Volume 3
Steam Generator Services

AREVA
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Steam Generator Services

AREVA’S COMPREHENSIVE PROGRAM FOR SG CLEANLINESS MANAGEMENT

The best possible steam generator (SG) performance is prerequisite to optimal plant availability and for future life time extension.

Steam generator performance parameters can be reduced by fouling and corrosion degradation – both resulting in a reduction of heat transfer. Corrosion phenomena are caused by the accumulation of non-volatile contaminants, i.e., corrosion products and salt impurities in scales and crevices. Tube scaling ultimately results in a reduction of power output.

AREVA has a long history and the most comprehensive experience in servicing nuclear power plants worldwide. AREVA has been using a systematic approach for evaluation of steam generator performance based on operational data and inspection results to elaborate the best solution to satisfy plant operator needs.

AREVA owns several technologies for inspections, primary and secondary side cleaning of steam generators. The principles of the AREVA approach are based on an assessment of the current SG situation, performance of suitable countermeasures (ranging from off-site technical support to on-site SG cleaning) and subsequent evaluation of the results.
Steam Generator Services

Water Chemistry Data (e.g., iron ingress, hide-out) → Inspection Results (e.g., visual, sludge mapping) → Thermal Performance (e.g., heat transfer) → Steam Generator Assessment

If No measures required, go to Continuous Steam Generator Surveillance.

If Measures required, proceed as follows:

- Primary Side SG Cleaning
  - SIVABLAST® (mechanical cleaning)
- Secondary Side SG Cleaning
  - Preventive Chemical Cleaning
  - Curative Chemical Cleaning
  - Mechanical Cleaning (e.g., tube sheet and/or inner bundle lancing, upper bundle flushing)

Improvements → Continuous Steam Generator Surveillance
Water and steam serve in the steam-water cycle as the energy transport and work media. They should not cause nor enhance corrosion of construction materials and should not have any negative influence on normal plant operation. In a more detailed form, the main goals of the steam-water cycle chemistry are to:

- Minimize metal release rates of the structural materials
- Minimize probability of selective and/or localized forms of corrosion
- Minimize deposition of corrosion products on heat transfer surfaces
- Avoid formation of aggressive media, particularly local aggressive environments under deposits

These goals are especially valid for the steam generators (SGs), which have to be considered as the key components of the secondary side. The best possible performance of the SG is a prerequisite for optimum plant availability and possible plant life time extension. The major opponent to that is corrosion and fouling of the heating tubes. Effective ways of counteracting all degradation problems and thus of improving the SG performance are to keep SGs in clean condition or if necessary, to plan cleaning measures such as mechanical tube sheet lancing or chemical cleaning.
Based on more than 40 years’ experience in steam-water cycle water chemistry treatment AREVA developed an overall methodology assessing the steam generator cleanliness condition by evaluating all available operational and inspection data together.

In order to gain a complete picture all relevant information are evaluated, structured and indexed using the AREVA Fouling Index Tool Box.

- Water chemistry data (e.g., corrosion product mass balances, impurity ingress)
- Inspection data (e.g., visual inspections and tube sheet lancing results)
- Thermal performance data (e.g., heat transfer calculations)
The overall fouling index can be used as a basic indicator to decide whether countermeasures are necessary. Three zones are defined, which are indicated with different colors:

- Green zone (Index 0 to 50): No cleaning actions are foreseen
- Orange zone (Index 50 to 80): An optimization of the chemistry program shall be considered (corrosion product control, oxygen control etc.), and cleaning measures shall be planned in a long term
- Red zone (Index 80 to 100): Cleaning actions have to be initiated as soon as possible. Possible cleaning actions are mechanical tube sheet lancing with high pressure water jets or chemical cleaning of the whole tube bundle

Of course, the final decision is not entirely based on the overall index. Any localized problems (e.g., tube denting in the vicinity of the tube support plate) as well as on the individual fouling indicators must also be taken into account.

The AREVA Fouling Index approach combines manufacturer’s experience with plant data and enables plant operators to monitor the condition of a specific SG and to compare SGs in kind of a benchmark with other plants.

- As a first step, AREVA’s systematic approach of an overall SG assessment serves as a criterion whether countermeasures are necessary or not.
- The second step of the assessment is used to decide which kind of measures should be considered for improvement of SG performance.
All considerable measures are plant specific and depend on various parameters, like plant design, water chemistry regime and authority environmental requirements.

Typical countermeasures are the optimization of water chemistry treatment with regard to corrosion product control by complementing the applied water chemistry, using film forming amines or the improvement of oxygen control and redox conditions by installation of state of the art diagnostic systems. The result of the SG assessment could also lead to recommendations to perform a mechanical, preventive or curative chemical cleaning.

The performance of steam generator assessment and evaluation of the field proven AREVA SG Fouling Index yields several advantages for plant operators:

• The AREVA SG health assessment systematically uses all suitable and important plant data, i.e., it can be considered as a check list of the main plant data.
• The application of the AREVA SG Fouling Index allows specific cleaning measures in due time and enables the establishment maintenance strategy based on SG status.
• An annually performed SG assessment enables the plant operator to derive a key figure for steam generator cleanliness over the long term.
• The standardization by indexing the parameters allow a cross comparison among different plants.
• The success of cleaning measures can be verified.
• Steam generator cleanliness offers the perspective for plant life time extension.
• The AREVA Fouling Index Tool Box was developed based on experience gathered by Siemens over more than 30 years of operations. It was adapted and applied for various chemistry treatments also at nuclear plants of other OEMs.
PRIMARy SIDE STEAM GENERATOR CLEANING

SIVABLAST®

The SIVABLAST® Mechanical Tube Cleaning System is a closed loop recirculation blasting process with:

- Excellent cleaning efficiency
- Very low base material attack down to 1 µm
- Low waste generation due to reuse of cleaning material which offer:
  - Improved heat exchanger performance
  - Avoiding or counteracting corrosion phenomena
  - Regaining and improvement of EC testability and evaluation

Field proven:

- On Steam Generators of nuclear power plants
- On different HX coolers in conventional and nuclear power plants on the secondary / primary plant side
- With horizontal and vertical heat exchangers
- With stainless steel, copper based, nickel alloy and low alloy steel tube material

Figure 1 – Carbon Steel tube before and after SIVABLAST

Before

After

Figure 2 – Eddie Current Testing Records
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SIVABLAST® – MECHANICAL TUBE CLEANING SYSTEM EQUIPMENT
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SIVABLAST® – SUCTION SYSTEM FOR STEAM GENERATOR CLEANING

AREVA has patented suction header systems
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SIVABLAST® – STEAM GENERATOR CLEANING

The Manipulator and operation support have to be provided by the Partner

The Blasting Head with two or three nozzle technique
### SIVABLAST® – RESULTS AT CANDU REACTORS

<table>
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<tr>
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<td>1.1</td>
<td>1.1</td>
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<td>716</td>
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<td>Amount of waste drums</td>
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<td>RHIT Reactor Header Inlet Temperature °C</td>
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<td>PHT Flow Primary Heat Transfer Flow %</td>
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<td>+3 – 6%</td>
<td>+5%</td>
<td>n.d</td>
<td>+2.5%</td>
<td>+0.4%</td>
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Steam Generator Services

RANGER
A New Approach to Steam Generator NDE

AREVA offers an innovative approach to steam generator non-destructive examination (NDE). RANGER performs various types of steam generator tube inspection and repair. The manipulator features an enhanced design that enables quick and easy installation, requiring only one person. Dose reduction? Less than 1/3 of the personnel exposure compared to earlier manipulators.

