Database for assessment of power system generators within demonstrational diagnostic centre

VLADIMIR POLUZANSKI, NIKOLA MILADINOVIC, NIKOLA ILIC, JELENA LAZIC, ALEKSANDAR NIKOLIC
Electrical Measurement department
Institute Nikola Tesla
Koste Glavinica 8a Belgrade
SERBIA
vladimir.poluzanski@ieent.org http://www.ieent.org

Abstract: - This paper describes database for assessment of power system generators developed and used in the institute Nikola Tesla. The database contains general information about generators, large amount of testing and operational data as well as data acquired from monitoring and SCADA systems. Software applications used for database access and analysis are also described. DBMS is SQL Server 2012 and applications are written in Visual C#. The important role of the database in growth of expert knowledge within demonstrational diagnostic centre is emphasized.

Key-Words: - database, generator, diagnostic centre, condition monitoring, insulation system, data acquisition

1 Introduction

The overall condition rating of power system generator is a complex analysis of structural parameters, service conditions, maintenance history and results of periodic testing including factory tests, as well as insight into the history of identical or similar units (sister units) [1].

Asset condition monitoring has replaced plan based monitoring procedures, with emphasis on risk assessment and evaluation of remaining or consumed life of equipment. In order to reduce maintenance costs, increase remaining life and prevent outage and failures, different measurement techniques are available, with basic concept changed from individual measurements to integrated ones. The experiences of the world's leading companies suggest that the optimal contribution to the diagnostic of generators is realized by centralized monitoring [2].

In order to integrate all available relevant data for diagnostic of its power system generators into one centralized system, Electric Power Industry of Serbia (EPS), in collaboration with the institute Nikola Tesla formed a demonstrational diagnostic centre within the Institute.

Forming of demonstrational diagnostic centre was proceeded by several years work of experts from the Institute within various studies conducted for EPS. In those studies relevant data for diagnostic of power system generators was defined, collected, processed and inserted into database. Data was collected from archives of the Institute, power plants and other accredited institutions which conducted off-line measurements. The database contains generators' nameplate data, large amount of testing and operational data as well as data acquired from monitoring and SCADA systems.

The database is designed and implemented as modular and is open for expansion to new categories of data. Particularly important are the possibilities of using the wealth of information provided by the database, as seen in Fig. 1.

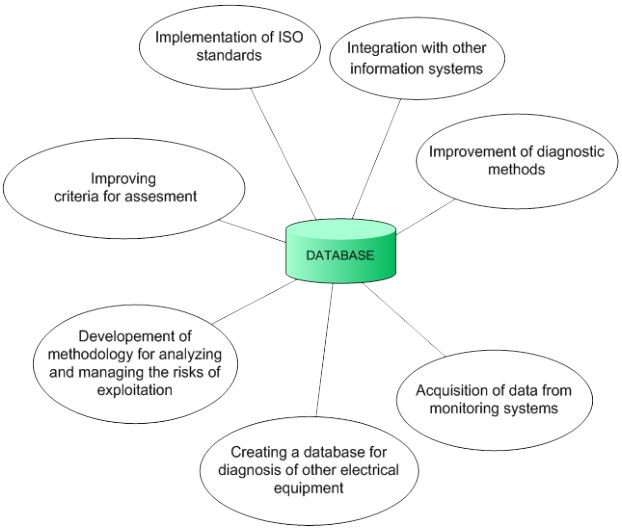

Fig.1 The possibilities of using information provided by the database

ISBN: 978-960-474-365-0

In addition to power system generators from EPS database contains information about all generators where the Institute has conducted measurements. This includes power system generators from the local industry and electric power companies of neighboring countries.

2 Database as part of demonstrational diagnostic centre for power system generators

Diagnostic centre for power system generators in its nature is distributed and consists of central part (located at the Institute) and a number of separate parts that are located at different power plants. Communication between different parts of the centre and their functional integration into unified system via available communication technologies is also necessary. According to the conclusions of studies center should take part in the planning of maintenance of rotating electrical machines in EPS. Therefore, the organization of the center involves the active participation of all stakeholders in its daily work, shown in Fig.2.

