Stack Monitoring and Sampling

Curtiss-Wright provides a complete solution for the sampling and monitoring of radioactive effluents in stack and duct ventilation systems

- Compliance with national and local environmental laws
- Prove your authorized site discharges
- Prevent or mitigate the effects of radioactive releases

- Complete safety systems design
- System installation and commissioning
- Bespoke training
- Preventative maintenance visits annually

- Post installation service support
- Guaranteed response times
- Software support
- Aging and obsolescence management

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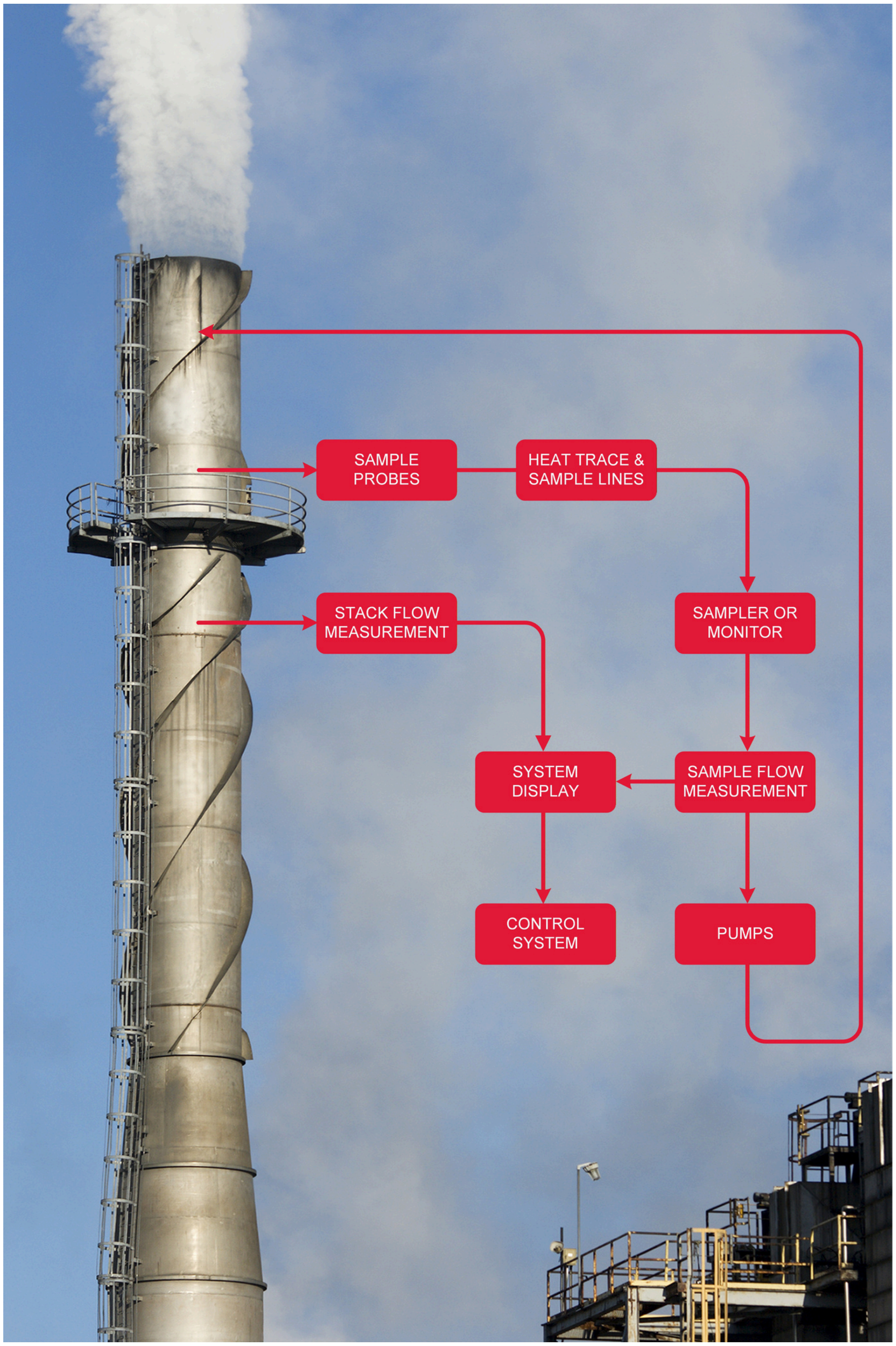
Stack Systems



A stack monitoring or sampling system comprises a number of key elements. These combine within a system to offer a monitoring or sampling solution to assess radioactive effluent releases as efficiently, accurately and fast as possible. Key parts of the system design include probes to extract a sample from the stack, collectors to collect the sample, detector(s) to measure, and pumps and controllers to regulate the sampling loop.

