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MiPower™

Empowering Power System Engineers

Power Transmission and Distribution System Analysis Software Suite

POWER RESEARCH AND DEVELOPMENT CONSULTANTS NEWSLETTER

Quarterly Newsletter

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Inside This Issue

Editorial Board

From MD's Desk

Dear Friends,
The recent grid collapse in the Indian power grid affecting the northern region on July 30th and again the entire NEW grid on July 31st have resulted in major steps being taken by the generation and transmission utilities to have a re-look into their planning, operation, protection and control of the power system. The question being raised is: why such a catastrophic incident occurred, when we have sound system planning principles, operational procedures and guidelines, sophisticated SCADA system and above all, the protection systems in position. Post mortem analysis of such incidences generally has, in the past resulted in passing on the buck or indulging in blame game rather than finding the real root cause, so that corrective actions could be taken to avoid the repeat of the incidents in future. In this issue, I thought of discussing the major steps that we need to take immediately to avoid such recurrences in future. The steps to be taken should be carefully studied rather than taking some adhoc measures for the sake of compliance to the findings of the post mortem report of such grid disturbances.

The first aspect to be looked into is the planning of STU and CTU systems as per the planning guidelines in vogue. In the 11th plan, about 54,000 MW of generation capacity has been added in the Indian power sector. However, the amount spent on the transmission system development during the same period by the CTU and STUs appears to be inadequate. Besides, many of the merchandised power plants are availing the short term open access and selling their power rather than having long term contract with the distribution companies or even developing their own transmission system for power evacuation. Even though the short term open access will better utilize the existing transmission infrastructure, required system strengthening will not be forthcoming in this arrangement. In many of the STUs, due to various reasons the substations are commissioned at a faster pace as compared to transmission lines. Unless the transmission network is strengthened at both higher and lower voltage levels, merely constructing substations with LILO of the existing lines will not help. Wherever the right-of-way is a problem, the line loading can be enhanced by suitable dynamic compensation and application of series FACTS devices. It is apparent that the cost incurred in the additional lines is always higher with the attendant obstacles in statutory clearances as compared to enhancing the power handling capacity of the existing transmission corridor by deployment of FACTS devices. The purpose of providing the dynamic compensation is many fold viz., voltage control, enhancing the system stability, mitigating the low frequency power oscillations, static and dynamic system security enhancement, increasing the power transfer capability of the transmission lines to name a few. The quantum and location of the dynamic compensation should be studied through load flow analysis during light load and peak load conditions, various load generation balance conditions, system contingencies and also transient and dynamic stability studies considering system disturbances.

The second aspect to be looked into is the operational studies based on the SCADA system data. Sincere efforts should be made to upgrade the EMS functions running with reasonable accuracy in the load dispatch centers. The outage management software used for the system maintenance should be linked to the real time system data and unless the system security standards are met, no outage should be allowed. Even if the outages have to be taken, the curtailment in the load/generation should be clearly indicated and implemented.

The third and the foremost exercise is to conduct the independent protection audit of the entire system, not just few substations. The protection audit should be a holistic approach and include the verification of the relay settings rather than mere collection of the protection data from the substations. Based on system studies, special protection systems (SPS), if required should be designed to take care of eventualities. Controlled system separation relay settings, under frequency load shedding relay settings and generator under frequency relay settings should be carefully coordinated. It is advisable to prepare the protection manual containing the protection philosophy for different voltage class of substations and lines, the type of relays to be deployed, the setting principles to be adopted etc.

PRDC is happy to announce that with its vast experience, we are geared up to help the utilities in the system planning and operational studies, set the EMS functions up and running and also participate in the protection system audit.

I wish all the readers, their family members, relatives and friends happy and prosperous new year 2013.

Dr. R. Nagaraja
Managing Director

Technical Article

IDMT Co-ordination at Transmission Level for an Inter-connected Industrial System

Nitesh Kumar D.

1. Introduction

Relay co-ordination at transmission voltage level involves a greater level of complexity as the network consists of number of feeders interconnected to form a grid system along with interconnected generators and loads. The co-ordination has to be selective enough to only isolate the faulty section without affecting the interconnected generators and loads, as also clearing the fault within the critical clearing time of the interconnected generators. In a small industrial system this is generally achieved by the use of instantaneous element in the relay (to clear within critical clearing time of generator). However co-ordination at transmission voltage level, use of instantaneous relays can lead to spurious tripping as either sufficient fault current discrimination will not be available and/or setting of appropriate pick up value and operating time will be difficult considering the line lengths, various interconnections and fault impedance that can be involved.

Considering the above factors, the primary protection on transmission lines will be distance relays which are distance sensitive and clear the fault at pre defined operating time for a fault in respective zone. In order to guarantee isolation of faulty section, back up protection is provided in the form of over current (IDMT) co-ordination. The present article deals with issues concerning with IDMT co-ordination in the transmission system.

2. Issues Related to IDMT Co-ordination

Generally in a transmission system (utility network), IDMT relays are only provided as backup to zone two protection of distance relay and no co-ordination is carried out with adjoining IDMT relays. This is due to the fact that IDMT co-ordination will not be possible, considering that the starting and ending point of coordination cannot be determined for a utility network. However while dealing with industrial system, this problem does not exist and it is possible to co-ordinate IDMT relays for transmission lines. Some of the critical issues that arise during IDMT co-ordination for industrial system are as follows –

- In an event of fault, the current flowing through the relay will vary significantly depending on the fault location and fault in-feed. This can possess significant co-ordination problem and can be overcome by making the relays directionally sensitive. Reference [1] highlights the difficulty in using non directional over current relays in transmission system.

- The fault contribution from a given section of line will vary depending on the network configuration at the instant of occurrence of fault, i.e. whether if any of the line is taken out for maintenance.

Therefore the relay co-ordination has to be carried out such that co-ordination exists even during N-1 contingency and also considering high impedance faults.

