Voltage (HV)	>24kV

We use a high voltage distribution method in India.(HVDC).

3. HIGH VOLTAGE DISTRIBUTION SYSTEM (HVDS)

In the HVDS project, lengthy LT mains are transformed into 11 kV mains by building the proper capacity distribution transformer as close to the end as possible, and the supply is then given to the consumer at the right voltage level. These lines can be converted to HVDS, which will dramatically minimize the technical losses in the LT line and allow for a 28-fold reduction in the current flowing through the lines.

Reasons of higher losses:

i) poor quality equipments

ii) low power factor

iii)Lengthy distribution lines

iv) Too many stages of transformations

v). Transformer Losses

VI. RISK DUE TO DISTURBANCES IN POWER QUALITY

1. Type of power quality disturbance:

1.1 Voltage Sag

The voltage sag, which normally lasts between 0.5 and 10 rounds inside the customers' premises, is the most prevalent type of power quality disturbance. Line to line (LL), line to ground (LG), three phase to ground (LLLG), and double-line to ground (LLG) faults are among the short circuit faults that are frequently associated with it.

1.2 Voltage Swell

It is too closely tied to the energy system's short track faults. In a (LG) fault, the swell is produced at non-fault levels whereas the sag may be produced at the location where the fault occurred. It can be done by switching off and re-energizing a large capacitor bank or a large load .

1.3 The interruption

The supply voltage was lost for the duration of the interruption, which was no more than one minute. The voltage supply could be 10% less than what it is supposed to be. The effects of interruption and system failure include energy device problems and manage features.

1.4 Harmonics

Its currents can have sinusoidal voltages or frequencies that are integer multiples of the fundamental frequency (50 or 60Hz). Particularly responsible for this are nonlinear loads like inverters, rectifiers, and various static energy conversion systems.

1.5 Transients

In strength devices, the transient is recognised as an unwelcome and temporary event. It can be classed as oscillatory and impulsive. The oscillating temporary and heavy load, along with the capacitor financial institution's on/off switching on/off, produced the transient. Impulsive temporary is the term used to describe the temporary that typically follows a lightning strike.

1.6 Voltage flickers

The flickers are organized deviations from the supply voltage boundary or a series from a random voltage difference, whose importance does not exceed 0.9 to 1.1 pu. The term "fluctuations" refers to the voltage perversions caused by the constant and rapid accounting inside the load. While fluctuation is an unwelcome result of some loads' inconsistent voltage, it is an electromagnetic phenomena. Every phrase has an equivalent meaning according to standards..

1.7. Variations in Power Frequency

It is well known that its particular titular amount is perverted inside its fundamental frequency (60 or 50 Hz). Due to a mismatch between the generation and load, there is a modest version at frequency.

VII. HARMONIC ELIMINATION TECHNIQUES

By putting a filter at the load end, harmonic contents can be kept below a safe level to prevent harmonics from impairing the functioning of delicate equipment. Installing filters at the point where distinct loads are connected in two different ways in the power system network is the simplest technique to get rid of harmonics of various orders.

7.1 Connected Filters in the Series

These filters have a series connection to the power grid and provide high impedance at turning frequencies. Filters' high impedance makes it possible to pass a relatively small number of harmonics. Series filters have the disadvantage of being expensive due to the requirement for filter components with full load current ratings.

7.2 Shunt-connected filters

It gives a very low impedance path to harmonics and is one of the most widely used filters in A.C. power system networks. Shunt connected filters are less expensive than series connected filters because they are built with graded insulation levels, which lowers the cost of the component parts.

7.3 Passive Filters

These circuits, which give extremely high or low impedance at tuning frequency, are LC resonating or parallel resonating circuits. These filters have three different characteristics: resistive at tuned frequencies, capacitive below tuned frequencies, and inductive above tuned frequencies.

7.4 Shunt Active Power Filters

Shunt active power filters are based on voltage source inverters (VSI) have been used recently. Shunt active power filters work on the basis that a current source generates current harmonics. This theory applies to any sort of load that is regarded as a harmonic source since these components are equivalent to the amplitude of current harmonics and opposite in phase.

