

## EDAC 21

### System for Detection, Alarm and Recording of Criticality Accidents



#### DESCRIPTION

Criticality Accident Alarm Systems (CAAS) are required in nuclear facilities where an accidental criticality excursion could result from operational processes. In general, most production-oriented nuclear fuel cycle facilities require a CAAS system because the fissile material is managed in quantities that exceed critically-safe mass limits.

The EDAC-21 is a 3rd generation system, continually building upon the 1970's design that was introduced and co-developed by the CEA (the French Atomic Energy Commission). The 3rd generation system now available takes advantage of several significant design features that have evolved:

1. Three type of probes: a neutron probe, a gamma probe and a neutron-gamma probe.

2. A neutron and/or gamma-ray detector and alarm logic module reside in each detector head. This technology makes use of a neutron scintillator and a gamma-ray scintillator that provide high-reliability and performance. Because scintillation detectors are used, a light-emitting-diode with a feedback circuit allows continuous state of health monitoring of the detector. Any electronic failure of a probe is communicated back to the control unit and to the Ethernet network. This electronic feedback circuit checks complete functionality of the system, not just a portion of the system.

3. The alarm logic in each probe is sensitive to both criticality excursion scenarios: the "prompt-critical" metal system and the "slow-cooker" non-metal accident.

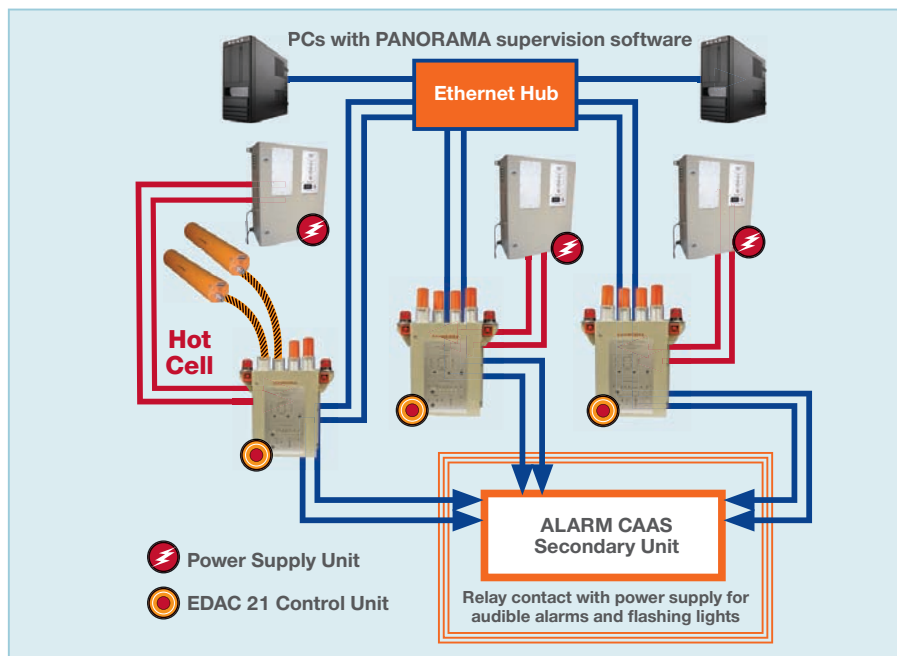
4. Each control unit, which supports up to four probes (same type), is a completely modular design that easily enables additional units to be placed directly onto the existing system network. All alarm functions and alarm latching mechanisms reside on each "independent and redundant" control unit. Local alarms on each control unit include redundant lights and horns. Remote horns and lights are driven from dry-contacts on each control unit. Alarms can also be broadcast over a network.

5. The system is autonomous. Each redundant set of probes and control-unit electronics will actuate local and remote alarms without the need for an operating system or software. However, the optional network and PANORAMA software that resides on each host computer, allows the facility operations managers and controllers to monitor state of health from the control room, as well as log data on system status and alarm functions.

#### FEATURES

- Detects neutrons and/or gamma rays
- Totally redundant detector and alarm circuit
- Activates alarms for immediate evacuation of operators (response time less than 100 ms)
- Two to four neutron and/or gamma detectors per monitoring area
- Continuous state-of-health monitoring on each detector
- Remote supervision
- Qualified under real criticality situations at SILENE reactor of the French Atomic Energy Commission (CEA)
- Qualification report by IRSN (French Institute of Nuclear Safety) available upon request
- Complies with the IEC 60860 (1987), ISO 7753 (1987) and ANSI/ANS-8.3 (1997)

# EDAC 21



## EDAC 21 System Overview

### SPECIFIC SYSTEM CAPABILITIES

#### SYSTEM ARCHITECTURE

The EDAC 21 consists of different modules: Control unit, probes and power supply unit.