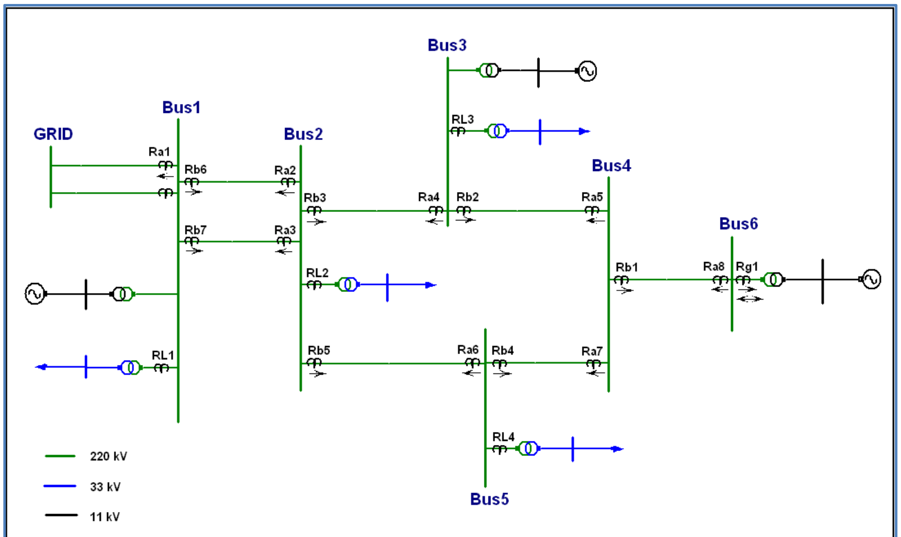


Fig 1: Sample System under Consideration

3. Methodology

The primary protection for transmission network is distance protection and IDMT is only used as back up protection and hence IDMT should operate only in case the primary protection fails to clear the fault.

Due to various errors that can be involved in distance measurement by the relay, distance setting is generally given such that the complete protection of the line is obtained by use of zone 1 & zone 2 [1] and hence the setting of IDMT relay is to be done such that its operating time for a remote end fault is after zone 2 operating time (which is generally 15 to 30 cycles [1]).

To ensure proper coordination of IDMT relays even during N-1 contingency, the relays on one section of the line can be coordinated while considering the other section to be out of service. This ensures that coordination is achieved at maximum fault current point and hence coordination during N-1 contingency and also during high impedance faults can be assured.

4. Sample Procedure

While carrying out co-ordination at transmission level for an industrial system, which is connected to grid at one point (consider sample system as shown in fig 1), the relays can be grouped into the following two categories in order to simplify the process of co-ordination.

- **First category** – relays looking towards the grid (Ra1, Ra2 up to Ra8).
- **Second category** – relays looking into the plant (Rb1, Rb2 up to Rb7).

Before starting co-ordination for transmission lines, the relays RL1 to RL4 (designated as load side relays) are considered to be properly co-ordinated with the downstream relays.

Co-ordination can be started from relay Ra1 by selecting a Time Multiplier Setting (TMS) such that for a fault at remote end of the line its operating time is after the operating time of the zone-2 distance relay. Setting for relay Ra2 and Ra3 can be arrived by co-ordinating (time discrimination of 300 ms [2]) it with Ra1 for a close in fault at Ra1 considering the other parallel line to be out of service.

For co-ordinating relay Ra4 and Ra5, lines from bus2 to bus5 and bus5 to bus4 is considered out of service. Relay Ra4 is now co-ordinated with Ra2 for a close in fault at Ra2 and relay Ra5 is co-ordinated with Ra4 for a close in fault at Ra4. An initial setting for relay Ra8(1) is arrived at by co-ordinating it with Ra5. On similar lines relays Ra6 and Ra7 is co-ordinated by considering line from bus2 to bus3 and bus3 to bus4 to be out of service. Relay Ra8(2) is again co-ordinated with relay Ra7 for a close in fault at Ra7. The setting for relay Ra8 is fixed by considering Ra8(1) and Ra8(2), which ever of the two is greater.

Further to have effective co-ordination of relay Ra8 with relay Rg1 on transformer HV side, both non directional and directional relay can be used at transformer HV side. The non directional relay is meant for backup protection for relay Ra8 and directional relay is used as primary protection for fault on transformer HV side, so as to achieve faster operation for close in faults.

The IDMT setting of relay Rg1 (directional) is started with minimum TMS and can be considered as starting point for co-ordination of relays looking into the plant. Relays looking into the plant (Rb1, Rb2 up to Rb7) are now co-ordinated on similar lines by considering one section of line under maintenance as explained above.

During the process of co-ordination, care should be taken that relays RL1 to RL4 (load side relays) are co-ordinated with the respective relays on transmission lines which will pick up for a close in fault at load side relays.

5. Coordination and Validation Using MiPower Software

In order to carry out relay coordination for such a complex system accurately while adopting the above explained procedure, a versatile and user friendly computational tool is required. MiPower [3] software provides protection simulation module which enables the coordination of such system with ease.

The features which can be used for this purpose are as follows –

- The entire system under consideration can be modelled accurately and can be drawn in graphical user interface.
- Short circuit can be simulated at desired location and results plotted on the GUI. This can be used to calculate the close-in fault current for each relay.
- Using the calculated fault currents, the appropriate relay settings can be arrived at.

Relays can be individually modelled and the calculated setting can be given as user defined settings. These can be simulated using the relay coordination module and the validation of settings can be done. The following tools are available for validation of calculated settings.

Protection Simulation –

In this, fault is created at desired location and the relays which pickup along with their respective operating time is displayed on the GUI, as shown in fig 2.

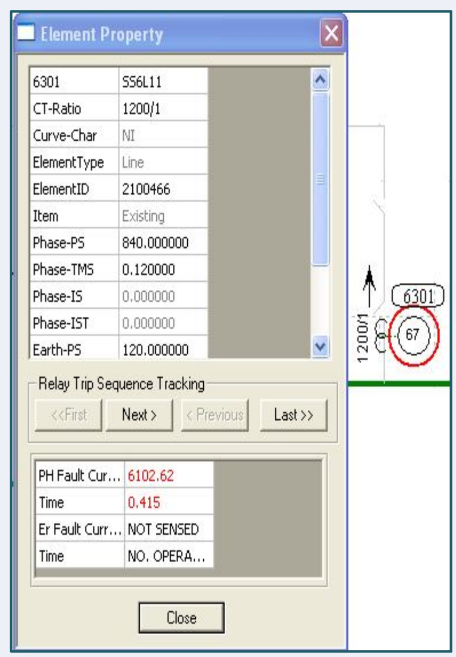


Fig 2: Protection Simulation Result

This enables to validate the appropriate discrimination time. Also different contingency cases, as discussed earlier can be simulated and results validated.

Relay Characteristic Curve – In this, the relay characteristic curves of all the primary and backup relays can be plotted on a single graph. If no two curves intersect each other within the maximum fault current point, then coordination can be assured even for high impedance faults. Also curves can be normalized to obtain the actual coordination in case of systems having multiple fault feeds. The relay coordination for the sample system considered is as shown in fig 3.