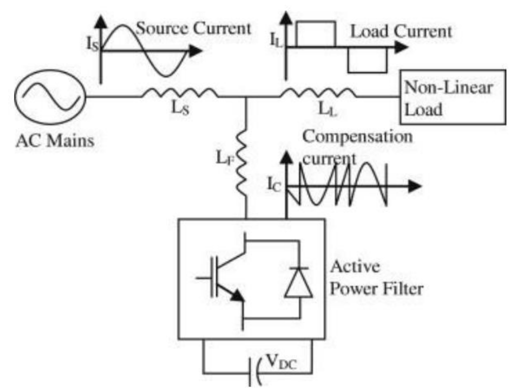


Fig 7.1 Shunt active power filter

Using a matching transformer, it is possible to regulate the end voltage of the load or line and eliminate voltage harmonics. Electric companies can implement it using line impedances and passive shunt compensators to adjust for voltage harmonics and dampen harmonic propagation caused by resonance.

7.5 Series Active Power Filters

Figure 7.5 depicts the fundamental block layout of a series active power filter. It is linked in series with the mains before the load to decrease voltage harmonics, regulate the voltage at the load or line's terminals, and perform other tasks. Electric companies can implement it using line impedances and passive shunt compensators to adjust for voltage harmonics and dampen harmonic propagation caused by resonance.