Redundant Tube Identification Meets EPRI Guideline

The integrated machine vision system recognizes tubes as they enter the arm camera’s field of view. Tool-tip position is calculated and compared to the tool-tip position determined by the arm encoders. This completely redundant and independent approach to tube ID verification virtually eliminates the possibility of mis-encoding a tube.

Saves Time and Dose

As replacement steam generators and new plants become commonplace, RANGER enables us to set up, inspect, and leave site quickly. The result? We can preserve your schedules and support multiple customers simultaneously. RANGER saves time and dose, reduces peripheral equipment, and reduces customer requirements for site support. This robot is quickly setting new standards for the future — and it’s just one phase of our rapid deployment strategy that includes all-in-one eddy current instruments, a self-contained inspection trailer.
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Features and Benefits

• One-piece design remains folded until installed then unfolds in the SG for use
• One person installs RANGER in less than ten minutes
• Fully intuitive – graphic screen controls coupled with Eddy Current acquisition software allow the inspection to progress smoothly with minimal burden to the operator
• Ability to withstand high-pressure washing (for possible decontamination needs)
• Control-box design allows for plugging or the addition of audio/video plug-in modules
• Performs eddy current inspection automatically from an input tube inspection list
• Can return to previous inspection candidates in seconds – even in a distant quadrant, allowing faster closeout
• Requires no arm breaks to reach inspection locations, saving time and dose over past manipulator designs
• Seamlessly interfaces with all eddy current and repair processes
• Local control hand-held pendant allows for basic functional checkout and installation without the need for an operator at the remote computer station

The Latest Technical Design Innovations

• Direct movement from tube X to tube Y without any rotational/translational components — independent of whether pitch is square or triangular
• On-board sensors track temperature and total radiation dose received (these features enhance maintenance practices)
• Electric “Hot Shoe” connector permits easy loading and removal of EC guide tube and wrist
• Accurate absolute encoders within the joints allow the integral kinematic software to align the tool tip (including multiple guide-tube tools) with any target tube within the manipulator’s reach
Steam Generator Services

- RANGER’s machine-vision image processing software uses the in-arm camera view to compensate cable pull and arm flexure for precise tube alignment.
- Machine vision software also recognizes and “counts” tubes as they enter the field of view providing a redundant indication with which tube the manipulator is aligned.
- An on-board redundant high-speed serial interface reduces required cabling to the manipulator while increasing reliability.
- Completely electronic operation eliminates the need for site air.
- Incorporates slip-rings within the joints to eliminate the need for pass-around cables that can get easily damaged.
- Pole-load super-finger tube-sheet anchor coupled with an integral cable and winch assembly eliminates the need for man-way mounted installation devices.
- On-board electronics are mounted within the arm.
- Modular control box design enhances flexibility.
SUBMARINE SYSTEM FOR INSPECTIONS (SUSI)

From our innovative tooling through design, qualification and responsive site support, AREVA is an industry leader in Non-Destructive Examination (NDE). Tired of hard-to-reach areas in your plant? You can count on our global resources to provide a solution that gets you back on the grid safely and efficiently – with the reliable performance you expect. That’s why we offer the Submarine System for Inspections (SUSI).

SUSI is available in a variety of models to meet your specific need: the 420, 270, 190 and mini. These robotic tools can visually inspect both primary and secondary side components and PHT internals. SUSI also performs visual inspection of baffle bolts. SUSI can also serve as a gripping device to retrieve foreign objects.

A Variety of Inspections

The SUSI 420 is utilized in the inspection of RPVs and RPV internals, the primary loop from the steam generator (SG) and main coolant lines, and can perform core check after reload. The SUSI 270 examines the main coolant pump housings and the top of SG tube bundles. SUSI 190 and Mini-SUSI can verify the integrity of SG tube bundles and gaps.

In fact, SUSI can examine most reactor coolant system components as well as pressure vessels, tanks and piping in nuclear power plants worldwide. In addition, the robot can be calibrated under water at any
time during the inspection. A separate satellite camera system can be deployed with SUSI or on its own to further enhance inspection results in hard-to-reach areas.

The Standard for Baffle Bolt UT Examination

SUSI is an essential tool for highly effective Baffle Bolt Exams. Want enhanced reliability? SUSI delivers – and also saves time. In fact, AREVA recently developed a specialized UT technique to inspect baffle bolts for a customer with an urgent need. We demonstrated and tested the technique on samples of the same type of bolts slated for inspection. The entire process, from phone call to delivery, took only two weeks. But there’s more. The UT examination on-site progressed so well, the scope was expanded to encompass ALL 8 rows or 864 of the customer’s baffle-to-former bolts. All completed in just 56 hours.

Benefits

- Efficient inspection for both the primary and secondary side
- A variety of models to meet your specific needs
- Fully remote operation reduces dose
- Reliable baffle bolt inspections save time and get you back on the grid safely
SECONDARY SIDE STEAM GENERATOR CLEANING

REASONS BEHIND SS SG CLEANING

During operation of the plant, chemical sediment is transported and deposited throughout the steam generator and must be removed to prevent tube degradation.

Any amount of sludge left in the generator feeds the hard deposit area and collar formation and creates a higher potential of steam channels in the hard sludge deposit areas.

Sludge that is distributed throughout the upper bundle adheres to the tube surface and decreases the steam transport efficiency of the generator creating fouling in the tube support sheets which invariably effects flow and heat transport.

Sludge Lancing, Visual inspection, and Eddycurrent technology advancements throughout the years have changed the way we approach these matters.
Steam Generator Services

UPPER BUNDLE FLUSH

Overview

Two different deposit formations occur in the upper steam generator internals

- Scale which forms on the tubes
- Blockage of the support plate lattice grid or broaches

Both types can be detrimental to steam generator performance and may degrade heat transfer and steam output

- Tube degradation
- Locked tube support plate crevices
- Fouled Tube Support Plate (TSP) flow openings
- Lattice grid or broach blockage

Upper Bundle Flush primarily addresses the support plate blockage. It’s targeted for newly formed or soft sludge deposits. The flushing action helps to remove significant portions of deposit, mitigating the potential for the reduction of steam flow and reduced Steam Generator performance.

Upper Bundle Flush equipment is not complex, but its effectiveness to remove soft sludge without any significant impact to outage length has been clearly demonstrated at several US plants.
Although lancing effectively cleans the tube sheet, the process typically removes only 10 to 20 percent of the total material deposited in the SG.

The balance is deposited throughout the SG, causing reduced power output, chemical hideout and additional corrosion. Combining upper bundle flush with lancing will significantly enhance results.

A typical flush utilizes up to four dependable, high-volume pumps that efficiently circulate water from the base of the SG through existing accesses at 1,000 to 2,000 GPM to spray nozzles located above the upper bundle area.

When performed with water lancing, an upper bundle flush provides a powerful solution for the removal of troublesome deposits from the SG
Steam Generator Services

Upper Bundle Flush Process

A series of nozzles are installed into the steam drum to spray water across the top of the tube bundle.

The nozzle design used is dependant on the steam generator design, some attach in the moisture separators and some are installed into the lower access door just above the tube-bundle. Both types have proven to be effective and produce the same flow rate. A spray nozzle for the seventh support plate may be utilized to direct spray the tube bundle with a greater intensely.