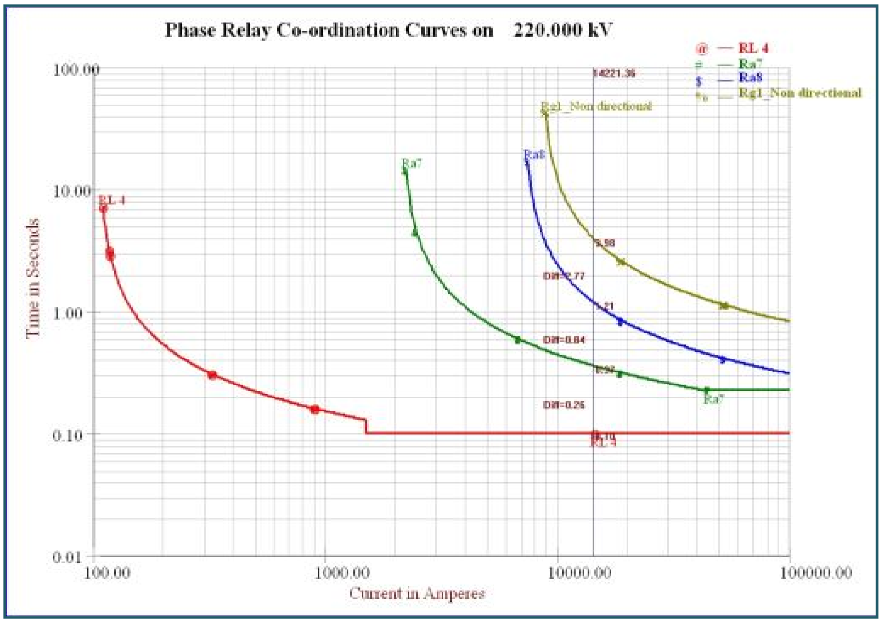


Fig 3: Normalized Relay Coordination Curves

6. Conclusion

The article highlights issues related to IDMT co-ordination at transmission level and a brief methodology that can be adopted to overcome these issues is presented. Further it also highlights the primary protection for transmission system based on impedance (or admittance) and the mechanism of back up protection using IDMT relay along with simulation.

7. References

[1] IEEE guide for protective relay applications to transmission lines, IEEE std. C37.113-1999

[2] IEEE recommended practice for protection and coordination of industrial and commercial power systems, IEEE std 242-2001

[3] MiPower Version 8.0-2012, user manual, PRDC Bangalore

Cyber-attacks and Cyber Terrorism

The Computer Emergency Response Teams (CERT-In), have been set up by the Power Ministry. The Ministry has constituted CERTs for Thermal, Hydro and Transmission, with their nodal agencies being NTPCBSE -2.44 %, NHPCBSE 1.32 % and Power Grid, respectively. These teams have been constituted to "take necessary action to prevent cyber-attacks on the utilities under their jurisdiction". Indian Computer Emergency Response Teams (CERT-In), under the Ministry of Communication and Information Technology has prepared a Crisis Management Plan (CMP). The plan is for countering cyber-attacks and cyber terrorism for preventing the large scale disruption in the functioning of critical information systems of government, public and private sector resources and services.

Courtesy: *Indiainfoline.com*

Consultancy Services Rendered

Protection Review Study for FIJI Power Network

Fiji Electricity Authority (FEA) is undertaking investments to upgrade Fiji's generation and transmission systems to meet future demand. In line with the requirement, comprehensive power system analysis has been carried out by PRDC and detailed recommendations were made. As part of the analysis, protection review study was carried out which will facilitate FEA to determine its power system requirements to compliment the physical structure of the network and provide the level of reliability and stability required.

In this project, power system network was represented from 3.3kV to 132kV. Power system analysis studies were comprehensively carried out. Studies included load flow analysis, short circuit, transient stability, relay coordination and unit protection. A detailed protection manual was prepared.

Network Analysis was performed for combination of various operating scenarios and availability of hydro and diesel generation- like peak hydro- low diesel generation, low hydro- peak diesel generation etc. Based on detailed analysis, network losses, voltages at buses and loading of lines were found out and necessary recommendations were given. Stability studies were also carried out at important network locations like three phase fault at 132/33 kV transformer, three phase to ground fault at 33 kV S/C line etc. The critical clearing times were found out at these important locations.

Entire FEA power system network's protection systems of Over Current, Earth Fault, Restricted Earth Fault, Transformer Differential, Line/Cable Differential, Distance protection and Generator protection were modeled. Based on the detailed studies, relay settings have been reviewed, and new settings were proposed. Under frequency load shedding relay settings were reviewed and in line with international practices, under frequency based load shedding schemes were developed and appropriate relay settings were given.

Further, eight typical 11 kV feeders were analyzed and methodology for relay co-ordination, including fuse - fuse, fuse – relay, relay - reclosure coordination, was developed for these feeders. Few tripping events were analyzed and reasons behind multiple trips were listed. Recommendations included proposal of directional over current and distance relays, new generic type of recloser and revised relay settings. After detailed analysis, recommendation was made to replace old electromechanical relays with the state of the art numerical relays having disturbance recording and communication facilities. A budgetary estimate to replace the existing electromechanical relays was given. A phase out plan, spread over a period of five years, for old relays sub-station wise was prepared. As part of the capacity building to the FEA engineers, PRDC has conducted training program on power system studies along with power system protection. The latest trends and developments in each protection schemes were explained along with the detailed sample calculations for all types of protections. This will help engineer's understanding and acquaint him/her with all the parameters considered and basis for relay settings. A detailed protection manual was prepared which elaborates the procedure to be adopted to incorporate the relay setting changes with proper password protection and basis for change in relay settings. It also recommended changes in the existing report format to bring in adequate information like sequence of relay operation, for the management to understand the incidence of fault and the follow up actions to be taken. The format for reporting a tripping incidence was also specified in the protection review report.

Dynamic Analysis of TYPE-A Wind Farm

In just a few decades wind power has developed from an alternative energy source to a new fast growing generation sector. Wind power plants have a positive impact on the global and regional environment. Today wind power plants produce electric power at a very competitive cost and contribute to a large share of power in many countries.