We assist with design in early stages of a project to ensure equipment can be sited in the optimum location. This ensures measurements provide the most accurate results possible. It has been found that an early design of discharge measurement equipment provides the most cost effective and efficient system.

An important choice is whether a monitor and/or sampler is incorporated in the system design. A monitoring system will use a detector that measures sampled radioactivity in real time and is used wherever instantaneous measurements and alarms are required. A sampler, however, is used for regulatory purposes, as it will collect a sample which is removed from the system and retrospectively counted in a laboratory.

In the majority of systems, the bulk air flow in the stack or duct will need to be measured. Many air flow measurement technologies are available. Curtiss-Wright's preference is to use an averaging Pitot device. The averaging Pitot is well proven, well documented and substantiated within international standards. It is easily tested and calibrated in-situ, without the need for expensive removal and return to external testing laboratories.

Radioactive monitoring or sampling equipment may be a small part of a nuclear facility, but it is extremely important that the system works efficiently and correctly. To ensure that the equipment is in the optimum location, early consideration as to its position increases accuracy, reduces cost and confidence in a good engineering solution.

Where systems must be retrospectively installed into existing facilities or where the conditions are not ideal, Curtiss-Wright can advise as to the best location to position equipment and design bespoke solutions to overcome limitations of site conditions.

Sample Probes

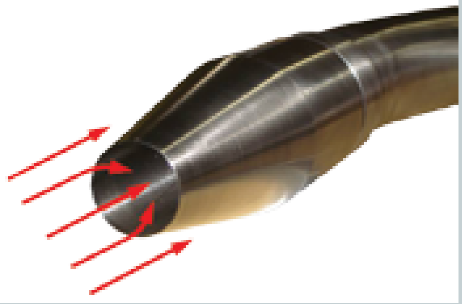
Curtiss-Wright uses three types of stack sample probes. Isokinetic and shrouded probes are used to extract particulate samples from stacks and ducts. Simple gas probes are used for gases.

Isokinetic Probes

Isokinetic sample probes are designed to extract a sample from the stack with the velocity of the air entering the nozzle flowing at the same velocity as the free gas stream in the stack. With two velocities equal, this ensures that there's no over or under sampling of the particulate. With the stack flow being at a fixed flow, and the sample flow being fixed, the diameter of the nozzle bore is the limiting factor to determine that the sample probe is operating under isokinetic conditions.

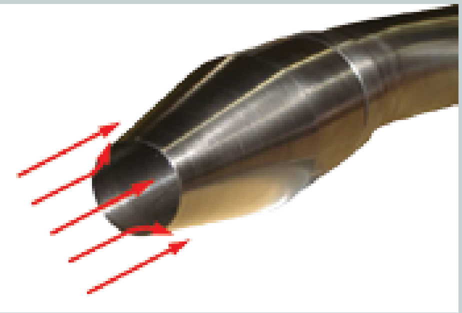
Oversampling

If the flowing velocity into the nozzle is greater than the free stream velocity, the system will oversample the amount of particulate in the stack. This results in overreporting of the activity released.



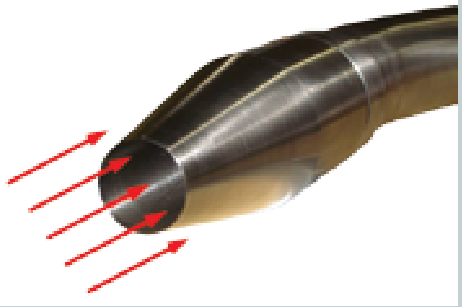
Undersampling

If the flowing velocity into the nozzle is less than the free stream velocity, the system will under sample the amount of particulate in the stack. This results in underreporting of the activity released.



Isokinetic Sampling

When the two velocities are the same, the nozzle collects a true representative sample of the particulate which is entrained in the stack flow system.



Shrouded Probes

A shrouded probe offers some benefits over an isokinetic sample probe. Where the isokinetic sample probe can only work within a defined set of flowing parameters, a shrouded probe can operate over a range of stack flow conditions. The outer shroud captures an intermediate sample from the main stack flow stream and the internal sample nozzle collects particulate from this smaller sample. The shrouded probe has been tested to determine the collection efficiency at different stack and sample flow rates.