Once the nozzles are installed, hoses are run from the tube-sheet hand holes to the pumps below. Then the hoses are run from the pumps discharge to the steam drum nozzles. The generator is then mounted with a slack tube sight glass and suction foot for draining.
The generator is then filled with demineralised water to run at a level just below the flow distribution baffle to allow the pumps to run without cavitations. The pumps are started and run for 12 hours. The flow is 500 gpm (1,893 lpm) per pump and 30 psi (2 bar).

AREVA’s lessons learned have lead to additional Research and Development enhancements for the Upper Bundle Flush system:

- A new design of nozzles allow the installation of two manifolds in place of 16 separate nozzles reducing the amount of equipment installation
- It reduces the installation time, thus reducing the dose received from the steam drum entry
- FME concerns are reduced

The reduced amount of equipment of the enhanced system eliminates the need for 32-2"X10’ hoses, 32 nozzles, two manifolds, and two large man-way penetration assemblies.

Lessons Learned also contribute the development and innovation of new techniques.
The outage at Sizewell (UK) in 2009 lead to the development and implementation of a new technique.

The static lance was adapted and a set of parameters loaded into the software to allow lancing on the seventh tube support plate prior to performing UBF. This enhanced system allowed the removal of more than twice the amount of debris removed from the previous outage with minimal schedule increase.

**RESULTS**

After performing the UBF there is only a minor blockage.
UBF SCHEDULE

The Upper Bundle Flush process is performed prior to the Water Lancing on the first generator and runs parallel the rest of the schedule. Upper Bundle Flush will finish before lancing and only impacts the start of Lancing. Upper Bundle Flush only impacts the entire schedule by an additional 12 – 24 hours compared to lancing alone.

Our normal scheduled duration for lancing in a typical plant is between 9 – 20 days, dependant on the amount of generators, scope of work, and amount of sludge / hard deposits.

Note: Time impact depends on heat sink requirements of the respective station.

UBF RESULTS DURING THE PAST FIVE YEARS

- Typically more deposits are removed during the first two UBF applications
- Experience has shown 2 – 4 times more sludge removed during lancing after performing UBF

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<tr>
<th>Plant</th>
<th>First Outage</th>
<th>Second Outage</th>
<th>Third Outage</th>
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<td>Plant 1 (with 2 SGs)</td>
<td>481 kg with UBF</td>
<td>537 kg with UBF</td>
<td>142 kg Lance only</td>
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<td>Plant 2 (with 2 SGs)</td>
<td>306 kg with UBF</td>
<td>225 kg with UBF</td>
<td>160 kg with UBF</td>
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<tr>
<td>Plant 3 (with 4 SGs)</td>
<td>123 kg Lance only</td>
<td>122 kg Lance only</td>
<td>227 kg with UBF</td>
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<td>Plant 4 (with 4 SGs)</td>
<td>45 kg Lance only</td>
<td>69 kg Lance only</td>
<td>126 kg with UBF</td>
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WATERLANCING

The general objectives for Waterlancing are to remove deposits, both hard and loose, from the tubesheet region in order to prevent the onset of degradation mechanisms and to allow for secondary side inspection of the tube surfaces and tubesheet area structures.

STATIC LANCING

Our system, in use since the late 1980s, is known as the Static Lance. Designed for use in Square pitch generators and has proven itself to be the industry leading system for efficiency and simplicity. It is a fully automated system that requires one time mounting and alignment, saving time and dose to the workers. The design of the system makes it invariably FME fail-safe as there are no moving parts or motors inside of the generator. The Static Lance system is qualified to operate at 1,980 psig (2,280 during transients). Normal operating pressure is 1,500 psig with 40 gpm flow rate of 80 gpm.

INNER BUNDLE LANCING

The Inner Bundle Lance is very effective at removing the bulk of the hard deposits from the centre region of the H/L. Inner bundle lancing adds an innovative delivery system that traverses rail guides mounted to a support fixture, which is attached to a secondary inspection port for positioning along the divider lane. The delivery system directs a patented flexible capillary lance 90 degrees into the tube bundle with precise position control for reaching specific tube locations, while a small modular control system operates the lancing index and spray functions. A high pressure fan spray of water is delivered at ~238 bar (~3500 psi) to the tube at the target area. The nature and design of this spray pattern are proven highly effective in removing hard-collar material from tubes. Inner bundle lancing effectively traverses the inner bundle to mechanically remove hard-collar material from the tubes, ensuring longer life and increased performance.
Multiple Jets:
- High volume – low to medium pressure
- Outer jets shepherd material to annulus
- Each lane cleaned multiple times on each pass
- Multiple passes
- Cleans multiple tube lanes thereby reducing side migration

Single Setup and Remote Alignment on each SG:
- More time spent cleaning
- Reduces dose
- Reduces schedule

Sweeping Action to Suction Foot:
- Patented suction foot design
- Minimizes water on tubesheet

Filtering available to 1 micron. Precisely aligned using Ultrasonics.
WATERLANCING EXPERIENCE SUMMARY

AREVA has lanced more than 200 Steam Generators globally and has performed more than 126 lancing jobs in North America since 1984:

• 85 lancing jobs at Westinghouse square pitch plants
• 41 lancing jobs at BandW and CE triangular pitch plants
• 12-18 hours typical lancing time per generator

AREVA has performed 10 consecutive waterlance campaigns at DNGS.

D1041 – Combined total (four Boilers) of 24.370 kg sludge was retained in the filters.
CHEMICAL CLEANING
The Value of Safety, Experience and Global Resources

Over the past two decades, AREVA has chemically cleaned more than 200 steam generators worldwide, spanning all major steam generator types: CANDU, Westinghouse, Combustion Engineering, AREVA, BandW, and VVER – including bulk deposits and crevice cleaning.

In fact, we are the only vendor with proven performance in both low- and high-temperature steam generator chemical cleaning (SGCC) processes. Since 2005, we have safely, and efficiently performed 13 of the most recent 16 steam generator chemical cleanings in North America. Our Safety First culture has resulted in zero reportable or lost time OSHA incidents for all of our North American chemical cleaning campaigns. We have also successfully executed international applications in 10 countries.

Getting the Job Done Your Way is Our Top Priority

AREVA has a history and reputation of working with our clients to meet or exceed outage schedule commitments. We have customized solutions that get you back on the grid quickly, with enhanced steam generator performance. AREVA will meet your needs, delivering the most cost-effective solutions that enhance performance at your plant by extending the life of your steam generators.
AREVA Chemical Cleaning Processes

AREVA is offering the C³ (Customized Chemical Cleaning) concept to comply to all customer needs and requirements. Each cleaning is tailored to the plant and SG specific situation.

The portfolio ranges from preventive soft chemical cleaning methods to curative full scale cleaning methods. Based on a comprehensive assessment of the SG condition (considering for example ECT-results, sludge mapping, chemistry data assessment, visual inspection), the optimum cleaning method is elaborated by a team of AREVA specialists working together with plant specialists.
Areas of Concern

Chemical cleaning methods address the complete tube surface and the complete support structure in contrast to mechanical cleaning methods, where the access is limited.