When it comes to Asia, India was the first country to develop wind power on a commercial scale. Most of the wind turbines in wind farm sites are squirrel cage induction generator (SCIG), this type of WTGs (Wind Turbine Generator) has been a workhorse for wind industry for decades. It has an inherent torque-speed curve that fits the wind turbine application quite naturally and also the over speed variation are quite small hence when SCIGs are used, it is referred to as TYPE A WTG. Apparently the major problem with this type of generators is the reactive power compensation for its excitation in order to generate the active power. This is greater disadvantage if the POI (Point Of Interconnection) of wind farm is a weak grid (electric transmission system with high rates of electrical deviations or in other terms a minimal fault level due to lack of system strength). This reactive power consumption leads to increased transmission and distribution loss, poor voltage profile, overloading and reduction of T&D equipment.

The active power and reactive power due to the WTGs will affect the voltages on the network as current flows through the network impedances. For weaker networks the effect is more acute. Wind farms in earlier years were of small capacities and hence did not affect the strong grids as much was fed by conventional power plants. Currently wind power has penetrated to the power system network to a significant percentage. Apparently when a large wind farm (TYPE A WTG) is integrated to a weak grid and if a small voltage oscillation/disturbance is observed at transmission network or even for an internal fault, then it leads to a drastic variation in voltage at the wind turbine leading to shut down of the turbine. This operation leads to very large quantity of power interruption accumulating to noticeable commercial loss.

One such problem was noticed in a wind farm in Jaisalmer region of Rajasthan and study was taken by PRDC to understand the root of present or future problems and to recommend a feasible techno-economic option. To find out the root cause of problem, detailed dynamic analysis was carried out. To analyze the problem, the complete wind farm was modeled along with SCIG model in MiPower software. The simulation was conducted by integrating with the complete state transmission network.

The highlights of the study was,

- Considering the various operating condition, a detailed dynamic analysis was conducted with dynamic compensator model in MiPower.
- SVC/Statcom sizing.
- Dynamic studies have been conducted to identify the size and location of dynamic VAR compensation to mitigate the voltage fluctuations at the wind farm with various commissioning stages of transmission network.
- SVC specification was provided with suggestion to connect SVC at the pooling point (PCC)
- Further it was also noticed that the problem would be reduced with system strengthening which would improve short circuit level. Hence it has been suggested at design stage to incorporate a provision for shifting these compensators to other needy places.

Load Forecasting for BRPL

Following the privatization of Delhi's power sector and unbundling of the Delhi Vidyut Board in July 2002, the business of power distribution was transferred to BSES Yamuna Power Limited (BYPL) and BSES Rajdhani Power Limited (BRPL). These two of the three successor entities distribute electricity to 28.34 lakh customers in two thirds of Delhi. The company acquired assets, liabilities, proceedings and personnel of the Delhi Vidyut Board as per the terms and conditions contained in the transfer scheme.

The exercise of demand forecast becomes a vital factor for the utilities and is the basic input to the planning exercise. Demand forecast is also critical for financial planning and tariff filing. Growth in the demand is dependent on various factors including economic factors and policy variables such as Gross Domestic Product, Per Capita Income, Population, Industrial Production etc.

As power is one of the key-contributing factors to the economic growth and growth of other allied sectors, unrealistic forecasts can hamper the growth or disrupt meticulously planned policies of the Government in achieving the targeted growth of the State as well as the Country. Hence understanding the significance of the forecasts and the effects of unrealistic forecasts of demand becomes necessary.

The long term demand forecasting is used for capacity planning, strengthening of the T & D network, firming up for fuel linkages etc. It is a universally accepted business practice among utilities across the world to carry out demand estimations for the future. This task has been assigned to PRDC.

Energy sale forecast for all the categories has been carried with the following forecasting techniques:

- Trend Analysis
- Multi-Variable Regression
- CAGR

The division wise data is further consolidated together to arrive company wise data. Forecasting has been carried out for both at divisional level (category-wise) and company level (category-wise). The main objective behind this is to arrive at the forecasting figures using different approaches and then converge on the finalized forecast figures.

Comprehensive RE Development Study

PRDC has carried out technical study for comprehensive RE development in Tamilnadu for WISE. This project is funded by Shakthi Foundation along with CII and TEDA.

The report was presented to all the stakeholders through the workshops held in August 2012 and October 2012. Based on the feedback, the final report was released on 27th December 2012 with the presentation by WISE on the overall action plan and also by PRDC on the technical requirement.

PRDC'S Automated Fault Analysis System (MiFAS) - A 4000 Ft View of System Architecture

Range Gowda M. and Veena R. J.

1. Introduction

Faults in Power Systems are inevitable. Faults not only cause physical damage to the equipment due to their severity, but halt the power flow which in economics, is a loss proportional to time of outage. MiFAS aims to bring down this loss and improve the reliability of the system. At control centers, large amount of data is available which needs to be analyzed in order to better understand the system performance. If all this data is to be manually analyzed, the time taken is quite considerable while not guaranteeing accurate results. MiFAS assists the system operators in understanding the behavior of the protection system. This plays a vital role in preventing large outages.

2. MiFAS - Approach to Improve Power System Engineer's Insight

MiFAS aids the power system protection engineer to have:

• Consistency in analysis: All analyses are performed by computers nullifying variations due to human interpretation.

• Reduced time for analysis: Computers take less time for calculations as well as sequential analysis.

• Reduce expenditure: Frees up manpower for more complex analysis.

MiFAS is developed to reduce outage duration in the system by:

• Efficient utilization of resources and data, minimizing the need to install new hardware.

• Improving system operation by reducing the downtime during outages.

• Optimizing utilization of manpower by completing mundane, repetitive tasks.

• Supervision of the protection system to improve system reliability.

MiFAS provides assistance in operation, maintenance and protection.

Assistance in Operation:

• Location of the fault helps reduce outage time.

• By ensuring the adeptness of protection system, maximum part of the system may be kept in service.

• Reports help recognize faulted components and sections to be isolated even when primary protection fails.

• Auto-reclosure status helps determine corrective action to be taken by the operators.

• Time taken for analysis is reduced.

Assistance in Maintenance:

• Quick identification of components that need to be replaced or inspected.

• Time of outage is reduced by giving them accurate information regarding the faulted equipment.

• Helps to make optimal use of available personnel by tackling more severe faults first.

Assistance to Protection Engineers:

• Aids in determining the adequacy of protective actions taken.

• Identifies components that fail to act or mal operate.

• Verifies settings of various protection equipment.

• Helps in reducing the time taken for the analysis.

The additional features of MiFAS are:

• Provides system overview to the engineers at control room. The values of Fault clearing time, Auto-Re closure, Mal operation of relay, etc will be given on the user interface.

• Handles CT/CVT Saturation, failures, etc. and also assess protective scheme under various conditions like load throw off, load encroachment etc.

