

Positron emissions stack monitor



Key features

- Daily, weekly, monthly, and annual activity release totals updated in real time
- Historical data viewer of concentration, stack flow rate, and activity released with confirmation that system was continuously operational 24/7
- Faster data acquisition during releases for improved measurement accuracy

Overview

Ultra Energy's monitor for measuring positron emissions in ducts or stacks is used by customers with manufacturing facilities or research facilities using positron emitting isotopes to prove regulatory compliance. The positron concentration is combined with accurate stack flow measurement to calculate the released activity over different time intervals.

Technical specifications

Further features

- Two inches of lead shielding in a 4pi geometry provides reduced gamma background interference
- Pitot tube and Yokogawa pressure transmitter for stack flow measurement ensuring accurate release calculations
- Two diaphragm pumps for redundancy and reduced downtime, with a simple switch to change pumps
- Easy source checking for performance verification
- Ethernet connectivity for ease of installation and added flexibility in system access
- Separate Ethernet connections for monitor and facility network

System configuration

Ultra Energy's PET Facility stack monitor uses a 'bypass' method of measurement. This involves pulling a sample from the stack and measuring the radioactive concentration in a calibrated chamber. Pulling a small sample volume allows the system to measure higher activities than systems monitoring all of the activity in the stack or duct.

Unlike older designs that use a detector mounted on or near the duct, the UEE Stack Monitor removes a sample to a remote location for measurement. This ensures that the integrated stack release does not include activity held up in the duct or

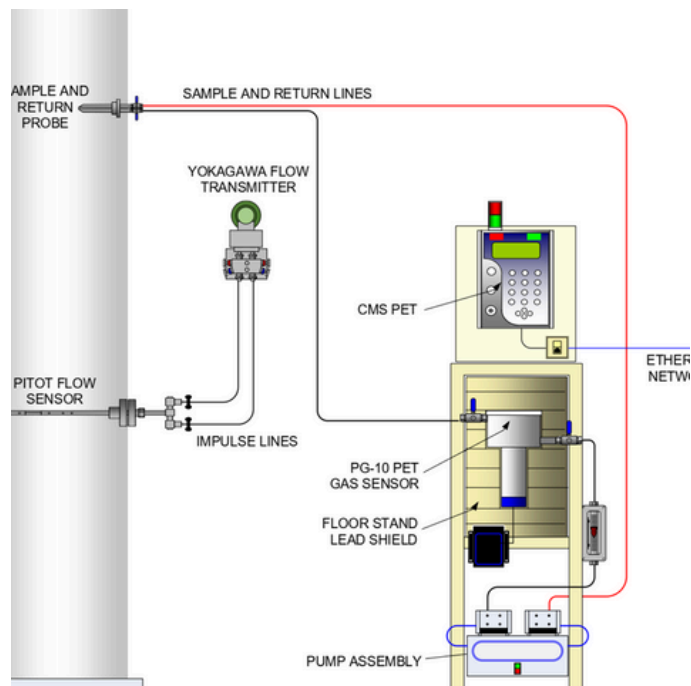
on the filter banks. The use of a by-pass system allows the system to be installed in a more convenient location and ensures that filter banks and other external sources will not result in inaccurate reported releases.

The detector uses a thin plastic scintillator, sensitive to the positron decay and with a very small response to the 511 keV gamma photons. This low response to ambient gamma fields, combined with the 2-inches of lead shielding, allows the system to be conveniently placed almost anywhere in the facility.

The monitor is supplied factory calibrated, achieved by comparing the response of the clients' detector with a solid source (positioned on the outside of the detection chamber) to an original primary calibration performed with $^{11}\text{CO}_2$ gas.

Depending on local requirements, after installation the client may choose to retain the calibration factor or re-calibrate using a controlled release of calibrated gas (e.g. $^{11}\text{CO}_2$ or $^{13}\text{N}_2$). Calibration procedures for both methods are available from us.