Shrouded probes can operate over a range of velocities, providing a cost saving, as expensive testing, which is required to determine isokinetic probes ideal position and nozzle bore, is not required. Another benefit is if a plant is required to decrease its fan speed during dark hours, a single probe can still be used, whereas multiple probes would be required if an isokinetic probe was chosen.

Gas Sample Probes

The gas sample probe assumes that there is a homogenous fully mixed volume of gas in the stack. The maximum length of sample lines is not so important, unlike particulate sample lines where sample losses occur due to plate-out within the transport system. However, care should be taken with the choice of sample line material, to ensure that there is no reaction between the gas being sampled and the material of construction.

Sample Lines/Trace Heating

Curtiss-Wright offers a range of sample conditioning systems that ensure the stack sample is delivered to the monitor/sampler in a representative and measurable form.

Sample Transport Lines

When considering transport lines for sampling particulate, the length of the pipe run should be kept as short as possible. The sample pipe work should be constructed from cold drawn tube and never schedule pipe. This is to ensure the inside of the particulate transport system has a smooth internal surface.

Horizontal straight tubing sections should be kept as short as possible and there should be no steps at the tube connections which reduce the tube diameter by more than 1%.

There will be some losses in the transport system, but careful design and consideration will optimize the overall efficiency of the system. For 10µm AD particles, the penetration from the free air stream to the collector should be more than 50%. Early design of the sample transport system can greatly increase the efficiency and reduce the cost of the overall system.

The efficiency of the transport system may be checked by computer modelling or by in-situ testing after the system has been installed.

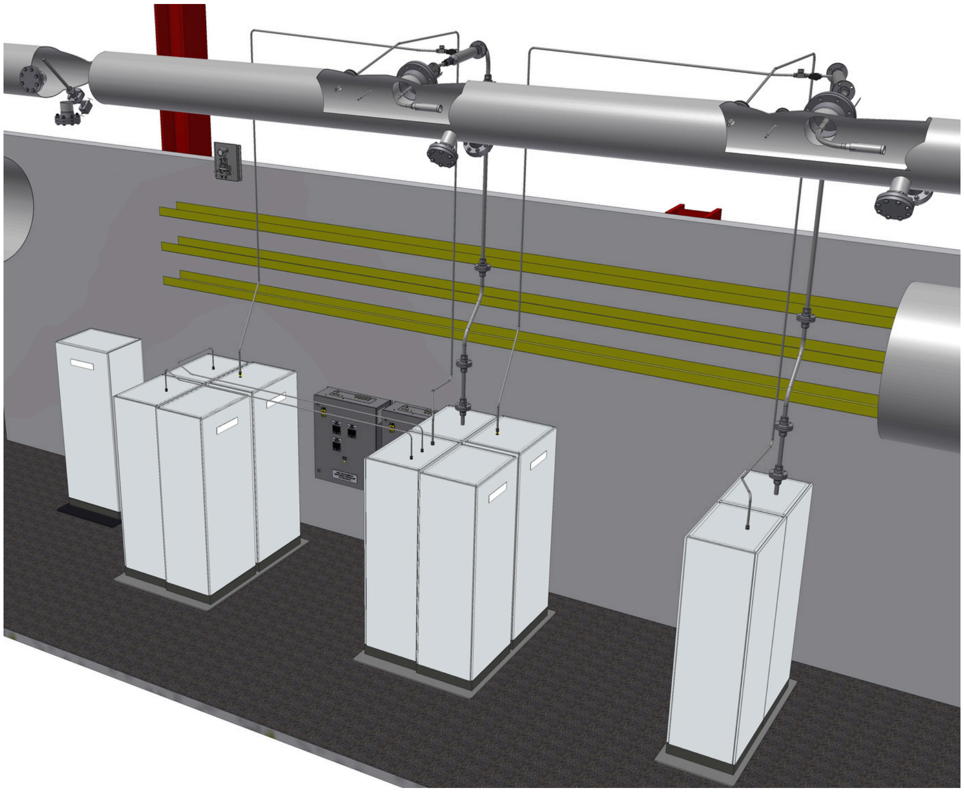
Sample transport lines for gaseous sampling are not affected as much as particulate sample lines, but care should be taken so as not to have excessive lengths or route paths through differing temperature regions, as this could aggravate potential condensation problems.