• Since Data will come to MiFAS at the local time from widespread areas, MiFAS will have a GPS based clock to synchronize all data to one timeline

• Electrical quantities as seen by the relay can be reproduced on demand.

• Fault will be classified based on their severity, helping maintenance in case of multiple faults in the system.

• Correction steps to Engineers shall be given by MiFAS if available.

• Due to huge amount of data to be handled, MiFAS will act as recorder of critical events so that power engineers can analyze and evaluate the system condition.

• Reports about results and state of the system can be generated on users demand in standard formats.

• MiFAS will perform analysis of critical events depending on region it covers. The different level of analysis are Unit Level, Bay Level, Station Level and System Level

• MiFAS will be customized to its level, for example MiFAS for transformer will take care of phenomena associated with it like Inrush, construction, protection scheme used etc. The analysis is intended to provide a better solution under fault conditions.

• MiFAS will conduct its analysis based on the standard methods.

• MiFAS will be customized to the user, maintenance crew will have more of the directions or procedure indicator system, and power engineer will have the more analysis options. Control centers will have a huge database to store more critical events

• MiFAS will have modular structure to facilitate expansion of functions and integration to SCADA, web-based app, SMS alerts, email etc.

3. MiFAS Information POV (Point of View)

MiFAS is initiated when a COMTRADE file is generated from relays or data recorders from different location, types and proprietors.

The software is designed to perform the following:

• **Fault Detection:** MiFAS is used at the control centre, the output provided by the Fault detection is by processing the COMTRADE files of each relay through a rule based expert system.

Power engineer's benefit as MiFAS not only acts as back up to protection gear in the field but also evaluator of condition of the same.

• **Fault Classification:** Classification provides the engineers information about the type of fault which in turn indicates the severity of fault, also gives the system reliability. Classification of fault is also through an expert system rule sets.

• **Fault Location:** Detection of fault, poses the next important step i.e., the location of fault, which is of paramount importance in transmission network, as maintenance crews have to attend to this as quickly as possible.

• **Relay Operation Analysis:** It is also important from protection engineer point of view to analyze the performance of various equipments. This facility provides the insight of relay operation and highlights if any issue associated with it.

The exchange of data is designed in such a way that it requires as little human interaction as possible. This facilitates efficient use of data and automation. MiFAS demands digital devices to be used, so that the analysis is free from manufacture type and can be multi-sourced (From Digital Recorder or Relays)

4. MiFAS Architecture

MiFAS is developed with a multitier architecture (Fig:1) using the proven industry standard C, C++, VC++ and MFC which partitions the whole system into distinct functional units like,

Presentation Layer: The user interface is available on machines connected to the system. Reads the results from the database and displays the appropriate information. MiFAS manager acts as the main UI to the user.

Database Layer: This takes care of storing and retrieving all the necessary information related to data and results.

Analysis Layer: This is the core power system application layer wherein all the MiFAS applications are executed and results generated.

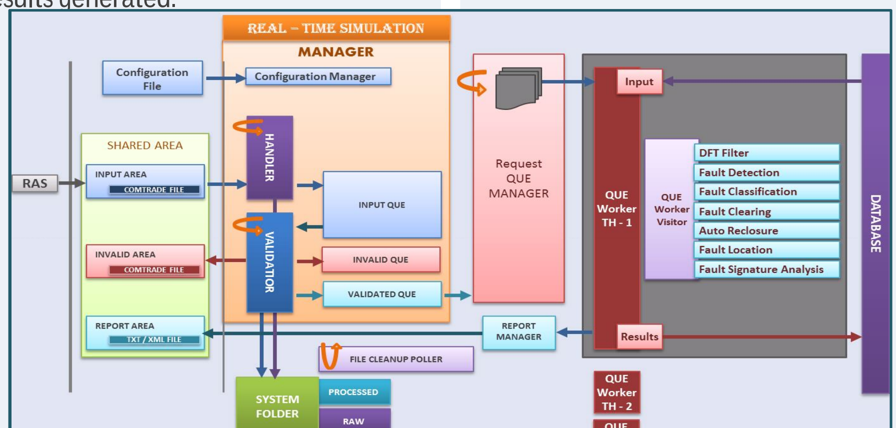


Figure 1: MiFAS Architecture

Above describes the partitioning of the application tiers. The presentation, business-logic, and integration tiers are physically located in the same application and implemented with well-defined interfaces to isolate each tier's responsibility, and maintains the application simple and scalable. All the real time data is collected by RAS and placed in a shared area. The data is in the form of COMTRADE files. Different folders are created to put different information such as input and output. Manager module has various sub modules to perform various activities. It has a configuration manager to read various configuration parameters such as shared area path, output folder area path, database information etc. Manager has process manager modules which will be constantly polling the input folder for any new files. If there are any files, they will be validated and processed. After the analysis of the individual comtrade files, the event identification algorithm determines the total number of faults and groups the comtrade files accordingly to do the further processing. If there is a fault, analysis is performed and results are placed in the database. This is handled by the analysis layer. A report manager is provided to generate and display the reports.

5. MiFAS – Vision and Future Enhancements

• Assisting operators by giving prompt alarms in critical situations

• Modifying relay settings if situation requires

• Suggesting change of devices including relays and circuit breakers.

• Sequence of events for a possible cascaded outage following any event

• Provision to perform real time simulation of an event.

• Determining cause of fault.

• Determination of best possible protection scheme

6. References

[1] T. Popovic and M. Kuhn, "Automated Fault Analysis: From Requirements to Implementation", PES General meeting, 2009, pp 1-6

[2] IEEE Standard Common Format for Transient Data Exchange, IEEE Standard C37.111-1999,1999

[3] M. Kezunovic, C.C Liu, J. McDonald and L Smith, "Automated Fault Analysis", IEEE Tutorial, IEEE PES, 2000

Events and Achievements

Seminar on "Understanding Power System Protection through Simulation" at Qatar

Dr. R. Nagaraja, MD, PRDC conducted a seminar on 'Understanding Power system protection through simulation' in Qatar on 18th October 2012. The event was organized under the auspices of the Qatar chapter of IE(I).

Power system protection engineering deals with precautionary measures to be taken to safeguard the power system during abnormal operating conditions.

The practice of protection engineering involves periodic fault studies followed by relay setting, checking and co-ordination studies.

These studies are necessary in order to ensure that the wide variety of protective relays function correctly with proper discrimination to provide selective isolation of faulty power system equipment.