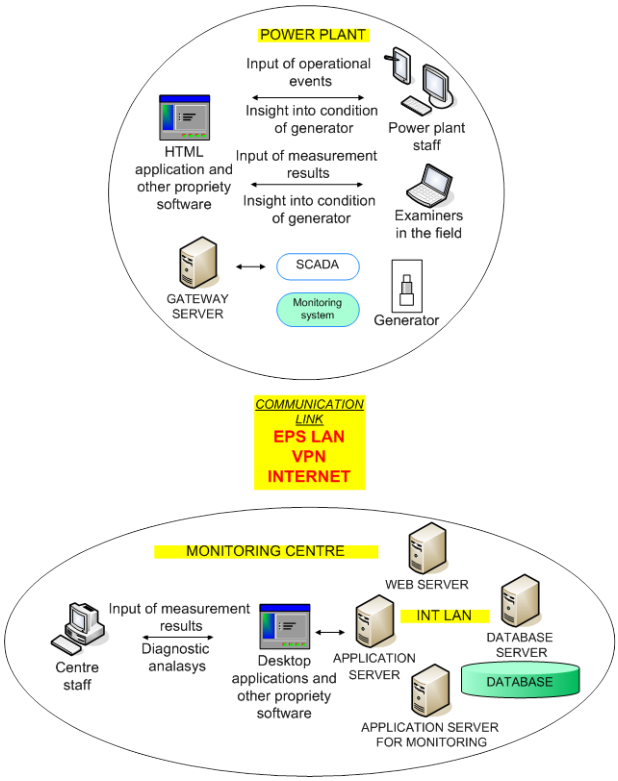

Fig.2 Organization of diagnostic centre

Within demonstrational diagnostic centre database occupies an important role as a tool for integration of large amount of heterogeneous data. This data consists of scalars, files, pictures, etc., some of which are from remote locations and in different property formats. In addition to current test data, the ability of comparative review of test and operational data history is also important. By using this data it is possible to make different statistical analysis, comparative analysis of sister units, monitor trends of various parameters and observe eventual correlations between them. In that way database, as part of demonstrational diagnostic centre, should lead to improvement of monitoring technology and diagnostic of power system generators and also have scientific expertise and educational role [3]-[7].

3 Database for assessment of power system generators

The database for assessment of power system generators contains nameplate data, large amount of testing and operational data as well as data acquired from monitoring and SCADA systems.

The database contains all relevant information specific to each generator: factory number, year of manufacture, manufacturer, owner, type of generator, placement in power plant, nominal power, nominal voltage, load regimes, type of cooling system and insulation class of rotor and stator windings etc. For each measurement, the database records: date and time of measurement, operators who conducted measurement, reason for measuring, conditions under which the measurement was conducted, the identification number of textual report, a list of the equipment used during the measurement etc. The database records evaluation of test results alongside recommended date for future testing. For each generator operational events are also recorded: various types of repairs, breakdowns, working hours etc.

The database contains following test results from off-line testing of generators' insulation systems:

- stator winding insulation resistance and polarization index tests
- stator winding dielectric dissipation factor
- tip-up and capacitance tests
- partial discharge measurements on the stator winding insulation
- AC leakage current test
- stator winding conductor resistance test
- Hi Pot (AC and DC) test of stator winding
- stepped direct overvoltage test
- rotor winding insulation resistance test
- rotor winding impedance test
- rotor winding insulation capacitance test
- rotor winding conductor resistance test

ISBN: 978-960-474-365-0

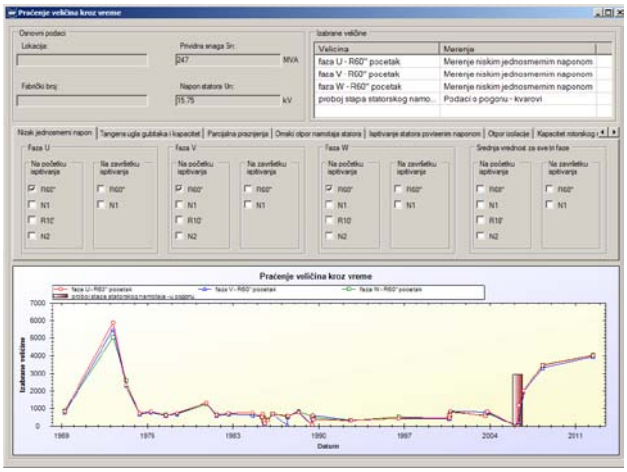

Fig.5 Turbo generator (210 MW) stator winding insulation resistance tests results (R60'' [MΩ] for all phases winding) during a lifetime and after rewinding (year 2006)

4.2 Propriety software

ICMmonitor communicates with measurement devices for partial discharge on power system generators through local or network connection. It has automated ability to gather data from different measuring devices (different IP addresses) in sequential manner by configured resolution (every hour for example). It stores data files on file system in different directories for each device. It also has rich graphical capabilities for analyzing data files, shown in Fig.6.