Trace Heating

In any system, it is important that the sample gas should be dry to avoid moisture damaging the detector or collection media. For example, Condensation may occur if the sample transport line travels through areas which have lower temperatures than the stack gas temperature

A common reason for these conditions occurring is when the sample is being removed from an external stack and then running through cooler exterior sections. If the stack temperature is greater than the cooler external air, any moisture in the sample gas could condense in the sample line, after which the liquid would be drawn onto the collector.

Information concerning the relative humidity for the stack gas and any temperature gradients along the transport route should be considered to determine if condensation problems could arise. We offer consultancy on trace heating requirements and a complete hardware design to control and temperature regulate sample transport lines if required.



Samplers

Curtiss-Wright offer a range of sampler designs with various mounting options including free standing enclosures or wall mounted back plates.

Tritium and C-14 Samplers

Tritium and C-14 sampling is achieved by passing the sample gas through liquid traps, where the liquid is then subsequently removed to a laboratory for analysis. The collection medium for Tritium can be either demineralized-water or glycol, whereas for C-14, typically sodium hydroxide would be used.

Depending on the chemical form of the isotope - organic or inorganic, a furnace and catalyst may be incorporated.

The flow of the free air stream in the duct and the sample flow through the collectors will be displayed in real-time the sampler enclosure. Additionally, totalizers are used to sum total sample flow and total stack flow.

Particulate Samplers

For particulate, the sample will be withdrawn from the duct or stack by means of either a shrouded or isokinetic sample probe. The sample is collected on filter medium which can either be card-mounted filter paper or a loose filter paper.

The size and geometry of the filter medium can be selected to suit site preference, sample flow requirements and the type of laboratory analysers being used. If sampling for Iodine is required, an alternative filter holder is used to accommodate to an Iodine filter such as TEDA impregnated Charcoal or Silver Zeolite.

As the record sampler is to be used for regulatory purposes, dual vacuum pumps are normally supplied, these pumps can be controlled either manually or with automatic changeover. Both the totalized stack and sample flows are recorded over the sampling period, with alarms to warn of flow rates which are outside a pre-defined range.R

Monitors

Curtiss-Wright has a range of radiation monitoring systems that are used for the continuous, real-time analysis of stack radioactive effluent.

Alpha-beta Particulate

For continuous measurement of radioactive particulates in stacks and ducts, nuclear facilities will often incorporate a Continuous Air Monitor (CAM) in their stack monitoring program. While a CAM offers a less sensitive result compared to laboratory analysis of a record sample, the system has the advantage of providing early warning to a failure of the process or filtration mechanisms.

Curtiss-Wright provides several system configurations for particulate. Depending on local requirements, the CAM system can be packaged within a floor standing enclosure, skid arrangement or wall mount panel. In addition, the CAM can be supplied mounted on a cart, which allows flexibility during decommissioning activities where the duct monitoring location may change. Irrespective of packaging, most particulate systems will, as a minimum, comprise of a CAM, mass flow controller, pump and sample flow totalizer.

Curtiss-Wright's CAM solution, the SmartCAM, offers a number of key features, including:

- Measurement of alpha and/or beta particulate
- Allows users to identify air concentration by isotope or as radon-compensated gross alpha
- Full alpha spectral analysis with unique radon-thoron peak fitting algorithm
- Improved measurement quality due to alpha spectrum stabilization enabled by continuous air pressure and temperature measurement and correction
- Fixed filter or moving filter configurations available

Iodine

Curtiss-Wright's iodine monitor is available in isotopic specific configurations for many iodine species and offers real time measurement of both molecular and organic forms of iodine. The sensor element of the system is called the continuous gas analysis and detection chamber (CGADC). The CGADC combines a sensitive scintillation detector with a stainless-steel measurement chamber housing a radioiodine filtration cartridge. The local processor and display unit for the system is the SmartMCA continuous air monitor. The SmartMCA uses a multichannel analyzer to provide isotopic specific Iodine concentration results, with automatic background compensation.

Features of the Curtiss-Wright SmartMCA include:

- Filtration mechanism captures all forms of radioiodine
- Achieves low MDLs through unique detector design with Bremsstrahlung shield
- Automatic background compensation
- Temperature spectrum stabilization reduces inaccurate measurement due to spectrum drift
- CMS analysis algorithm provides a low stable measurement at background, but ensures a fast response to rising concentration levels

Monitors (cont.)