Accessible areas for tube sheet / inner bundle lancing or upper bundle flushing

Localized problems: Blocked flow paths in the tube support structure

Localized problems: Hard sludge on the tubesheet

General tube fouling: Sludge layers over complete tube length (normally approx. 90% of deposits are adherent to the SG tubes)
Preventive Cleaning

Preventive cleaning methods have become state-of-the-art in chemical cleanings, maintaining the steam generators in ‘good’ and ‘clean’ conditions. These processes are intended to be applied on a regular base (for example every five years), whereas the actual frequency depends on annual iron ingress into the SG and deposit removal per cleaning application. Thus it is mandatory to remove a multitude of the annual iron ingress while keeping the corrosion extraordinary low.

AREVA’s proprietary DMT (Deposit Minimization Technique) with removal capacities of 250 kg to 1,000 kg per SG and corrosion of less than 10 µm (0.4 mils) answers all these needs due to its unique chemical concept.

The modular design of the equipment helps to keep plant intrusiveness and the overall duration low. The possibility to perform this process almost without any plant systems (especially without the plant’s internal heat source) allows us to merge the process into an outage schedule, where it fits best.
Curative Full Scale Cleaning

Curative full scale cleaning methods are the ultimate measure for older and heavily fouled steam generators or are applied in case of specific issues, like blockage problems at the tube support structure or hard deposits on the tube sheet.

These processes are applied usually once in a steam generator lifetime and are capable of removing more than 2,000 kg of magnetite per SG. General corrosion stays within the qualification limits to ensure component integrity.

The modular design of the equipment helps to keep plant intrusiveness and the overall duration low. The possibility to use residual heat for the high temperature process during plant shut-down limits the application duration to only a few days.

Our Track Record Speaks for Itself

Safety – No lost time or OSHA reportable accidents over the last five years of SGCC execution.

On Schedule – No schedule overruns in the last seven cleanings.

Proven Technology – Broadest range of options with different, qualified processes available. State of the art “real time” corrosion monitoring system.

Environmentally Safe Waste Processing – More than 2,500,000 gallons of SGCC waste processed and disposed safely with no environmental consequences.
Benefits

Innovative methods ensure more thorough cleaning, limit future degradation, and support the integrity of SG tubing – all resulting in enhanced SG performance.

We offer more options to preserve component integrity, comply with your schedule and meet your performance objectives.

Our responsive teams offer a large selection of processes to tailor solutions for your specific needs.
STEAM GENERATOR REPAIRS AND MODIFICATIONS

Steam Generator (SG) repairs and modifications require the field expertise and innovation of a proven leader. AREVA's support includes operations such as tube-pulling, tubesheet repair, tube plugging, plug replacement, refacing of flanges, tube stabilization and elimination of partition plate defects.

TUBE PULLING


TUBE PLUGGING

Tube plugging (choice of manual, semi-automatic or fully automatic equipment, e.g., PORTIS and ARAMIS), with a range of plugs for various tube diametres, including removable and sentinel plugs.

Total AREVA Rolled Plugs Installed to the end of 2007 = 92,724.

AREVA's process involves the installation of mechanical rolled plugs in each end of the tube.

AREVA has reached a plug installation rate of six to ten plugs per hour. With the additional cleaning step required and the installation of stakes in some cases AREVA estimates using a rate of three plugs per hour.

This process is much faster than the current welded plug process, and the plugs can be removed at a later date, allowing for repairs that may return the tube to service.
Steam Generator Services

AREVA performs the engineering calculations and tests required to qualify the plug design for use in the existing boilers and can utilized in future units. Also included is the Canadian Registration Number issuance through the Technical Standards and Safety Association. A mock-up demonstration of the completed plug design can be performed in our Lynchburg, VA location.

In 1993, mechanically rolled plugs were approved for use in Steam Generator Tubes at Pt. Lepreau Generating Station.

**IN-SITU PRESSURE TESTING**

Various degradation mechanisms have been observed by non-destructive examination (NDE) techniques, such as eddy current testing (ECT), in steam generators throughout the industry. The results of the NDE are used to characterize and size the defects in order or to keep the tube in service.

NDE results may be inconclusive regarding the extent of the degradation. Therefore, in the US, the Nuclear Regulatory Commission (NRC) has endorsed the practice of pressure testing tubes with defects.

Traditionally, a tube sample removal process was utilized to remove the affected tube section from the steam generator for laboratory burst testing. However, since the removal of a tube sample is costly in terms of time, money, and radiation dose an alternative to the laboratory burst test was developed known as In-situ Pressure Testing.

In-situ Pressure Testing is the process of a hydraulic pressurization of degraded tube regions to demonstrate load bearing capacity and allows for the testing of tube defects in the generator without removing a tube sample. Once the test is completed, the tube may
Steam Generator Services

be removed from service, particularly if test pressures exceed the tube design hydro test pressure. Thus, the structural integrity of the tube can be verified without the associated costs of removing a tube sample.

In-situ pressures testing addresses potential for past operability issues associated with ECT indications

- Full Cycle Justification Through Structural and Leakage Integrity Testing
- Structural Margins and Allowable Leakage
- Support APC / ARC
- Correlate Size, Growth, to Burst Integrity and Leakage
- Satisfy EPRI Guidelines and NEI Recommendations
INSPECTION SERVICES

AREVA SECONDARY SIDE INSPECTION

Peak Performance

Predictability. Reliability. Dependability. Maintaining your steam generators safely at peak performance requires insight and tenacity. At every turn AREVA can help you investigate issues, detect foreign material and monitor overall steam generator (SG) performance. We can give you a clear picture of what’s around every bend in your SGs. And when you feel like you are up against a tight spot – we can get you out.

Seamlessly Integrating the Primary and Secondary Side

We combine the best of expertise and technology to deliver the most cost-efficient, safe and reliable Secondary Side Inspection (SSI) results and can adapt technology from our global resources. We are committed to continual investing so our cutting edge technology can keep evolving. Our teams consider the total picture of your SG health by seamlessly integrating primary and secondary side services. Our number one mission is to safely remove foreign material out of your SGs while minimizing personnel radiation exposure.

Investing to Deliver Premier Technology

AREVA has invested millions in RandD to set a new industry standard for SSI. It starts with our new remotely controlled robotic crawler – no surface or crevice is left unexplored. The waterproof crawler enters the steam generator from a hand
hole and provides full access around the periphery region. Our design – unique to the industry – utilizes independent modular tracks allowing the crawler to traverse through the SG annulus, along the shell, on top of the shroud and other locations.

And an automated inner-bundle strip tool delivery system will increase access into tight triangular-pitch steam generators. Combined with our new 2.5 mm CCD camera and control system, our crawler can provide multiple views utilizing an automated pan/tilt camera assembly. The remote data control station can display all views simultaneously. In fact, AREVA’s video package uses a sub – 0.090” CCD-imager with over 250,000 pixels of resolution. The result? You further minimize personnel radiation exposure and get the complete picture of your inspection progress.
Communication with ECT Data Management

Our ECT mobile acquisition trailer is designed for quick setup, deployment and unloading so your plant gets back on the grid faster. Our SSI trailer can communicate directly with our remote eddy current analysis trailer personnel, further enhancing seamless integration and communication between primary and secondary steam generator activities. In fact, our systems can communicate with ECT data management to help verify that all foreign material identified by SSI is mapped into the Data Management files. These files can then be used for ECT inspections. All ECT calls for foreign material (PLPs) are fed to the SSI computers for video verification. Our SSI mobile acquisition trailer (including our Foreign Object Tracking System [FOTS] and Visual Inspection Enhanced Workflow System [VIEWs]) is continuously updated to enhance remote data analysis activities for both the primary and secondary side. Our teams are ready to evaluate and address any emerging issue to get your plant back on the grid faster.