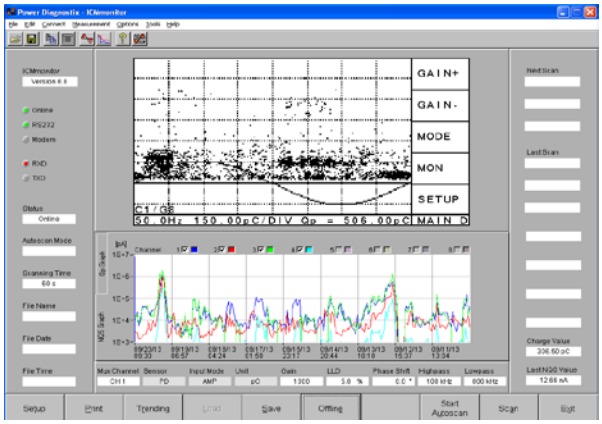

Fig.6 ICMmonitor's graphical view of partial discharge data

4.3 Application for SCADA remote access

This application acquires following parameters from SCADA and stores them into the database on daily basis: stator winding temperatures, stator core temperatures, active power, reactive power and currents, shown in Fig.7.

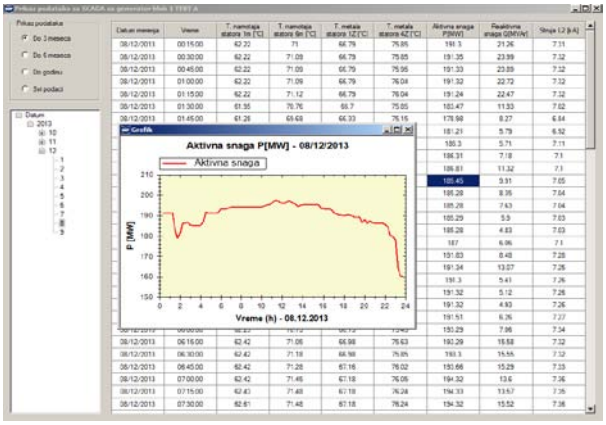

Fig.7 Active power graph from data acquired from generator's SCADA

5 Conclusion

The database for assessment of power system generators, within demonstrational diagnostic centre, is powerful tool for integration of all kind of different data relevant for diagnostic of generators. Its modular structure and flexibility in data access and storage, thanks to implementation of MS SQL Server's File Table data type, will allow storing data from newly introduced monitoring systems and test methods, in the future.

The database is open for integration into larger informational systems, primarily in the production and maintenance informational system of EPS (PROTIS).

In 2014 the database will be expanded with data from magnetic monitoring systems.

References:

[1] B.K. Gupta, I.M. Culbert, "Assessment of Insulation Condition in Rotating Machine Stators", IEEE Transactions on Energy Conversion, Vol. 7, No. 3, September 1992.

[2] M. Chafai, L. Refoufi, H. Bentarzi, "Reliability Assessment and Improvement of Large Power Induction Motor Winding Insulation Protection System Using Predictive Analysis", WSEAS Transactions on Circuits and Systems, Mart 2008

[3] Ignat, S.; Stancel, E.; Stoian, I., "Support for condition based maintenance Operating equipment performances monitoring," Automation Quality and Testing Robotics (AQTR), 2012 IEEE International Conference on , vol., no., pp.234,239, 24-27 May 2012, doi: 10.1109/AQTR.2012.6237709

[4] Yang Ping; Ren Wei, "A Fault Diagnosis System for Turbo-Generator Set by Data Mining," Computational Intelligence and

ISBN: 978-960-474-365-0

Security, 2006 International Conference on , vol.1, no., pp.801,804, Nov. 2006, doi: 10.1109/ICCIAS.2006.294246

[5] Warren, V.; Stone, G.C.; Fenger, M., "Advancements in partial discharge analysis to diagnose stator winding problems," Electrical Insulation, 2000. Conference Record of the 2000 IEEE International Symposium on , vol., no., pp.497,500, 2000, doi: 10.1109/ELINSL.2000.845557

[6] Wang, X.Y.; Zheng, J.H.; Zhu, S.Z.; Shen, S.D., "Parameter identification and database management system in power systems," Power System Technology, 2002. Proceedings. PowerCon 2002. International Conference on, vol.4, no., pp.2043,2046 vol.4, 2002, doi: 10.1109/ICPST.2002.1047140

[7] Kokko, V.I.J., "Electrical ageing in lifetime estimation of hydroelectric generator stator windings," Electrical Machines (ICEM), 2010 XIX International Conference on , vol., no., pp.1,5, 6-8 Sept. 2010, doi: 10.1109/ICELMACH.2010.5608311

[8] Kalen Delaney; Bob Beauchemin, Conor Cunningham, Jonathan Kehayias, Paul S., “Microsoft SQL Server 2012 Internals”, Microsoft Press, 2013

[9] Ying Bai, “Practical Database Programming With Visual C#.NET”, IEEE Press, 2010