Noble Gases

The noble gas monitor is an integrated solution for measurement of airborne concentration of radioactive (beta emitting) noble gases. The monitor is suitable for stack applications, and comprises detector, shielding, pump, flow sensor and continuous monitoring station (CMS) processor.

The heart of the system is the BG-10 scintillation detector. Offering unparalleled sensitivity to noble gases, the BG-10 uses a specially designed plastic scintillation sensor mounted in a shielded flow through measurement chamber.

The noble gas monitor has a standard configuration with a six-decade range of measurement or as a dual detector configuration offering a wider, extended measurement range.

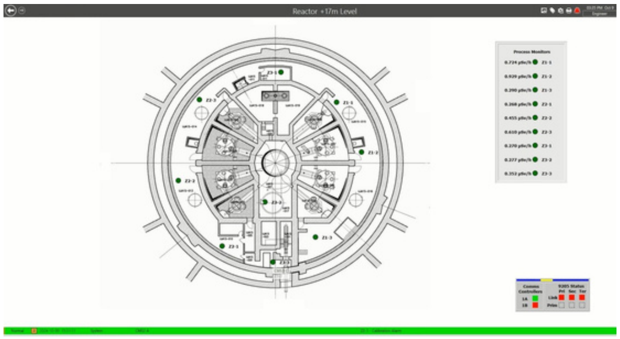
- Excellent MDL from minimal detector response to external sources of gamma
- Low response to NORM such as radon and thoron
- CMS analysis algorithm provides a low stable measurement at background, but ensures a fast response to rising concentration levels

Central data logging of effluent

Nuclear facility license requirements stipulate the need for continuous recording and management of effluent data, which typically uses PC loggers and supervisory control and data acquisition (SCADA) networks.

Curtiss-Wright offers a bespoke radiation monitoring SCADA called the 9205EMS, which collects real-time alarm status and result data from a network of the radiation detection instruments and stack monitoring equipment. From the system's inception in the early 1990s, the 9205EMS has been adopted at hundreds of nuclear facilities around the World.

- Facility floor plan view allows fast recognition of any alarm or status event
- Effluent data presented for stack releases on a daily, weekly, monthly and annual basis
- Automatic effluent release reports automatically generated at a user defined frequency
- To provide instant data access, the 9205EMS internet client allows an operator to review 9205EMS data from any computer on the network
- Graphical display of historic measurement
- Compatible with any network architecture



Stack Flow Measurement

Pitot Flow Meter

The choice of flow meter is dependent upon many factors, including the flow rate, geometry of the stack/ducting and location at which the flow meter can be installed. There are many designs and principles of measuring air flow, and within these types there are different configurations.

- Single point measurements
- Averaging flow meters in one plane
- Averaging flow meters in two planes

Curtiss-Wright favors flow meters based on the Pitot Tube principle. The working principles of the Pitot are well documented and covered in international standards and directives. They can be easily proved and checked in-situ, without the need for expensive removal and return to test laboratories. There are several basic formats of the Pitot device which have been enhanced by Curtiss-Wright to cover the wide range of installation requirements found in the nuclear industry.

- Simple construction with no moving or electrical parts in the flow stream
- Well documented performance data
- Can be calibrated in-situ

When combined with our differential pressure transmitter, Pitot flow meters offer a simple solution for measuring air flow. With increased accuracy, the volume of emissions into the environment can be controlled to a higher level than ever before. When used in conjunction with our range of monitoring and sampling equipment, even the smallest amounts of allowable discharge can be detected.

In a perfect installation, the length of duct into which the flow meter is to be installed would be at least 10 hydraulic diameters long. Under these conditions, the position of the flow meter would be at a point 70% along the duct. At this point the velocity profile would be regular and flat, but as stated above, this is a perfect installation. In the real-world things may not be as simple.

Differential Pressure Transmitter

When monitoring the air flow in ducts and stacks by means of a differential pressure generating device (Pitot tube, Venturi, etc.) the differential pressure to be measured tends to be less than 300 Pa.

Curtiss-Wright uses a transmitter that performs at such low pressures to provide accurate flow measurement. The pressure transmitter can be close-coupled to the Pitot flow meter or installed at a remote location. Curtiss-Wright manufactures pressure transmitters in its facility in Texas.

Pump and Pump Control Systems

Pumps

The motive power to draw the sample air through the sampler or monitor is provided by various vacuum pumps or air ejectors.

The type of pump chosen will depend upon factors unique to each installation, including sample flow rate, total pressure drop through the system, flowing temperature and the ambient atmospheric conditions at the site location, as well as pump heat levels, pump sound levels and routine maintenance considerations.