Real-time Processing and Position Tracking

VIEWs works hand-in-hand with FOTS. These advanced capabilities will provide real-time processing and positional tracking of your inspection – keeping the lines of real-time communication open between the primary and secondary side teams. AREVA teams consistently monitor FOTS applications when in use from our home base in Lynchburg, Virginia.
Steam Generator Services

Exclusive VIEWS System

Our exclusive data control system and crawler works together on positive tube identification through position tracking – you will know the crawler and tooling positions at all times, allowing for flexibility during inspections and delivering unsurpassed picture quality.

AREVA’s patented, next generation VIEWS control system includes visual inspection capture, processing and tracking software. It works with the latest data control stations to give you a clear and total view of the job at hand – with the highest quality image capture recording and printing devices.

VIEWS can help you plan and evaluate future plant performance.
Steam Generator Services

New SSI Mobile Acquisition Trailer

Our operators and data control systems can be housed anywhere at the plant site – even outside in our new SSI mobile acquisition trailer. This highly advanced technology centre includes the latest data analysis bays, full 1080p HD recording capabilities, and a customer meeting area.

It all allows you to watch your inspection in progress, or any other archived part of your inspection, on Blu-ray DVD via a 1080p HD plasma screen.

Upgraded Process Trailers and Static Lance Assemblies

To complement our inspection activities, AREVA’s upgraded process trailers and static lance assemblies support high-pressure / high-volume lancing for all steam generator designs. Lancing trailer renovations include improved exteriors to enhance the structural quality, appearance, and operating ergonomics; and programmable logic controllers drive the high-pressure pumps while providing real-time system diagnostics at the operator station.

New High-Pressure Lancing System

Our new high-pressure lancing system for triangular pitch steam generators enables fixed water jets to maintain tight water columns that penetrate completely through the SG tube bundle. This process transfers all of the energy to locations containing the most sludge and effectively removes hard collars. Visual inspections can be performed without dismounting the lancing equipment.
The Peace of Mind You Deserve

Ultimately, this is all about giving you the peace of mind that nothing in your steam generators is going to disrupt your plant performance and megawatt production. It's about keeping you on the grid during time of peak demand, and emerging from challenges successfully.
FOREIGN OBJECT TRACKING SYSTEM (FOTS)
Integrated Approach Accurately Locates Objects in SGs

AREVA’s advanced Foreign Object Tracking System (FOTS) helps customers more closely monitor, track and locate foreign objects in steam generators. FOTS integrates Data Management System Eddy Current (ECT) results with foreign object information provided by Foreign Object Search and Retrieval (FOSAR) personnel. The result? A centralized repository for reporting and resolving Possible Loose Parts (PLPs).

Enhancing a Reliable Process

In the secondary side of steam generators, foreign objects include any item that could become lost and cause mechanical damage. AREVA uses two methods to detect these objects: Visual confirmation by FOSAR personnel, or ECT that reveal a PLP. If we discover a PLP, FOTS automatically defines the signal as an “ECT/ PLP” item, pinpointing both the tube number and specific location of the PLP.

Depending on the detection method, we can also automatically identify tubes bounding the PLP. Once our teams identify a tube with a PLP, they can recommend actions at various stages of disposition, each requiring a response from the appropriate party (i.e. Analysis, Data Management or FOSAR personnel). FOTS will automatically display the ECT plan and associated results for affected and bounding tubes.

Graphic, video, or other document files available for a particular part may be uploaded into this system for convenient viewing and reference by all interested parties. If the Secondary Side Inspection personnel find there is an actual foreign object at a PLP location they will start FOSAR activities. All data gathered from attempts to remove the foreign object will be entered into the FOTS system. The benefit? A method for tracking and resolution now exists if the part is irretrievable.
Steam Generator Services

Reliable Data Gets the Job Done Right

AREVA’s FOTS system assists data management with determining whether a successful PLP bounding campaign is complete. It also assists analysis personnel in tracking their review of bounding tube information. The system helps utility personnel ensure that all PLP and foreign object information is available in one repository, fully managed and properly dispositioned.

Features and Benefits

- Significantly reduces the probability of errors when mapping foreign object locations
- Provides a single and controlled access source for FOTS data
- Allows pre-outage planning for FOSAR and SSI activities around historical PLPs stored in the FOTS System
- Allows you to modify the description of a foreign object, such as size, mass and length

Technical Features

- Web browser-based viewing and reporting capability.
- Rules defined to automatically trigger actions requiring attention based on ECT PLP or foreign object location, results information and previous action results.
- Integration with the secondary side inspection software facilitating easier access and utilization.
FOREIGN OBJECT SEARCH AND RETRIEVAL (FOSAR)
Fulfilling New and Unique Inspection Requirements

AREVA has field-proven success adapting tooling concepts to new and unique inspection requirements. That’s why we continually develop new Foreign Object Search and Retrieval (FOSAR) approaches and materials to complement the most innovative, advanced tooling design. In fact, we combine the latest technology with continuous upgrades of fibroscope, video probes, miniature cameras, processing equipment and computer enhancement techniques.


Throughout our secondary side inspection, we annotate all data verbally and graphically during collection. This critical technique enables inspectors to give experience-based input concerning inspection content. The advantage? You get more detailed information, with results recorded on SVHS videotape or DVD, along with the inspector’s description. We can provide the information on hard copy video prints or as digital image files, according to your specific need. And if you need FOSAR, our team is ready to deliver by using the industry’s most advanced tooling.

CIGAR™

AREVA’s patented Combined Inspection, Grappling and Retrieval (CIGAR™) tooling is the primary workhorse in FOSAR applications. CIGAR includes a specially AREVA’s patented CIGAR™ tooling features two working channels that are typically used to locate and retrieve foreign objects. In this case, the right channel has a video probe inserted and on the left channel, operators have inserted a high powered magnet that can retrieve the item.
designed mounting bracket to free the operator from continually having to hold the tool and to ensure it remains in place. Once the bracket is in place, one of the snorkels is fed into the hand hole. A deflector is used to start the snorkel around the outside of the bundle. Once installed, the snorkel is attached to the mount. The larger of the snorkels is used for periphery work and reaches about 90 degrees around the tube bundle in either direction, providing 100% coverage by working through opposite hand holes. The shorter CIGAR is more efficient near the hand holes and down the lane. If our team locates foreign objects, we can attach grapplers, snares, magnets or other tools to CIGAR through its spare working channel to retrieve the item.

Features and Benefits

• Field-proven success adapting tooling concepts to new and unique inspection requirements
• Information provided on hard copy video prints or as digital image files, according to your specific need
• Patented CIGAR tool provides unsurpassed access to annulus, no tube lane, and inner bundle regions of steam generators (SGs)
• Our SAM tool can deliver 1.5-mm fibre optic probes to the inner bundle in an OTSG or other triangular pitch unit
• Other inspection devices perform multi-pass mapping of top of tubesheet inner bundle conditions in square pitch designs

SAM

We also provide the Segmented Articulating Manipulator (SAM) tool. SAM is small enough to deliver 1.5 mm fibre optic probes to the inner bundle in an OTSG or other triangular pitch unit. Once inserted into a tube row, SAM can articulate upward or downward in the row to view support plate surfaces or provide alternate views of other
areas. Round versions of the SAM tooling are also utilized primarily for feedwater internals inspections to view backing rings and J-nozzle welds.

