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ADAM®/SIPLUG®: An Innovative Valve Monitoring System

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ABSTRACT

Optimized maintenance strategies are a key aspect for safe and undisturbed plant operation. Innovative valve service solutions, e.g. valve diagnostics can support this in an efficient way.

The ADAM®/SIPLUG® valve monitoring system allows full online monitoring of valves and actuators with automatic evaluation and assessment. Especially for safety-related and operation-related valves this provides valuable information on components condition to ensure proper function and contribute to optimization of maintenance strategies as well as effective maintenance performance.

The new SIPLUG®-4 modules are the evolutionary solution for valve diagnosis at the Motor Control Center (MCC). As the SIPLUG®-4 can be installed directly in the MCC outgoing actuator power cable it allows an easy installation in existing switchgear cabinets. Measurement at MCC means also zero effort for performance of diagnostics reducing the number of on-site activities. This results in decrease of maintenance costs and dose rates for deployed personnel.

The ADAM® evaluation software and database was developed in parallel with the hardware. It provides automatic analysis of the monitoring results using the limit values specified for the valves. The measured data can be transmitted via the power plant's local area network to the ADAM® data server, if the SIPLUG® online hardware is installed. With the mobile solution, the data can be transmitted via serial or USB interface to a PC or notebook. With this solution all measurement information will be available immediately in the offices of plant engineers. Also, with SIPLUG® online all operations of valves can be automatically recorded.

More than 25 years of experience in various plants worldwide show that the application of ADAM®/SIPLUG® valve diagnostics solution leads to increased plant safety and availability. Some of the references for ADAM®/SIPLUG® are Germany, Switzerland, Brazil, Spain and Eastern Europe.

1. INTRODUCTION

The stable function of valves and their actuators as specified by design is essential for a NPP operation that meets all safety and reliability requirements.

This goal implements optimized maintenance strategies that can be efficiently supported by dedicated valve services like innovative diagnostics solutions.

Main objective for using monitoring systems is the detection of changes in the functional behavior of valves and actuators without direct intervention (e.g. for visual inspection). This provides an important basis for the change to condition-based maintenance with full reference to valve design and specification.

2. AREVA'S INTEGRATED VALVE SERVICES

Taking the different aspects and criteria for the specified function of valves and actuators into account, AREVA established an integral approach, see Figure 1.

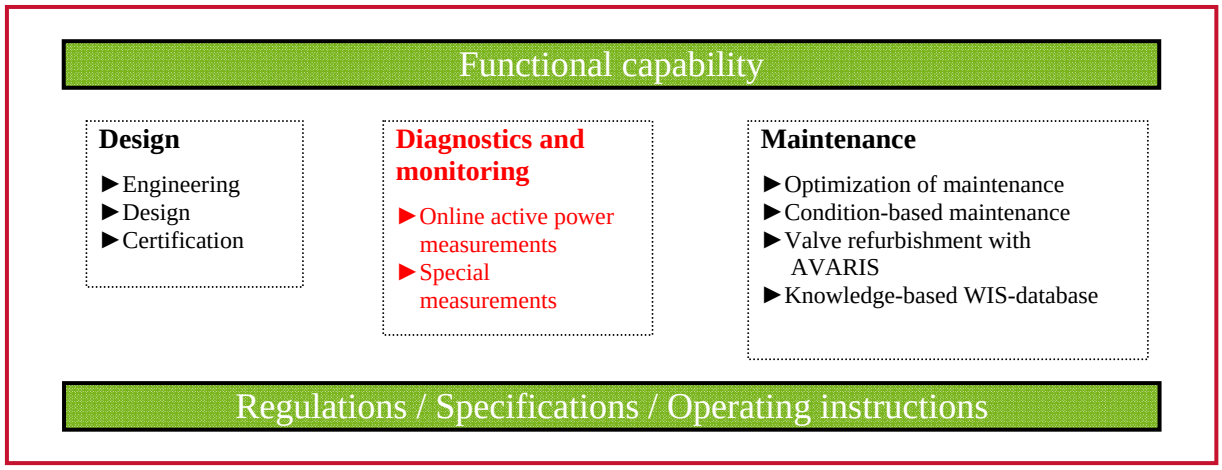

Figure 1 AREVA's Integrated Valve Concept

This concept is based on our extensive know-how in valve and actuator technology and has already been successfully implemented in Germany and abroad.