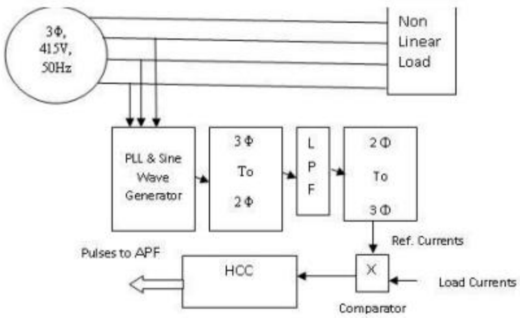


Fig 7.2. Series active power filter

VII. SIMULATION ILLUSTRATION OF ACTIVE POWER FILTERS

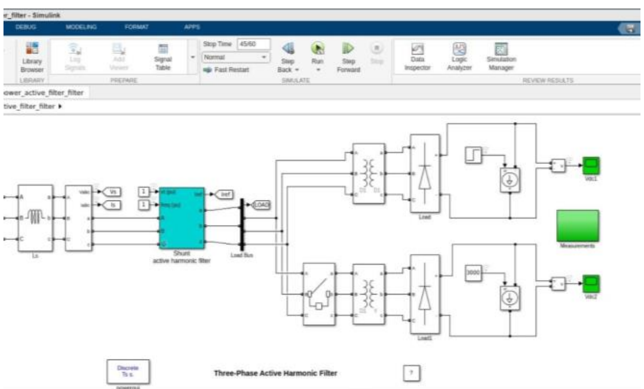


Fig. 8. Three phase active harmonic filter

IX. SIMULATION RESULTS

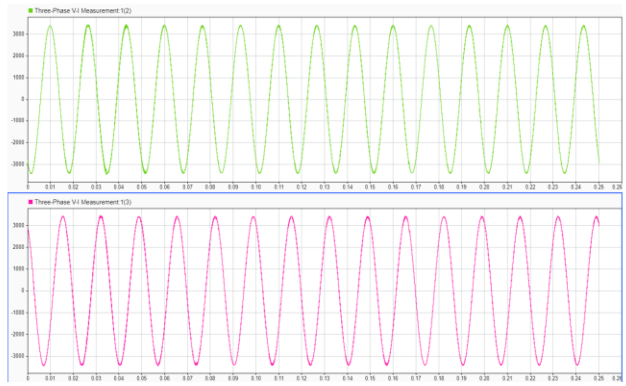


Fig. 9.1. Source voltage and current

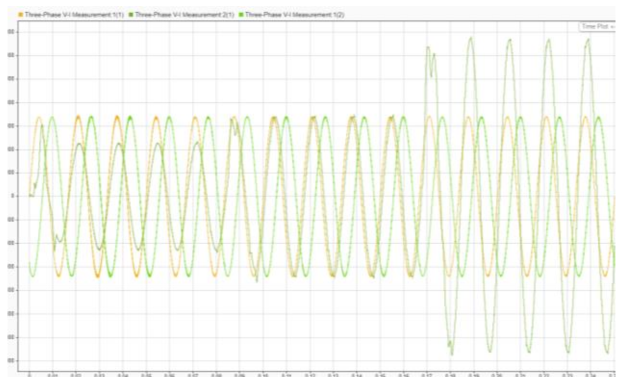


Fig. 9.2. Simulation of waveforms for unbalanced compensation. Phase to neutral voltages at the load terminals before and after the series compensation

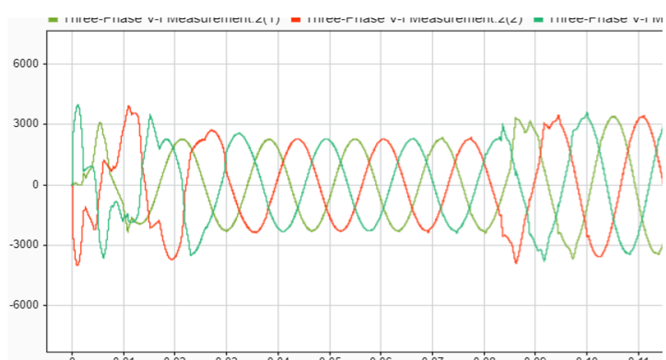
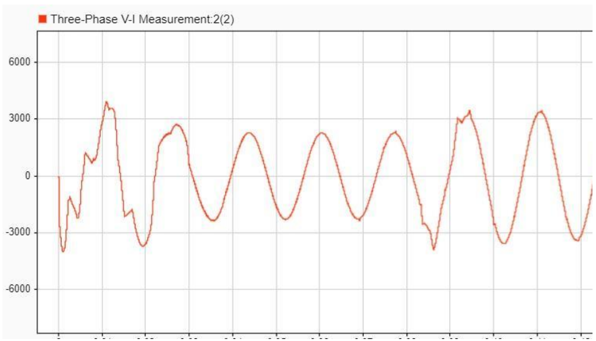


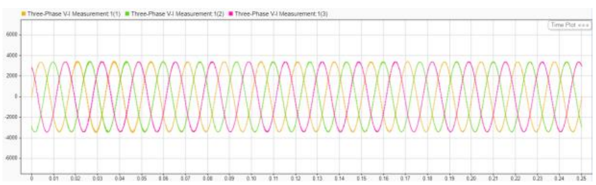
Fig. 9.3. Harmonic current for compensation of line currents flows to the ac mains before and after compensation

Fig. 9.4 The results of Simulation for unbalanced voltage and harmonic of current before and after compensation.

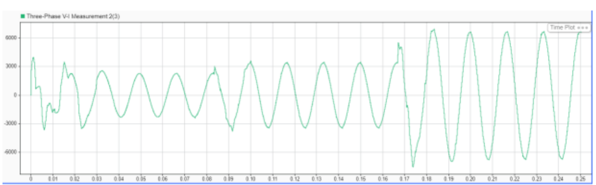
a) Neutral current of AC mains.



b) Phase to neutral load voltages.



c) Line current of AC mains.



X. CONCLUSION

The paper describes the various outcome categories that are important in the general risk picture and highlights some of the numerous facets of distribution system risk assessment.

Companies must gain expertise in implementing risk assessment methods to this area of business because the use of holistic risk analyses in distribution system asset management is still in its early phases.

The benefits of using active power filters in compensating power delivery networks are discussed in this essay.Shunt, series, and parallel circuit fundamentals Furthermore, the present state of the art in the active power filter industry has been briefly described. The effectiveness of a shunt active power filter in a faulty power delivery system was examined. The effectiveness with which active power controllers compensate for active power.

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