**GRAPPLING DEVICES**

Assorted grappling devices used with CIGAR are also used with SAM to retrieve loose parts. Some of these grappling devices have built-in articulation to promote easier manipulation. A “kit bag” of retrieval accessories has been compiled over the years and is available on site to cover any unique parts retrieval situation.

**UPPER BUNDLE INSPECTION**

AREVA’s top-down tooling can inspect the upper regions of the tube bundle of flow slot-style generators. The top down tool utilizes available ports at the U-bend region for some SG designs.

**DEVICES FOR INNER BUNDLE INSPECTION**

AREVA has available various submersible inspection devices, video crawlers, and a capillary inspection system for inner bundle observation. We developed divider lane indexing tooling to perform multi-pass mapping of top-of-tubesheet inner bundle conditions in square pitch SG designs.

**Comprehensive Analysis Support**

Analysis support from AREVA may be required if the loose part cannot be retrieved. We have the capability to perform such an analysis and can provide technical justification, for leaving a part in the steam generator. A loose parts analysis is based on the flow conditions, physical configuration and material conditions of both the steam generator and the loose part, along with the potential for wear.
Using knowledge of the steam generator and the flow conditions, we can perform a flow-induced vibration analysis or evaluate wear (through predictive wear techniques) to consider the potential effect of leaving the piece in the steam generator.

**Focussed on Your Specific Needs**

AREVA accommodates a site person to observe the inspection in real time outside containment at the data station. We also provide immediate image processing on the photo printer at the data station if necessary. We realize the significance of loose parts and their impact which AREVA facilitates by making immediate decisions related to part removal and sludge conditions. We have additional proven methods for all designs:

- Top-down tooling can inspect the upper regions of the tube bundle in flow slot-style generators
- Additional devices are available for inner bundle inspection and part retrieval:
  - Submersible robots
  - Video crawlers
  - Capillary inspection system
  - Divider lane indexing tooling (Square-pitch SG designs)
- Comprehensive analysis support available if loose part cannot be retrieved
AREVA is working with customers to manage steam generator (SG) secondary side deposit inventory. MAESTRO is our new integrated software tool designed to guide the engineering approach. Combined with Deposit Mapping Analysis to determine the deposition trend or to provide advance information for future maintenance planning, these tools are powerful allies for implementing highly effective SG asset management strategies.

**Comprehensive Strategies to Enhance Asset Management**

Each SG asset management strategy is a selected combination of mitigation techniques, which will uniquely affect SG tube deposit evolution and in turn, may affect SG tube plugging, heat transfer effectiveness, SG pressure, and ultimately, plant power production. MAESTRO evaluates competing strategies individually, as well as relative to a base case to quickly identify an optimum strategy in terms of net present value.

Deposit mapping is a non-invasive technique for imaging the deposit accumulation within a steam generator using bobbin coil examination eddy current data. The initial deposit mapping work covered only the accumulation on the tubing freespan between the SG tube support plates. In 2008, our expert teams expanded the analysis to include blockage evaluation of deposition within broached tube support plate structures, an important service to maximize safety.

**Ensuring Performance**

The deposit model used in the MAESTRO process employs specific thermodynamic data to estimate the overall heat transfer resistance at various points in time, and modifies
various deposit parameters to arrive at the combination of parameter values which best describes the historical heat transfer behavior of the fouled steam generator tubes. Once these parameters have been defined, the model can predict future performance within the life-cycle management portion of the MAESTRO tool for any chosen planning horizon.

Our new deposit mapping techniques provide very tangible value in characterizing the deposition severity and distribution within the bundle. This information is essential for accurate asset management decisions concerning when to perform deposit removal maintenance, as well as the most efficient process to be used. In addition to the tangible values of deposit mapping, there is substantial future value in developing a deeper understanding of the deposition process, support blockage, flow patterns and thermal hydraulic performance of your SG. The bottom line: Just the right combination of MAESTRO services and Deposit Mapping analyses can help prolong SG life. Knowledge is power.

Features and Benefits

- Both tools can be customized for site-specific conditions.
- MAESTRO quickly identifies an optimum asset management strategy.
- Deposit Mapping is non-invasive and has been expanded to include blockage within broached support structures.
- The deposit model used in the MAESTRO process can predict future performance.
- Our new deposit mapping techniques provide very tangible value in characterizing the deposition severity and distribution within the bundle.

Eliminates the Guesswork

Want to know exactly where steam generator tube deposits collect? You can. AREVA has a new technique for identifying their location. Our advanced Deposit Mapping...
Steam Generator Services

Services eliminate the guesswork of eddy current noise assumptions and visual inspection. We combine lower frequency eddy current examination data with a highly accurate calibration standard. Ambiguity is replaced with certainty by using this powerful assessment and predictive tool to measure deposition and fouling within the SG.

Advanced Maintenance Process

Although great care is taken to maintain the high purity of water entering your SG, the massive amount converted to steam every hour results in the accumulation of troublesome deposits. As with any boiling or distilling system, the pure water is converted to steam but any non-volatile impurities in the secondary system water remain and are concentrated within the steam generator.

Over time, these impurities collect on the interior surfaces of the SG and reduce the efficiency of heat transfer and fluid flow. The large number of tubes within a typical SG provides a large heat transfer area.

This is where most of the water turns into steam and leaves behind impurities as deposits on the outside of the tubing. As the deposit layer builds up, the transfer of energy into the secondary water becomes less efficient. This buildup can also lead to restriction of flow within the SG, causing further performance degradation. That's why AREVA has developed this advanced maintenance process. You can use the valuable information obtained in conjunction with thermal-hydraulic and chemistry models to develop SG program predictive and preventive strategies.
Steam Generator Services

Enhance the Efficiency of Other Maintenance Activities

In this case, knowledge truly is power. Knowing the actual deposit loading distribution will enhance the efficiency of actions such as chemical cleaning, sludge lancing and Upper Bundle Flush (UBF).

Features and Benefits

- Eliminate the guesswork of eddy current noise assumptions and visual inspection
- Use the valuable information obtained in conjunction with thermal-hydraulic and chemistry models to develop SG program predictive and preventive strategies
- Enhance the efficiency of other maintenance actions

Scenario Comparison – Cumulative NPV

Scenario Comparison – Deposit Inventory
CHEMISTRY AND MATERIALS CENTRE
Offering Solutions for a Crucial Challenge

The Electric Power Research Institute (EPRI) estimated in a study released in 2001 that corrosion damage costs the US electric power generating industry $17.3 billion annually, or about 7.9% of the cost of electricity to consumers. Presently, as much as 50% of all forced outages are attributable to corrosion damage. An estimated 22% ($3.8 billion) of this cost is considered avoidable. That’s why AREVA has expanded its chemistry services through construction of our innovative Chemistry and Materials Centre (CMC). Where you face corrosion challenges, we deliver comprehensive support and the convenience of one-stop solutions.

Comprehensive Laboratory Support

AREVA provides routine, emergent and specialized chemistry, corrosion and metallurgical testing and analysis support for operating nuclear power plants in the new CMC facility. Additionally, the lab will support internal AREVA production, research and development. Our 8,000 square-foot, two-story facility houses multiple laboratories. Using only the latest equipment and cutting-edge technologies, we can analyze radioactive and non-radioactive samples of solids, liquids and gases from all locations in your plants.