Activity concentration and stack flow rate are combined to calculate a release rate (e.g.: pCi/s or Bq/s) which is integrated to derive activity effluent. A user-configurable parameter called 'integration threshold' triggers the integration. This ensures the normal background count-rate, seen when the facility/cyclotron is not running, is not included in the effluent activity totals.



Technical specifications

Test data has shown that for positron decays between 250 keV to 2 MeV, detection efficiency is linear between $\pm 5\%$. Therefore a common calibration factor may be used for all standard PET isotopes (^{18}F , $^{13}\text{N}_2$, ^{11}C etc.).

Sources of background can interfere with traditional measurement systems, causing false effluent release readings. The PET stack monitor combines a number of methods to reduce this effect.

Firstly, the detector is a 'positron' detector, which has a low response to external gammas. It does not measure the 511 keV annihilation photons. This approach provides insensitivity to gamma background and flexibility about detector location resulting in better measurements and a more convenient installation.

Secondly, the detector is installed in a lead shield to reduce gamma interference. Finally (for challenging environments), an optional background compensation detector may be installed adjacent to the gas detector to perform automatic count-rate subtraction based on a ratio of inside to outside detectors' response.

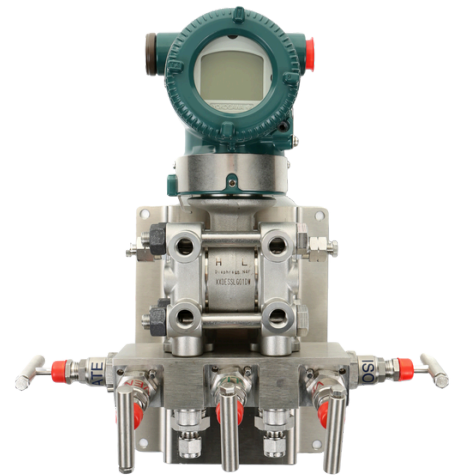
The by-pass configuration also allows the detection systems to be placed in a lower background area. For example, away from the activated charcoal filter bank that captures the activity of each release.

These methods produce a stable result unaffected by sources of shine (filters, cyclotron, sources, radiopharmaceuticals, etc.).

The standard system uses a unique double pump system. Only a single pump is used to pull the sample through the monitor. This provides the user with redundancy so, in the event a pump fails, the operator switches to the second pump to continue sampling.

Stack flow is a very important measurement parameter when deriving effluent releases. The UEE stack monitor uses a direct flow measurement (Pitot tube in the exhaust stack) for determination of actual stack flow under real world conditions – a regulatory imperative.

For most installations, a multi-point pitot tube combined with a Yokogawa pressure sensor provides a measurement of stack flow rate. The pitot takes a measurement of average flow across the whole span of the stack and offers better measurement accuracy when compared with conventional flow meters such as thermal anemometers.



The heart of the compliance monitoring system is the 9205-EMS Data Management System. The 9205 is an advanced SCADA-based data logger that records data from the CMS-PET (and any additional stations on the network), generates alarms in the event of system status change, compiles a result database of historic result data and allows the production of the effluent reports as required.

Technical specifications

Data acquisition system

The 9205EMS data management system provides the following data display screens:

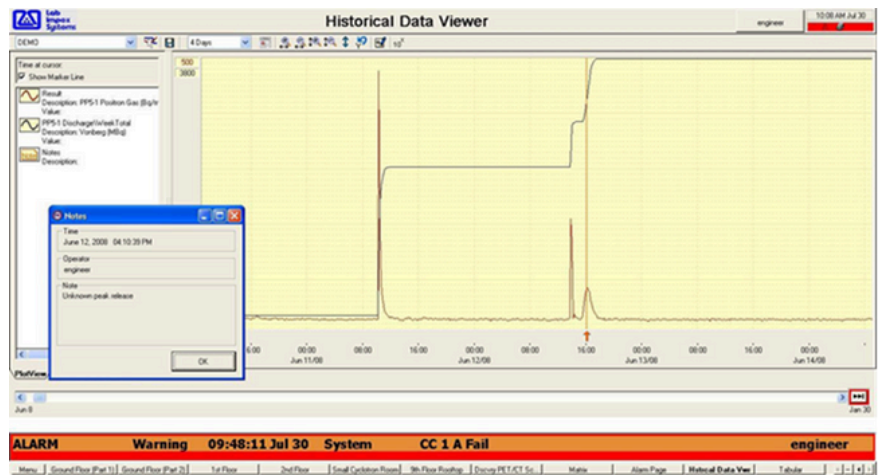
- Facility plan - location of each monitor, its status, and current measurement result
- Status matrix - current status (alarm, fail, maintenance, etc.) of each monitor on the network
- Alarm status - current network alarms and past network alarm events
- Effluent discharge - integrated releases and current stack effluent on a daily, weekly, monthly and annual basis
- Historic data (trend): historical data for user selectable channels, which can be grouped for ease of use.

It also supports features such as data export, report generation, multiple user access modes, data archiving and intranet / extranet integration.

The web interface option allows the use of 9205 system from any workstation that has a browser installed. Access is password protected. Working with the system remotely does not interfere with anyone using the main 9205 displays.

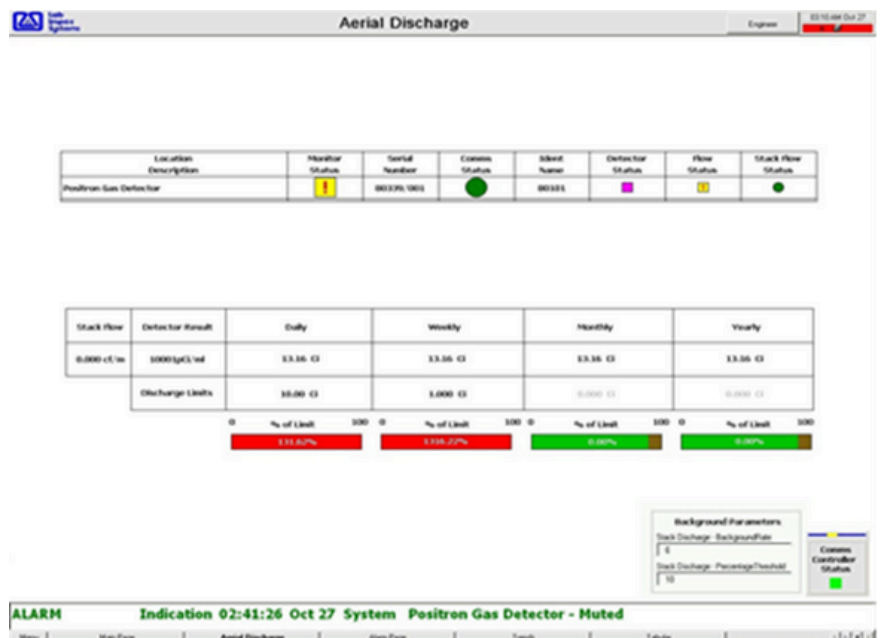
The 9205 software data archive and reporting system is fully featured and capable of meeting anticipated future regulatory requirements.

The system is expandable. Additional stack monitoring channels and/or area channels can be added at a specific site at much lower cost. Adding dose rate, alpha-beta aerosol/particulate monitors, or radioiodine channels is also possible. The system can be easily expanded ensuring that potential future production needs will be easily met with the UEE solution.



Historical data viewer displaying concentration as well as the weekly total for activity release.

The summary page below shows the daily, weekly, monthly, and annual alarm set points and the current release totals. The system updates these values in close to real-time. In this example, a release has caused an alarm that has exceeded both the daily and weekly release limits. The green shows that the monthly and annual limits are still below their alarm set point. Alarm set points are usually derived from the annual release limits specified in the facility license.