#### Control Unit

- The control unit contains a fully redundant set of processing boards. Failure of any single board does not cause a system failure. Board-level failures are communicated with a local alert message to the control unit and an Ethernet message communicated over the network so that maintenance can be performed.
- Mounted to each control unit is a set of redundant alarms: both horns and lights.
- The probes may be mounted in the top of the control unit or apart from the control unit, on a mounting bracket.
- The control unit connects to a DC power, uninterruptible power supply (the power supply unit), a dry contact output, and an RJ-45 connection to the Ethernet network.
- The control unit has a front panel display and controls to indicate “state of health,” annunciate alarms, and conduct tests and maintenance.

#### Probes

- The neutron and gamma detectors use state of the art scintillation plastic and signal-processing electronics.
- The probes also contain in a single enclosure the alarm logic boards, that upon alarm send alarm messages to the control unit.

#### Power Supply Unit

- Fully equipped power supply unit including redundant power supplies ensures 16 hours of autonomous operation in non-alarming mode plus 30 minutes in alarming.

#### Optional Ethernet Panel

- Network gear for providing a dedicated EDAC network is designed and tailored to facility needs and security requirements.

#### EDAC Software

- The EDAC software is written on the PANORAMA platform. When the network is implemented, each host computer includes the PANORAMA software.

#### Alarm CAAS Secondary Unit

- For a multi-area coverage (two or more EDAC 21), an alarming cabinet could be built on customer request.

#### STATUS INDICATORS

- Front panel access to indicators and controls ensures local control of detection devices and alarm generators:

#### Probe indicators (LED):

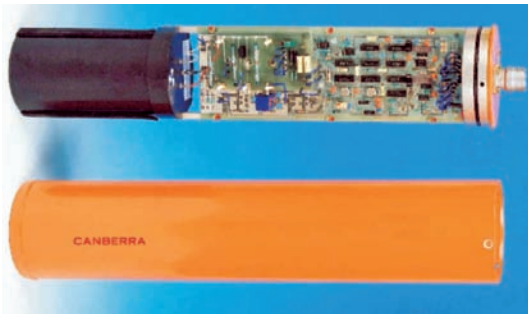
- 4 green “Correct Operation”
- 4 red “Alert”

#### Processing unit indicators:

- 2 red “Alarm” flashing beacons
- 2 audible alarms
- 2 redundant LED evacuation alarms



# EDAC 21



EDAC 21 – Gamma and /or Neutron Probe

- Individual or general tests of the detectors (measurement displayed using bar graphs; these tests are achieved under control of an operator who can deactivate them in case of possible criticality accident.
- Test of the cabinet indicator lights by pushbuttons.
- Acknowledgment of faults and alarms (audible and visual) by pushbuttons.
- As an option, the system is associated with one or two supervisor PCs on which the PANORAMA supervision software is implemented; this software is in charge of system monitoring, remote and real time archiving/recording of the events, remote control of the detector gain and edition of the logbook and detector test as described above.

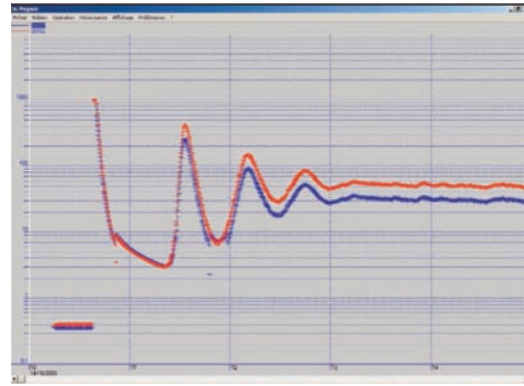
## DETECTOR FEATURES

Monitoring of the plant and surrounding buildings is ensured by a set of two, three or four detectors, each with:

- Spectral response balanced in a simple/mixed flux of referenced gamma and/or neutrons.
- Two phase alarm signal:

Probe Detection	Dose (Gy)	Dose rate (Gy/h)
Gamma + Neutron	$25 \times 10^{-6}$	$20 \times 10^{-3}$

- The probe dose-rate threshold can be modified in a limited range without invalidating the response qualifications. Consult factory for specific needs.
- The detector response is linear between the dose rates of 1 mGy/hr to 10 Gy/hr. Above 10 Gy/hr the detector does not fail and continues to alarm.
- Possibility of detecting accidents with extremely slow dynamics corresponding to very low reactivities.
- Constant state of health monitoring provided by light source (LED), integrated into the detector.
- The detector can be placed in a remote location and connected by cable to the control unit (maximum distance 300 m).