These include but are not limited to:

- PHT system
- Moderator water
- Secondary plant water
- Cooling water
- Fuel deposits (crud)
- Steam generator deposits
Steam Generator Services

- Resins
- Environmental samples
- Foreign materials
- Consumable materials
- Failure analysis
- Non-aqueous liquids

A One-Stop Chemistry Resource

As your one-stop Chemistry Services resource, we can also provide specialty testing and technical capabilities to address specific customer needs, including regulatory and materials performance issues.

Only the finest, seasoned technical experts in power plant chemistry and corrosion control staff our CMC. High-quality, on-time delivery of lab results complements current AREVA engineering solutions for routine and long-term customer needs, whether servicing existing plants or preparing for the design and construction of new plants.

Features and Benefits
- New laboratory provides routine, emergent and specialized chemistry, corrosion and metallurgical testing and analysis support.
- We use only the latest equipment and cutting-edge technologies.
- Within the CMC we can analyze radioactive and non-radioactive samples of solids, liquids and gases from all locations in your plants.
- By combining our CMC with our in-house technical staff, we offer the convenience of a one-stop shop.
AREVA’s Metrology Services unit has a full-time staff of professionals dedicated to support the measurement needs of the nuclear industry and ongoing research and development efforts.

Our commitment, coupled with an extensive inventory of advanced technologies, makes AREVA the industry’s most experienced and versatile provider of quality metrology services. We know the importance of outage efficiency. That’s why our level of nuclear experience and in-depth knowledge of outage schedules ensures seamless integration with other outage activities. All of our operators are OSHA-certified, adhering to stringent safety practices.

Moreover, we are committed to ongoing innovation and technical training for a superior end product. Our teams can support a wide range of needs – from precision measurements accurate within .001” to large-scale, survey-grade accuracy and as built surface modeling accurate within .25”. Our wide range of metrology services supports design engineering, fabrication, installation, dimensional receipt inspection, large volume surface modeling, and interference detection and animation creation. Innovative technologies include digital photogrammetry, complete 3D CADD analysis and
visualization, laser tracking, industrial total stations, and laser scanning.

**Versatile Photogrammetry Technology**

Photogrammetry is one of the most versatile measurement technologies available for the industrial market. In fact, we can even achieve accuracy to within +/- .005. An operator takes pictures of the object of interest from varying angles. We’ve even developed a new offering for underwater photogrammetry. Since the digital camera works on typical photographic principles, an image is captured at a high shutter speed, eliminating the need for a tripod or stable perch. The ability to take seemingly arbitrary handheld pictures from varying angles minimizes the impact of ongoing work. One can survey an entire object without interrupting or disturbing other activities and personnel within the area.

**Helping You Achieve the Perfect Fit**

Our measurement and modeling services can enable you to implement the design and fabrication associated with plant system modifications and new or replacement components – much earlier in the project life-cycle. It’s all to provide the compatibility to mate to existing systems including piping – even to flanged connections, HVAC, electrical and support structures.
Steam Generator Services

We can analyze potential interference conditions long before your component is built and delivered. But there’s more. If incorporated into design engineering, we can ensure an interference-free piping and system modification design. We also verify that components meet their design dimensional specifications – prior to leaving the fabricator’s facility to allow for modification if required.

Features and Benefits

- Advanced metrology services
- American Society of Photogrammetry and Remote Sensing (ASPRS) certified photogrammetrist on staff
- Proven experience integrating multiple metrology technologies
- Installation and design risk mitigation
- Advanced interference notification
- Minimized rework
- Schedule savings = decreased cost
- Reduced personnel radiation exposure
- Customized applications to meet your specific needs

Technical Features

Fast results – We make results available within minutes of completing the object photography (when using our single camera system). But we can provide instant results when we use our two-camera online system.
Steam Generator Services

Flexibility
AREVA uses the system in a wide range of applications, including partial inspection, deformation measurement – and partial adjustment.

Portable
We can take our battery-operated, highly portable system to the most remote locations. In fact, our teams can complete a measurement at the customer site with just one “size-wise” carry-on case and a laptop computer.

Minimal Temperature Effect
Our team can typically complete photography in 10-15 minutes, reducing the effect of temperature differential between the start and end of measurement.

Immune to Vibration
The system even works in unstable environments including vibrating or unstable floors, man lifts, cranes and ladders. The object being scanned can vibrate or move during the measurement without affecting the results.

Versatile in Confined Spaces
The small system can operate in even the most challenging line-of-sight environments.

High Data Rates
The system lends itself well to high-point data requirements. Increased processing time for larger volumes of data is minimal.

Proven Track Record
AREVA enjoys a field-proven track record of providing the latest high-tech metrology services.
Steam Generator Services

METROLOGY SERVICES 3D CADD ANALYSIS AND VISUALIZATION

AREVA’s Metrology Services unit has a full-time staff of professionals dedicated to support the measurement needs of the nuclear industry. Our commitment, coupled with an extensive inventory of advanced technologies, makes AREVA the industry’s most experienced and versatile provider of quality metrology services. We know the importance of outage efficiency. That’s why our level of nuclear experience and in-depth knowledge of outage schedules ensures seamless integration with other outage activities. All of our operators are OSHA certified, adhering to stringent safety practices. We are committed to ongoing innovation and technical training for a superior end product.

Our teams can support a wide range of needs — from precision measurements accurate within .001” to large-scale, survey-grade accuracy and as-built surface modeling accurate within .25”. Our wide range of metrology services supports design engineering, fabrication, installation, dimensional receipt inspection, large volume surface modeling, and interference detection and animation creation.

Innovative technologies include complete 3D CADD analysis and visualization, laser tracking, industrial total stations, photogrammetry and laser scanning.

As-Built 3D CADD Analysis Eliminates Spatial Conflicts

AREVA Metrology teams offer you superior 3D CADD services by utilizing only the most advanced, innovative measurement technologies. We use 3D visualization abilities to virtually eliminate the possibility of spatial conflicts with structural elements in new designs.

We can perform services for component removal and installation interference detection, as-built modeling and animation creation.
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Helping You Achieve the Perfect Fit

Our measurement and modeling services enable you to implement the design and fabrication associated with plant system modifications and new or replacement components — much earlier in the project life-cycle. This provides the compatibility to mate to existing systems including piping — even to flanged connections, HVAC, electrical and support structures.

We can analyze potential interference conditions long before your component is built and delivered. If incorporated into design engineering, we can ensure an interference free piping and system modification design. We also verify that components meet their design dimensional specifications — prior to leaving the fabricator’s facility to allow for modification if required.

Technical Features

- As-built 3D modeling generates as-built 3D CADD models of existing components and structures to support design modifications, load path analysis and volumetric studies
- As-built 3D modeling supports:
  - Component installation interface alignment
  - Component load path interference detection
  - Interference-free piping design modifications
  - Interference-free structural design modifications
  - Electronic component removal and installation simulation
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METROLOGY SERVICES LASER SCANNING

New technology advancements offer easy visualization and basic measurement extraction from the collected data. Also, new software will allow users to perform virtual walk-through and measurement tasks from their own personal computer. The software is intuitive and requires no training, its accurate (+/- .25 inch) and comes with unlimited usage restrictions.

Laser Scanning Captures Complex Surface Geometries

Laser scanning accurately captures complex or irregular surface geometries of objects that require engineering or survey-grade accuracy (+/- .125 inch). The process substantially enhances efficiency to help measure and model every feature within the survey envelope, especially hard-to-reach, awkward areas and items. We can easily export the finished as-built 3D models to popular CAD packages for subsequent use in design of facilities, interference-free system modifications or site documentation. Laser scanning also replaces traditional field walk downs, minimizing resources and personnel dose exposure while increasing the amount and accuracy of the collected data.