Performance specifications

9205EMS performance specifications	
0216/075 monitoring skid	
Detector type	<ul style="list-style-type: none"> Scintillation detector comprising thin plastic scintillator with light guide, photomultiplier and dynode chain
Detector characteristics	<ul style="list-style-type: none"> Geometry rectangular prism Width 13mm Length 76mm Temperature range -10 to +50°C Weight approximately 2 kg
Performance	<ul style="list-style-type: none"> Efficiency >12% Typical background <1 cps
Measuring chamber	<ul style="list-style-type: none"> Type 750 ml stainless steel Connections 2 x 10 mm O.D. pipe Diameter approximately 100 mm (4 inches) Height approximately 100 mm (4 inches)
Weight and dimensions	<ul style="list-style-type: none"> Width 532 mm (21 inches) Depth 613 mm (24 inches) Height 1556 mm (61 inches) Mass 200 kg (441 pounds)
Operating environment	<ul style="list-style-type: none"> Indoor use or suitably enclosed Operating temperature range -10 to 50°C (-4°F to 122°F) Maximum relative humidity 95% (up to 30°C)
9205EMS data acquisition system	
Computer	<ul style="list-style-type: none"> Standard DELL computer with 16 GB Memory and DVD +/- RW Dual 500 GB drives in RAID 1 configuration Dual Ethernet 100MB connections MS Windows 10 Pro (64-bit) ENGLISH

Performance specifications

9205EMS performance specifications	
Displays	<ul style="list-style-type: none"> • 1920 x 1080 minimum resolution • Delivered with a single display (multiple monitor capable)
Alarms	<ul style="list-style-type: none"> • Audible using computer speaker bar and visual using color changes and flashing bar on display
CMS PET electronics	
Physical characteristics	<ul style="list-style-type: none"> • Stainless steel enclosure • Rated as IP54
Display	<ul style="list-style-type: none"> • Large LCD graphic display (114mm x 64mm (4.5" x 2.5") with backlight) • Fully sealed membrane keypad • Both digital and analogue display • Key switch • Two layer status light column (Totem Pole, Red + Green LED)
Inputs	<ul style="list-style-type: none"> • Pulse input for detector counts • Logarithmic 4 to 20 mA for stack flow
Data storage	<ul style="list-style-type: none"> • Non-volatile data capability for seven days count history at minimum five minute data log intervals • 9205 logs data much faster every 1-2 seconds during a release • Non-volatile data capability for event history (last 100 events)
Outputs	<ul style="list-style-type: none"> • Fail-safe relay contacts for fault and alarms • 3 relay outputs (Alarm, Alert and Fault) • 2 x 4 to 20 mA analog outputs • Ethernet 10Base T to 9205 data acquisition system
System power	<ul style="list-style-type: none"> • Mains AC 86 - 260 VAC, frequency 50/60Hz

Performance specifications

9205EMS performance specifications	
Yokogawa Flow Transmitter	
Key characteristics	<ul style="list-style-type: none"> • EJX120A-JES4G-Z19EN/D3/M11 • Unit connected by means of two impulse lines to Pitot tube • $\pm 0.09\%$ Accuracy • $\pm 0.15\%$ per year stability • 150ms Response Time • Exida and TUV SIL 2/3 Certified

Comprehensive Service Agreements are available which can include telephone or e-mail support, annual preventative maintenance visits, calibration assistance, and discounts on spare parts.

About Ultra Energy

Organizations working with nuclear and industrial technologies have a responsibility to safeguard people, the environment and infrastructure. We provide solutions that give our customers complete, long-term protection and control of safety critical systems, while helping them increase the net value derived from investments over their total lifespan.

Part of Ultra Group, Ultra Energy has worked with nuclear and industrial customers for over 60 years. We're embedded in strategic national infrastructure and helping organizations develop future applications. We support continuous operation of industrial sites with protection and control solutions that monitor and manage factors such as radiation, neutrons, temperature and pressure within safety critical systems.

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