For a bubbler type of sampler (Tritium/C14) a diaphragm pump is used. When sampling particulate a dry running rotary vane pump is required. If the service required is for a monitor, a single vacuum pump is sufficient. In general terms when equipment is being used for accountancy purposes two pumps are used, one run and one standby. In the event of loss of vacuum an alarm alerts an operator that the run pump has failed and the standby pump should takeover. If the equipment is in an unmanned area the pump changeover is automatic.

If the facility has an installed compressed air supply, an air ejector could be used as an alternative to electrical vacuum pumps. These have the advantage of having no moving parts, are typically both quieter and produce less heat. As the air compressor on many sites is supplied from a UPS, the system would remain in sampling mode even in the event of a power failure.

Pump Control Systems

The pump control system can be as simple as a single on/off switch to a fully automated control system. Often the sampling system is the equipment used to record discharge for regulatory purposes so it is important to maintain sampling during operation of the plant. To ensure continuous sampling in the event of a pump failure, dual vacuum pumps are incorporated into the design of the system.

Considerations covered by the Curtiss-Wright design:

- Selection of which pump is designated “Run” and “Standby”
- Indication of which pump is running
- Indication of pump failure
- Reset pump failure alarm
- Pump manual stop/start
- Individual pump run timer

Nuclear Services and Support

Nuclear services and continued support both on-site and off to ensure extended operation throughout the facility's life.

Annual Flow Testing

It is becoming ever more important to be able to prove that a site, building or process is complying with all the relevant legislation regarding emissions into the environment. We assist our clients to achieve their goals written into their environmental monitoring system's aims.

- Comply and prove their authorized site discharges
- Comply with the relevant national and local environmental laws
- Prevent or mitigate the effects of environmental incidents
- Help promote environmental monitoring awareness to staff

It is well documented that gaseous discharges are very difficult to quantify. We employ tried and tested methods to verify that site flow measurement procedures and equipment meet the needs of our clients' regulator.

All tests are conducted in accordance with detailed documented data/procedures as covered by relevant standards. Not only can the actual flow be measured but characterization tests of the stack can determine that the location of any sampling equipment is producing a representative example of the discharge via the main stack.

As legislation concerning emissions into the atmosphere becomes more restrictive, remember that Curtiss-Wright offers a full range of expertise to help you to meet the legal requirements for environmental monitoring.

Duct Characterization Tests

These tests are carried out to determine two factors concerning a duct/stack flow system. The first is to establish the velocity profile at the point at which any sampling of the air stream is performed. The second is to produce an accurate and traceable measurement of the flow rate, against which any permanently fitted flow meter can be referenced.

These tests can be used as an annual check to determine that systems are still working to their design specifications. Their results can also be used to show trends in fan efficiency, discharge rates etc.

Another reason for undertaking these tests is to establish the velocity profile within the duct, so that the nozzle position of a sample probe can be determined. The velocity at the exact location position will then be used to calculate the diameter of the isokinetic sample probe nozzle bore.

There are several national standards and directives covering duct/stack flow measurements and sampling. In Europe the relevant standard is ISO 2889. In the US it is ANSI N13.1.

Instrument Service and Support

Curtiss-Wright is committed to providing high quality after-sales service to our customers. We offer a suite of support packages to meet service level requirements. All Curtiss-Wright service engineers are classified workers, RPS trained and hold CCNSG safety passports.

Comprehensive range of maintenance and repair service contracts, tailored to specifically meet with client requirements

- Guaranteed response times
- Commissioning and setting to work
- Bespoke training
- Software support
- Preventative maintenance visits annually
- Ad hoc repairs

Curtiss-Wright
Innovation House, Lancaster Road, Ferndown Industrial Estate
Wimborne, Dorset BH21 7SQ
United Kingdom

T: +44 (0) 1202 850 450
E: sales@ncs.curtisswright.com
W: nuclear.curtisswright.com

CURTISS-WRIGHT INSTRUMENTATION & CONTROL

Curtiss-Wright is an established leader in the design, manufacture, supply, support, lifetime extension and decommissioning of instrumentation and control products and systems for the worldwide nuclear industry. As part of our extensive portfolio, we offer a comprehensive range of stack effluent monitoring and sampling systems to satisfy the requirements of international standards, best practice and regulators. With monitoring and control installations across the globe, our systems have been protecting personnel, the environment and major country infrastructure since the 1950s.