There is also the need to conduct a detailed post mortem analysis to ensure that the circuit breakers responded correctly to certain system faults. Computer aided tools help the protection engineer to conduct the required studies to arrive at adequate settings and verify the settings through simulation.

Dr. Nagaraja highlighted the importance of simulation and covered various issues involved in protection co-ordination.

Dr. R. Nagaraja, MD, PRDC being honored by the Qatar Chapter of The Institution of Engineers (India)

India Wind Power 2012

The 'Wind Power India 2012' conference was held during 28-30, November 2012 in Chennai. The conference was organized by Indian Wind Turbine Manufacturer's Association (IWTMA), World Institute of Sustainable Energy (WISE) and Global Wind Energy Council (GWEC). The conference was inaugurated by Dr. Farooq Abdullah, Hon'ble Union Minister of New and Renewable Energy. The conference comes at a time when the wind sector is poised to reach an installed capacity of over 18,000 MW. The conference themes covered a wide range of inter-disciplinary topics and they gave significant focus on the global issues of climate change highlighting wind energy as a sustainable solution for growth. The conference was attended by developers, investors, policy drivers, regulators, financiers, researchers, academicians and consultants.

Dr. R. Nagaraja, Managing Director, PRDC gave a presentation on 'Need for proactive action plan for grid augmentation in states' at the conference.

Dr. Balaraman, CGM, PRDC also delivered an invited talk on 'Green Energy Corridor'. The talk focused on the recent study carried out by POWERGRID to identify transmission infrastructure and other control requirements for Renewable Energy capacity addition program in 12th Plan besides providing a comprehensive report with estimation of capex requirement and financing strategy.

Workshop on “Recent Trends in Control and Protection of Large Interconnected Power Systems”

PRDC organized a One-day workshop on ‘Recent trends in control and protection of large interconnected power systems’ in New Delhi on 31st October 2012.

The workshop was inaugurated by Shri. Alok Gupta, Member (Hydro), Central Electricity Authority. The other dignitaries present on the occasion were Shri. K. Ramanathan, Ex-Member, CEA and Shri Pankaj Batra, Chief (Engineering), CERC and Dr. R. Nagaraja, Managing Director, PRDC. The workshop was attended by more than 120 delegates representing utilities, industries, regulators, consultants and academia. The inauguration was followed with the launch of **MiPower Version 8.0**, an upgraded version of PRDC’s power system analysis software that has advanced features both in modeling and simulation. Another important event of the inaugural function was release of the special issue of PRDC’s in-house Newsletter focusing on **Power System Studies.** This was followed by technical sessions, power system simulation case studies using MiPower Version 8.0 software and panel discussion by eminent power sector experts.

In his first presentation, Dr. Balaraman, CGM, PRDC covered the Planning and Operational aspects of Large Interconnected System. Critical Issues discussed were: Network Capacity Planning, Transmission Line loadability, Constraints in transmission system, Power Transfer Limits, Dynamic and Thermal rating of Over Head Lines and Network Optimization. PRDC’s capability in offering such services was also highlighted. In the second session, Dr. R. Nagaraja, MD, PRDC covered protection aspects of large interconnected power system. He discussed the topics of reliability of power system operation, types of protection, recent trends in protection with specific reference to Phasor Measurement Unit (PMU) and IED. He also accentuated on the need for Automated Fault Analysis System and ended the presentation by emphasizing the need for coordination among all stake holders. Subsequently, Dr. Nagaraja presented various case studies using the simulation capabilities of MiPower™ package. The case study depicting various events of the July 31st blackout of the NEW grid was well appreciated by the delegates of the workshop. Shri. M.M. Babu Narayanan, CTA, PRDC presented the topic of dynamic compensation in power transmission with specific reference to power oscillation damping.

The talk highlighted the need for dynamic voltage and reactive power support. The application of FACTS technology and the opportunities offered by FACTS controllers were presented. Case studies of dynamic compensation and power oscillation damping using FACTS devices were also presented.

The workshop concluded with a Panel Discussion on **“Challenges in synchronous operation of national power grid”** with panelists Dr. S.C. Srivastava, Dy. Director, IIT, Kanpur, Shri Mata Prasad, Ex-Executive Director, NTPC, Dr. R. Nagaraja, MD, PRDC, Dr. S. Mukhopadhyaya, Ex-Chief engineer,CEA and Shri Vasant Mehto, Advisor, MPPTCL. There was a consensus among the panelists and participants on the need to consider all aspects of strengthening the transmission system before a full-fledged national grid is realized by synchronizing the southern and NEW grids. This would help in avoiding recurrence of blackouts such as the northern grid that happened in July 2012.

Our Expertise in Training

Upcoming Events

At PRDC, we conduct various training programmes throughout the year. The duration of the training programme varies from one to four weeks.

One Week Training

We conduct one week training programme on MiPower. It's a Standard Course.

MiPower Training Level 1

Level 1 is a training programme on basic theory & simple problems (hands-on).

Level 1 Batch:

1. 7th Jan 2013 to 11th Jan 2013
2. 11th Mar 2013 to 15th Mar 2013

MiPower Training Level 2

Level 2 is a training programme which consists of only hands-on and solving own system problems, sorting out issues and clarifications.

Level 2 Batch:

1. 11th Feb 2013 to 15th Feb 2013

Short Term Training / Workshop

In addition to the above said programme PRDC is also conducting short term training program and workshops to impart knowledge and practical approach on specific topics, which are of relevance to power engineers in day-to-day works. Such training not only enhances their knowledge but also helps to implement in their regular routine works.

For short term and special trainings contact our marketing team:

marketingteam@prdcinfotech.com

Training Calendar - 2013

Training Schedule of PRDC Training Centre For the Year 2013

Month / Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
January						S	M						S	M						S	M						S	M			
February			S	M						S	M						S	M						S	M				x	x	x
March			S	M						S	M						S	M						S	M						S
April	M						S	M						S	M						S	M						S	M		x
May					S	M						S	M						S	M						S	M				
June		S	M						S	M						S	M						S	M						S	x
July	M						S	M						S	M						S	M						S	M		
August				S	M						S	M						S	M						S	M					
September	S	M						S							S	M						S	M						S	M	x
October						S	M						S	M						S	M						S	M			
November			S	M						S	M						S	M						S	M						x
December	S	M						S	M						S	M						S	M						S	M	

L1 **MiPower Client Training Level 1:** Basic Theory & Simple problems (hands on)*

L2 **MiPower Client Training Level 2:** Only hands on and solving own system problems & sorting out issues and clarifications*.