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Component replacement challenges occur when engineering designs and plans meet real-world conditions — often during the critical stages of on-site execution, resulting in schedule delays and cost overruns. But now you can avoid the uncertainties of theoretical design information. AREVA offers comprehensive metrology services to help you collect, measure and analyze real-world data for the specific needs of your plant.

**Laser Trackers — The Ultimate Tool for Accuracy**

For extreme accuracy — even within only .001 of an inch — AREVA utilizes laser tracker technology. The iterative tracker design we use features a superior sealed mechanical system with years of experience in harsh environmental operations. Now we can align, measure, and scan faster and easier than ever before. This latest innovation also minimizes systematic measurement errors, resulting in superior tracker stability, range and accuracy.

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Technical Specifications

Specifications

- Max lateral target speed: > 3.0 metres/sec (120°/sec)
- Max acceleration all directions: > 2 g

Range of Measurements

- Horizontal: 640° (± 320°)
- Vertical: + 80° to - 60°
- Measuring Dia. (IFM and ADM): > 120 metres (400 feet)*
- Angle Resolution: ± 0.07 arc-second
- Internal level accuracy: ± 2 arc-second

3-D spatial measuring performance

- Resolution: 1 µm
- Repeatability: 2.5 ppm (2 sigma)
- Absolute Accuracy of a 3D Coordinate
  - Static: ± 5 ppm (2 sigma) 0.001” (25 µm)
  - at 16 feet (5 metres)
  - Dynamic: ± 10 ppm (2 sigma) 0.002” (50 µm)
  - at 16 feet (5 metres)

Laser Interferometer Distance Performance

- Resolution: 1 µm (user programmable from 0.1 to 1 µm)
- Accuracy: better than 0.5 ppm
- Maximum speed: infinite

ADM Distance Performance

- Resolution: 1 µm (user programmable from 0.1 to 1 µm)
- Accuracy: ±15µm or 1.5ppm, (whichever is greater) / ±
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- 0.0006” (15 µm) at 16 feet (5 metres) / ± 0.0012”
- (30 µm) at 65 feet (20m)
- Maximum speed: infinite

Environmental
- Air Temperature: -10°C to > 40°C (14°F to > 104°F)
- Barometric Pressure: 580 mmHg - 800 mmHg
- Relative Humidity: 10-92.5% Non-condensing
- Altitude: 2000 Metres

Physical Features
- Weight of Tracker Head: 8.5kg (18.5lbs)
- Weight of Controller: 3.2kg (7lbs)
- Total Package Weight: 23kg (50lbs)**

* with selected targets
** includes carrying case, tracker, controller, tools, cable, accessories
BALANCE OF PLANT

BOP HEAT EXCHANGER SERVICE
Successfully Extend Component Life

Want to extend component life and minimize unplanned shutdowns? Consider AREVA’s tube repair services for feedwater heaters and other BOP heat exchangers. Our field-proven solutions have helped customers regain lost heat-transfer surface area and effectively extended the life of their components. Our responsive teams can help minimize the risk of unplanned shutdowns from heat exchanger issues. As a result, the replacement of heat exchangers can be delayed or even postponed indefinitely while maintaining plant reliability.

Features and Benefits
• Our field-proven solutions have helped customers regain lost heat-transfer surface area.
• Heat Exchanger services can extend the life of your components.
• Minimize the risk of unplanned shutdowns from heat exchanger issues.

An Innovative Process Delivers Results You Can Count On

Are tube wall losses and degraded plugging margins a threat to your plant performance? AREVA has innovative solutions to correct and reverse these common heat exchanger problems. By working through the tube ends via the channel heads of the component we can install a sleeve inside the damaged portion of the tube. This sleeve provides a new pressure boundary bridge across the defect, creating a new structural boundary. The result? Tubes which would otherwise be removed from service by plugging can continue to provide their heat transfer function. Moreover, AREVA’s innovative sleeving system allows our teams to perform repairs anywhere along straight sections of tubing – as much
as 50 feet or more from the tube end. The process requires access to only one end of the tube, which makes it possible to install sleeves in straight sections of U-tube heat exchangers.

In certain feedwater heater designs, tube degradation generally can occur due to either high cross-flow in the heater drain cooler region (commonly due to power plant uprates) or by-pass flow through the feedwater heater drain cooler end plate. Where these by-pass flow conditions occur, AREVA implements an additional repair step to expand the tube at the drain cooler end plate. The combination of tube expansion and sleeving can minimize the risk of future tube damage while leaving degraded tubes in service.

During a three-week period in a recent outage season, AREVA installed 479 sleeves in four feedwater heaters. This repair work allowed customers to leave 103 tubes in service that would otherwise have been plugged, avoiding a 1.2% loss in heat transfer as opposed to tube plugging. We also expanded 1076 tubes into the drain cooler end plate in two feedwater heaters. Because of the tube expansions, the operating conditions for both feedwater heaters returned to their as-designed values and flow spiking was eliminated.

Safety and Efficiency are Always Our Top Priorities

AREVA performs general outage heat exchanger maintenance work in addition to specialty tube repairs. In fact, during a recent five-week span, our Heat Exchanger service crew worked on more than 20 different heat exchangers, performing closure removal/reinstallation, tube cleaning, tube plugging, tube integrity pressure tests, closure bolting repair, and tube bundle replacement. These components were located throughout the plant in the turbine building, the auxiliary building, and the reactor containment building.
Not only did all post maintenance reviews performed on the components pass inspection, but our service team worked more than 6,500 hours without any personnel safety issues. Whatever your specific need, we can tailor a plan to deliver these kinds of results for your plant.
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CHEMICAL CLEANING FOR FIRE PROTECTION SYSTEM PIPING
Dissolve Corrosion Products More Efficiently

AREVA now offers thorough, safe and cost effective cleaning for your fire protection system piping. In conjunction with our exclusive high-tech resources, we use an innovative process that features enhanced chemistry and application engineering. After completing and studying a deposit analysis, we perform bench optimization testing to determine the specific needs for your fire protection system. That’s why we can dissolve corrosion products more efficiently than other vendors. We can perform work at plants with other underground and above-ground piping systems.

Process Removes Hematite

Our proven method removes hematite deposits that compromise the “C” Factor and potential performance of your plant’s system. The cleaning process includes the addition of patented FerroQuest FQ chemistry to the fire protection tank, lowering the pH to a level necessary to dissolve deposits while protecting system metallurgy and circulating the solution through the piping system.

Minimize Plant Shutdown Time; Increase “C” Factor

Our unique chemistry allows us to perform chemical cleanings on-line, minimizing plant shutdown time and also minimizing the use of limited operating conditions. In fact, it can remove thousands of pounds of deposits, strengthening your plant’s ability to protect its structures, systems and components – and to increase “C” factor. In addition, we can complete the project without any disruption to plant operations and without shutting down your fire protection safety system.
About AREVA Canada

AREVA has been in Canada for more than 40 years and has a presence in several Canadian provinces and Nunavut. AREVA Canada has more than 600 employees and contractors in several locations across the country that are engaged in exploration, mining, manufacturing and solutions for CO₂-free power generation. A leader in Canada’s uranium production, AREVA is also a major player in the manufacture of radiation measuring equipment, and as a services and engineering provider for Canadian nuclear reactors.

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