The three main fields which are the foundation for a steady and safe function of valves and actuators

- Calculation / design
- Maintenance / repair

- Diagnosis and monitoring

give the frame for AREVA's Integrated Valve Concept. The main scope of this concept is:

- Valve technology and valve qualification
- Estimation of remaining service life time of valves
- Engineering support
- Valves and actuators diagnostic services with ADAM® / SIPLUG®
- Maintenance strategy optimization with focus on Condition Based Maintenance (CBM)
- Selective maintenance and valve refurbishment with AVARIS
- Knowledge-based database called WIS

From the total scope, focus of this paper is the "Valves and actuators diagnostic services with ADAM® / SIPLUG®". Before learning in the next chapter about AREVA's Valve Diagnostics Concept it is also important to answer the question about the reasons and motivation for valve diagnostics in general, which can be answered as follows

- Verification of the functional behavior of valves and actuators at operating conditions and safety-related conditions
- Verification of appropriate safety margin of torque and force
- Timely initiation of measures for identified changes / irregularities
- Traceability of fault messages
- Increased plant availability

3. ADAM® / SIPLUG® CONCEPT

With its modular approach, AREVA covers the complete scope of products and services for state-of-the-art diagnosis on valves and actuators in nuclear power plants. This modular approach includes several measurement equipments based on SIPLUG®, the ADAM® software and a wide range of services. To have an overview, see next figure.

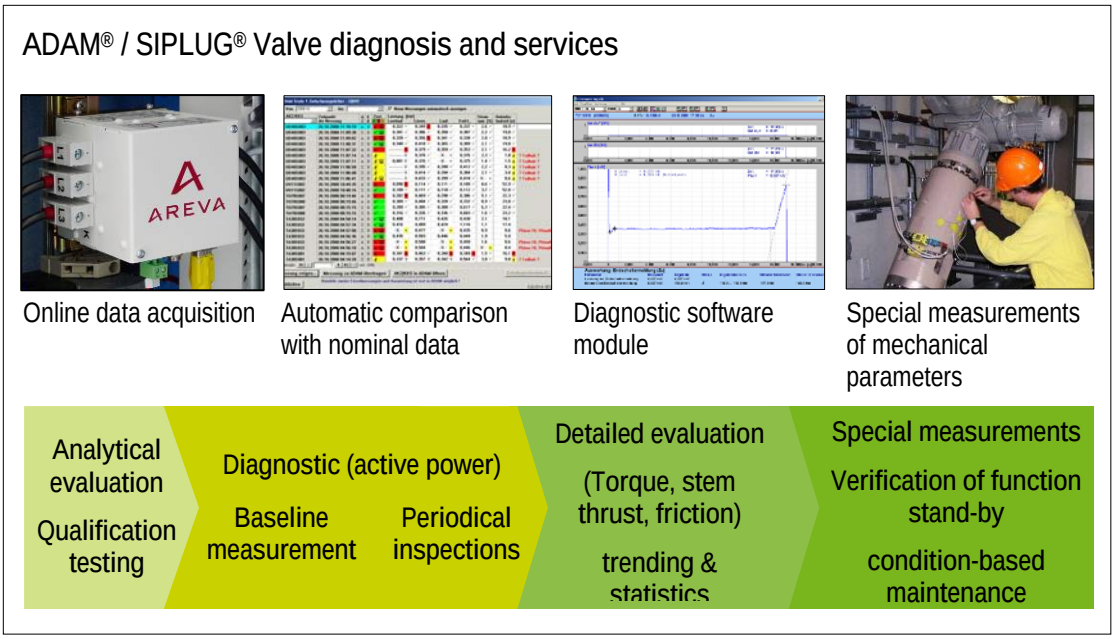

Figure 2 ADAM® / SIPLUG® Valve and actuator diagnostics concept

SIPLUG® technology provides dedicated diagnostics solutions for different customer requirements. It is designed for data acquisition inside or outside the plug-in units of the switchgear of nuclear power plants.

With the **SIPLUG®** diagnosis modules the plant operator will be able to perform the assessment of electrical and mechanical characteristics of motor-operated valves and their electrical actuators through active power measurement.

The new **SIPLUG®-4** modules (Figure 3) are the evolutionary solution for valve diagnosis at the Motor Control Center (MCC). As the **SIPLUG®-4** can be installed directly in the MCC outgoing actuator power cable it requires less engineering work and allows an easy installation in existing switchgear cabinets.

Figure 3 SIPLUG®-4 module

For the monitoring of solenoid valves another type of **SIPLUG®** is available which supports the assessment of the dynamic and electrical behavior of solenoid-operated valves by measurement of voltage and current.