* **Participants are requested to choose the training as per their need i.e. Level 1 or Level 2**

PRDC PARTICIPATES IN NPSC 2012

The 17th National Power Systems Conference (NPSC 2012) was held at Indian Institute of Technology, BHU, Varanasi during 12th to 14th December 2012. NPSC is a platform, where Utilities, Regulators, Industries and Academia came together to share the ideas about the research happenings and major developments in Power sector. NPSC 2012 was organized with Tutorials, Plenary lectures, Paper and Poster presentations and added with the spice of well organized cultural program. Sessions were arranged in several areas to explore each field in detail. Major areas covered are as follows:

- Power system analysis
- Power system protection
- Power markets
- Power system planning
- Renewable energy
- Distribution systems
- Power electronics and drives
- Special topics in power systems

Contribution of PRDC:

PRDC contributed to NPSC 2012 as a Platinum sponsor for the event. Dr. R Nagaraja, Managing Director, PRDC delivered an invited talk on **"Protection of Large Interconnected Power Systems"** in one of the Plenary sessions. Three technical papers were presented by PRDC engineers at the NPSC 2012. The papers presented are as follows:

[1] Faraz Z Khan, Raghavendra G and Madhusoodana K, "An Overview of Automated Fault Analysis System for Transmission Network"

[2] Veerabrahmam Bathini, R. Nagaraja and K. Parthasarathy, "Guidelines for Selection of Neutral Reactors rating for Shunt Compensated EHV Transmission lines"

[3] Chandrashekhar Reddy Atla, K. Balaraman and R. Nagaraja, " Optimal Short term Hydro Thermal Coordination for Large scale Power system using MILP"

Did you know?

Power Quality and Harmonic Analysis of End User Devices

Among the non-linear loads used in household, Compact Fluorescent Lamps (CFLs) and LED lamps are becoming more widespread, while incandescent lamps are intended to be replaced by these types of lighting devices. LEDs and CFLs are significantly more efficient and economical than incandescent lamps, and are expected to be used in 100% of residential lighting in the future. As nonlinear loads, LEDs and CFLs produce highly distorted currents. A large number of customers using LEDs or CFLs for domestic, commercial and industrial lighting could determine important Power Quality problems. The paper reports experimental measurement results regarding Power Quality in indoor lighting systems. The harmonic absorptions of several types of luminaries are analyzed, highlighting the impact behavior of different lamps function of used luminaries' technologies. The recorded harmonic absorption allows characterizing the harmonic spectrum variability of the investigated lamps.

Source: *Energies 2012, 5(12), 5453-5466; doi:10.3390/en5125453*

National Energy Conservation Day Highlights Critical Role of Citizens in Energy Security

Inaugurating the Annual National Energy Conservation Day on December 14, 2012, Hon'ble President of India, Shri Pranab Mukherjee said that it is worthwhile to note that policies to promote energy efficiency, along with high energy prices and structural changes in the Indian economy towards the services sector have resulted in a sharp decline in energy intensity of the Indian economy. This is a direct contribution of policies to reduce energy use during the Eleventh Five Year Plan period which has yielded 10,836 MW of avoided generation capacity. The President informed the gathering that the nations's demand for energy will double in a short while and the demand for imported energy is likely to increase by 8 per cent annually. Shri Pranab Mukherjee also advocated an equitable and multilateral response to climate change for effective reduction of energy consumption. He added that enforcement of energy conservation policies is critical to climate change.

Source: *Ministry of Power*

India fast emerging hub for wind power gear makers

Wind energy could soon supply 5 GW annually to fight chronic power shortages in the country, according to the India Wind Energy Outlook, prepared by WISE, IWTMA and GWEC. Officially released at the opening of Wind Power India 2012 by the Hon. Minister of New and Renewable Energy Dr. Farooq Abdullah, the report examines the state of the Indian wind power industry, and finds that up to 89 GW of wind power could be installed by 2020, up from current 18 GW. This would attract around $16.5 billion of annual investment to the sector, create 179,000 new jobs and save 179 tons of CO2 annually. By 2030, the installed capacity could reach as much as 191 GW.

Source: *GWEC*

India Solar Power Sector Analysis

India is emerging as one of the leading solar PV markets in the world as the country is blessed with immense potential for solar energy as most of the states have more than 300 sunny days and the specific average annual solar energy yield in India is estimated between 1700 – 1900 kWh per kWp. Indian Solar power has the potential to generate 50,000 MW which would be enough to meet over 5% of power requirement by 2022.

Solar power has emerged as one of the key renewable sources and presents an exciting opportunity for India. In past few years, the solar PV industry has experienced substantial growth primarily driven by favourable policies of central and state governments to support its development.

The Gujarat State Solar Policy and the Centre's Jawaharlal Nehru National Solar Mission (JNNSM) are at the forefront of solar power development in India. As a result, power generation capacities from solar have increased from 20 MW in FY'2011 to nearly 940 MW in FY'2012 and by June 2012 it crossed 1 GW. Most of the installed capacity over 600 MW comes from Gujarat.

Source: *researchandmarkets.com*

ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS LOCATED IN THE REGION OF MAIN LAND AND ISLANDS (30.11.2012)

Region	Gas	Coal	Diesel	Total Thermal	Nuclear	Hydro (Renewable)	RES (MNRE)	Grand Total
State	49933.00	5215.32	602.61	55750.93	0.00	27380.00	3569.92	86700.85
Private	28945.38	6985.50	597.14	36528.02	0.00	2565.00	22286.22	61409.24
Central	41995.00	6702.23	0.00	48697.23	4780.00	9349.40	0.00	62826.63
Total	120873.38	18903.05	1199.75	140976.18	4780.00	39294.40	25856.14	210936.72

Source:cea.nic.in

Blood Donation Camp @ PRDC

As an employee friendly organization PRDC organizes various community building activities. One among them is blood donation camp. For the third time PRDC had organized a blood donation camp on 20th December 2012 which was a success. Many people turned out and the enthusiasm and eagerness among all the donors was fantastic. The camp started on schedule time and finished on time. Total number of blood units collected was 58 units. It's the highest among the earlier blood donation camps.

Dussehra Celebrations @ PRDC

MiP-RE Scheduler

MiP-RE Scheduler

Comprehensive | User Friendly | Easy to Use

Conceptualized by Industry Experts for Renewable energy scheduling as per IEGC Provisions

Increased energy requirement and environmental concerns has made the renewable energy sources as an alternative. Technology advances are opening up a huge new market for renewable power. The share of RE in the energy sector, as on March 2011, is 10.63% of total generation capacity of India. Unlike conventional power plant, renewable sources in particular wind and solar need a different mechanism for scheduling and operation. The issue is more complicated with this distributed sources where the number of owners are high. CERC has taken note of the above and have formulated the mechanism for scheduling and dispatching wind and solar in IEGC-2010. Our product MiP-RE Scheduler facilitates the utilities in scheduling, accepting the schedule and settling the UI charges. The web based product takes into consideration multiple owners and accepts the schedule from each of the pooling sub-station with the provision to revise the schedule, consolidates the final schedule and helps in computing the deviations as per the regulatory requirement.

Product Highlights

MiP-RE Scheduler

Scheduler home page facilitates to

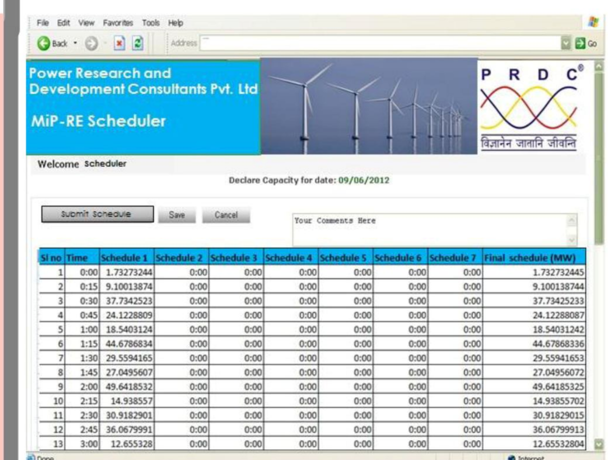
- Submit the schedule as per the requirement for next 24 hours starting from 00:00 hours
- Revise the schedule as per the provisions in the code for the valid blocks.
- Resubmit the schedule.
- Retrieve and view the schedule
- Compare the schedule with the actual generation and frequency, if actual generation and frequency is available.
- Receive the UI statement report

System operator/Designated agency homepage facilitates to

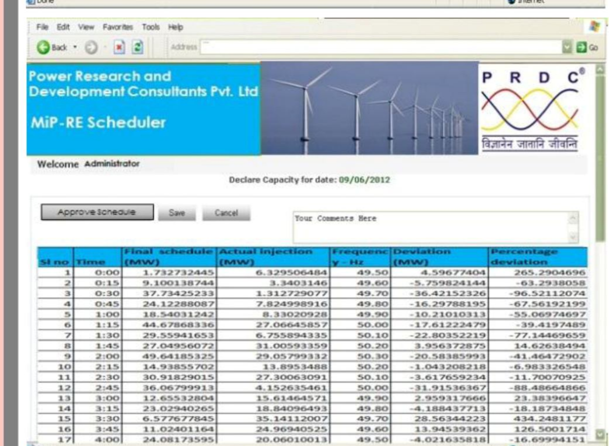
- Accept the schedule as per the requirement
- Accept the modified schedule as per the requirement
- Modify the schedule, if the schedule has come though fax or any other means with proper authorization
- Accept the actual generation against each block from the meter download or from online or from fax etc.
- Actual generation key-in provision if the generation has come via fax with authorization
- Accept the actual system frequency as per the provision against each block
- Create and send the UI statement for each scheduler.

System administrator homepage facilitates to

- Create the scheduler
- Create the system operator
- Send messages to them, if required
- Manage the UI rate home page.
- Mange the data backup, cleaning etc.



Sl no	Time	Schedule 1	Schedule 2	Schedule 3	Schedule 4	Schedule 5	Schedule 6	Schedule 7	Final schedule (MW)
1	0:00	1.73273244	0:00	0:00	0:00	0:00	0:00	0:00	1.732732445
2	0:15	9.10013874	0:00	0:00	0:00	0:00	0:00	0:00	9.100138744
3	0:30	37.7342523	0:00	0:00	0:00	0:00	0:00	0:00	37.73425233
4	0:45	24.1228809	0:00	0:00	0:00	0:00	0:00	0:00	24.12288087
5	1:00	18.5403124	0:00	0:00	0:00	0:00	0:00	0:00	18.54031242
6	1:15	44.6786834	0:00	0:00	0:00	0:00	0:00	0:00	44.67868336
7	1:30	29.5594165	0:00	0:00	0:00	0:00	0:00	0:00	29.55941653
8	1:45	27.0495607	0:00	0:00	0:00	0:00	0:00	0:00	27.04956072
9	2:00	49.6418532	0:00	0:00	0:00	0:00	0:00	0:00	49.64185325
10	2:15	14.938557	0:00	0:00	0:00	0:00	0:00	0:00	14.93855702
11	2:30	30.9182901	0:00	0:00	0:00	0:00	0:00	0:00	30.91829015
12	2:45	36.0679991	0:00	0:00	0:00	0:00	0:00	0:00	36.06799913
13	3:00	12.655328	0:00	0:00	0:00	0:00	0:00	0:00	12.65532804



Sl no	Time	Final schedule (MW)	Actual injection (MW)	Frequency - Hz	Deviation (MW)	Percentage deviation
1	0:00	1.732732445	6.329506484	49.50	4.59677404	265.2904696
2	0:15	9.100138744	3.3403146	49.60	-5.759824144	-63.2938058
3	0:30	37.73425233	1.312729077	49.70	-36.42152326	-96.52112074
4	0:45	24.12288087	7.824998916	49.80	-16.29788195	-67.56192199
5	1:00	18.54031242	8.33020928	49.90	-10.21010313	-55.06974697
6	1:15	44.67868336	27.06645857	50.00	-17.61222479	-39.4197489
7	1:30	29.55941653	6.755894335	50.10	-22.80352219	-77.14469659
8	1:45	27.04956072	31.00593359	50.20	3.956372875	14.62638494
9	2:00	49.64185325	29.05799332	50.30	-20.58385993	-41.46472902
10	2:15	14.93855702	13.8953488	50.20	-1.043208218	-6.983326548
11	2:30	30.91829015	27.30063091	50.10	-3.617659234	-11.70070925
12	2:45	36.06799913	4.152635461	50.00	-31.91536367	-88.48664866
13	3:00	12.65532804	15.61464571	49.90	2.959317666	23.38396647
14	3:15	23.02940265	18.84096493	49.80	-4.188437713	-18.18734848
15	3:30	6.577677845	35.14112007	49.70	28.56344223	434.2481177
16	3:45	11.02401164	24.96940525	49.60	13.94539362	126.5001714
17	4:00	24.08173595	20.06010013	49.50	-4.021635818	-16.69994151

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