SIPLUG® DAW3 allows parallel measuring and recording of electrical and mechanical data for the diagnosis of valves and actuators. Flexibility in use has taken priority in the design of the device; the integration of additional input channels represents a significant extension of functionality within the **SIPLUG®** series. In addition to acquisition of electrical signals there are four additional channels with integrated programmable preamplifiers, three for force or torque measurement and one channel designated to the displacement path / rotation angle.

The **ADAM®** evaluation software and database was developed in parallel with the hardware. It provides automatic analysis of the monitoring results using the limit values specified for the valves. The measured data can be transmitted via the power plant's local area network to the **ADAM®** data server, if the **SIPLUG®** online hardware is installed. With the mobile solution, the data can be transmitted via serial or USB interface to a PC or notebook. With this solution all measurement information will be available immediately in the offices of plant engineers.

With **SIPLUG®** online all operations of valves can be automatically recorded. Ring buffer always keeps the last valve operations in the **SIPLUG®** memory, even if power fails. Consequently, post-fault analyzing is possible, if some irregularity during valve movement is recorded.

Data are immediately available for further analysis / evaluation. The system provides fully automated evaluation (Figure 4) of each valve operation with flag status results. This provides a full overview on valve status at any time.

Measurement at MCC means a zero effort for performance of diagnostics reducing the number of on-site activities. This results in decrease of maintenance costs and dose rates for deployed personnel.

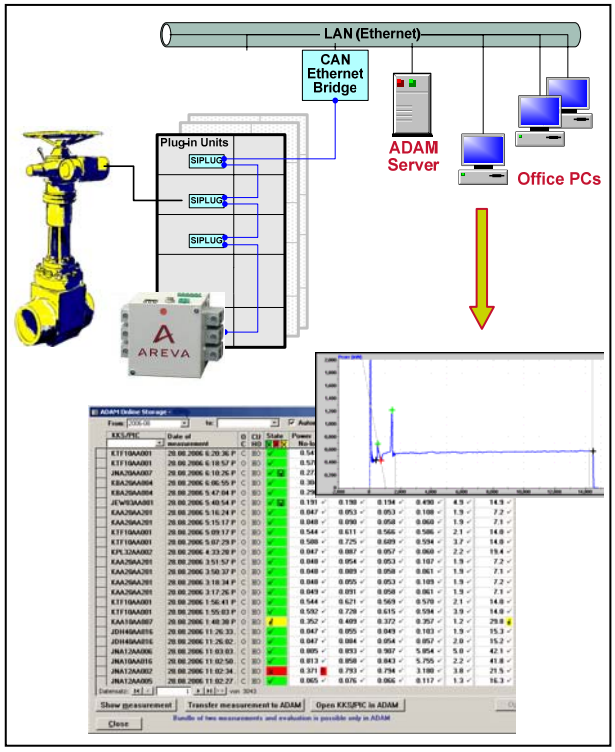

Figure 4 SIPLUG® online with automated evaluation

The next figure gives an overview of the different types of valves in a NPP connected to **SIPLUG®** (valve diagnostics hardware), **ADAM®** (valve diagnostics software) and to **WIS** (knowledge-based database).

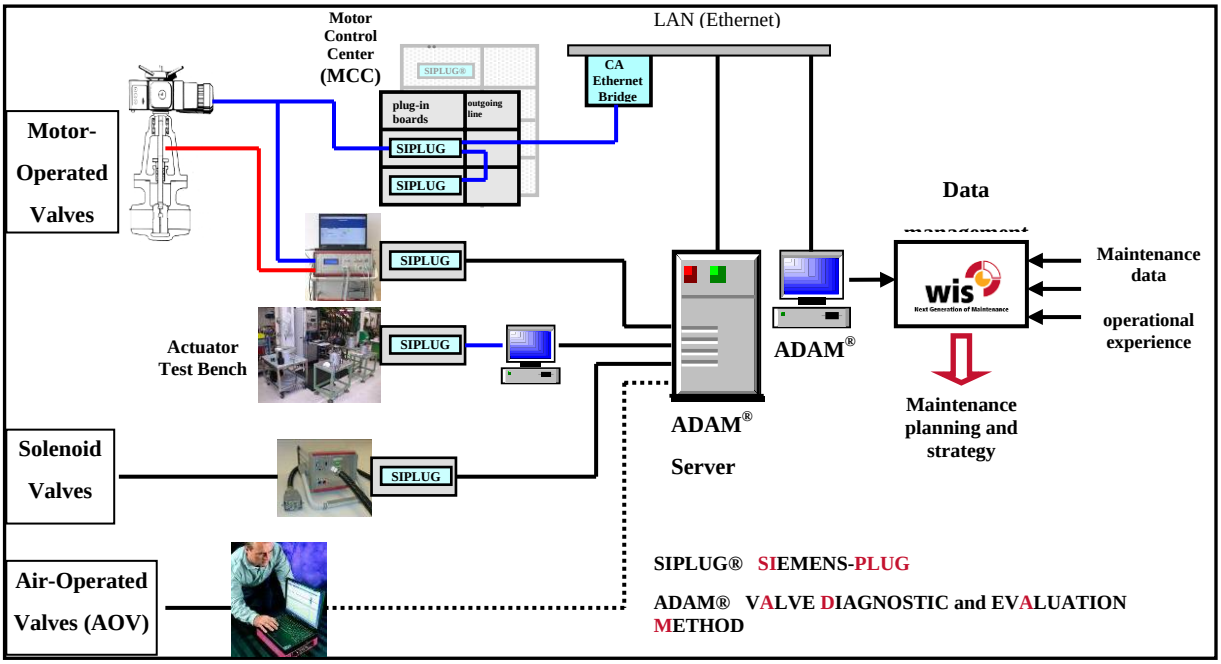

Figure 5 ADAM® / SIPLUG® valve and actuator diagnostics overview

4. VALVE DIAGNOSTICS SERVICES

Combining the features of these valve monitoring tools and equipment with expert knowledge and experience in valves and actuators design, function and maintenance we also provide a full range of related service activities to support plants in all stages of valve diagnosis:

- Performance of active power measurements of the actuator
  - in-situ,
  - from switchboard or
  - online
- Performance of baseline measurements of actuators during valve maintenance and establishment of correlation between active power and torque
- Additional direct measurements of mechanical parameters (e.g. torque, thrust)
- Evaluation and assessment of measurements and comparison with nominal values and allowable limits
- Determination of changes in the function of valves and actuators during their lifetime
- Root cause analysis and/or discussions with experts and authorities of an accredited inspection body
- Provision of recommendations (> condition-based maintenance)

5. TESTING OF ELECTRICAL ACTUATORS

As above mentioned part of AREVA's scope in the area of valve diagnostics services is the efficient and precise testing and adjustment of actuators, e.g. at the end of maintenance activities. This is an important basis for future valve diagnostics via active power measurements without disassembling of the actuator.

Early diagnostics of faulty operation of a valve can be done by determining the torques of the valve actuator on a regular basis.

For testing and adjustment of electric actuators AREVA developed mobile actuator test devices **(MDP**), see Figure 2.

- The MDP consists essentially of an electromagnetic brake. It is available in different sizes for actuators in the torque range of 10 to 3.500 Nm
- The MDP ensures a precise increase and decrease of the actuator braking torque for simulation of built-in conditions on the valve
- The MDP control device is embedded in ADAM® using torque gradient requirements and for recording, processing and storage of data in ADAM®
- Possibilities: Loop-in operation of the actuator or operation with autonomous control unit

Figure 2 MDP family with control unit and data acquisition

Implementation of the torque / active power correlation in **ADAM®** provides the basis for evaluation of mechanical valve behavior from active power measurement during operation.

Figure 3 ADAM® system with MDP test benches and control panel in a workshop

6. REFERENCES

AREVA has more than 25 years international experience in valve & actuator diagnostics, e.g. in Germany, Switzerland, Brazil, Spain, Finland, China and Eastern Europe.

In different nuclear power plants safety-related and operation-related valves are monitored continuously:

- PWR 1 600 MOV equipped with SIPLUG® online; about 70,000 valve operations per year recorded and automatically evaluated via ADAM® software
- PWR 2 1,000 MOV monitored with SIPLUG®
  120 SOV with SIPLUG® MAG
- BWR 1 550 MOV monitored with SIPLUG®

In addition specific in-situ valve diagnostics (active power, force, torque) are yearly performed in several nuclear power plants in the above mentioned countries.

7. CONCLUSION

Especially for safety and availability related valves, a steady function according specification and design is essential for safe and reliable plant operation.

Valve monitoring and diagnosis provides important information on the condition and functional behavior of valves and actuators and, therefore, supports the way to condition-based maintenance.

AREVA provides a complete scope of products and services for state-of-the-art diagnosis on valves and actuators in nuclear power plants. With longtime experience and know-how we support plants in all stages of valve diagnostics considering specific valve design / engineering aspects as well as maintenance requirements.