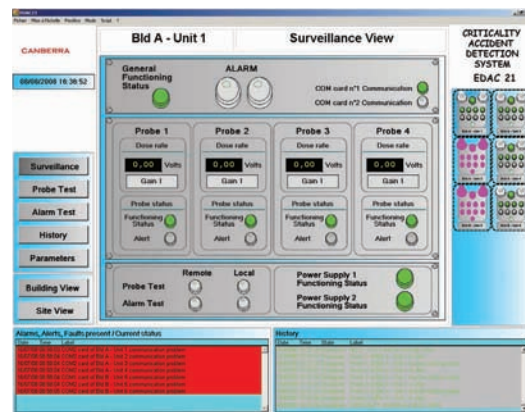


Real recording on SILENE reactor  
2-probe version – Free evolution – Time scale: 1 hour. Voltage is a function of time during SILENE testing for EDAC 21. Unit accurately traces time profile for two probes during free oscillation of SILENE reactor.

## REMOTE SUPERVISION USING EXTERNAL PC

- The graphic user interface makes it possible to know in real or delayed time:
- Data status for each detector (correct operation, alert, measurement).
- Real time display of the response from each detector.
- History readings and events for each detector.

This information is shown on specific screens and is password protected.



The graphical human interface: surveillance view of an EDAC unit

## INFORMATION SUPPLIED BY THE SYSTEM

- Detector response and status information for each detector.
- Comprehensive view of all significant events (alert, alarm, fault, or test) with date/time stamp using the log file maintained on the optional supervisor PC.
- Manual test of the cabinet using two buttons. The first button checks the status of each detector, and the second button checks the functionality of the alarm.
- These operations may also be performed remotely on the optional supervisor PC.

# EDAC 21

## SYSTEM VALIDATION TEST

- Before system delivery and installation, detectors are calibrated for accurate responses.
- Optionally, each system can be tested and validated on the SILENE experimental equipment of CEA.

## CHOICE OF DETECTOR LOCATION

- Optionally, an assessment can be carried out to determine the best possible number and position of the detectors to ensure reliable detection and emergency functions (Please consult us).

## SPECIFICATIONS

### COMPLIANCE

- Meets or exceeds the IEC 60860 (1987), ISO 7753 (1987), ANSI/ANS 8.3 (1997) standards.

### REDUNDANCY

- By parallelization of:
  - processing circuitry
  - alarm circuitry
  - safety path from detector to alarm employs the principal of redundancy for the whole system except for detector logic which is 2-out-of-3 or 2-out-of-4 alarm logic
  - communication and supervision circuitry
- This configuration meets the criticality standards in case of failure of part of the circuitry.

### RELIABILITY

- System remained fully operational under conditions of a criticality excursion on three separate test reactors. System was shown to have survived the criticality event in each case.
- The system is seismically qualified.

### MAINTAINABILITY

- "Hot swappable" design concept allows replacement of processing and alarm circuitry components without powering down the system.

### SUPERVISION

- The graphic interface allows real time (or delayed time) knowledge of:
  - Data status for each detector
  - History of the events
  - Crisis communication (optional)

### ALARM INDICATION

- AUDIBLE – Two sirens.
- VISUAL – Two flashing beacons and two LEDs.

## POWER

- LOW VOLTAGE POWER CABINET – To protect the system against possible failure of the LVPS, lead-acid batteries of the EDAC 21 ensure continuous power supply in accordance with the specified standards.
- LOW VOLTAGE POWER SUPPLY – 12 V.
- MAINS – 110 -240 V ac/50/60 Hz.
- BATTERY CAPACITY – 40 Ah each.
- Batteries are doubled.

## PHYSICAL

### CONTROL UNIT

- WIDTH – 940 mm (37.0 in.).
- DEPTH – 360 mm (14.2 in.).
- HEIGHT – 190 mm (46.9 in.) including detectors, 940 mm (37.0 in.) excluding detectors.
- OPERATING TEMPERATURE (probes included) –
  - 10 °C (14 °F) to +45 °C (113 °F).
- OPERATING HUMIDITY (probes included) – 40% to 90%.
- MOUNTING – Wall mount.
- MASS – 80 kg (176 lb) (detectors excluded)

### PROBE

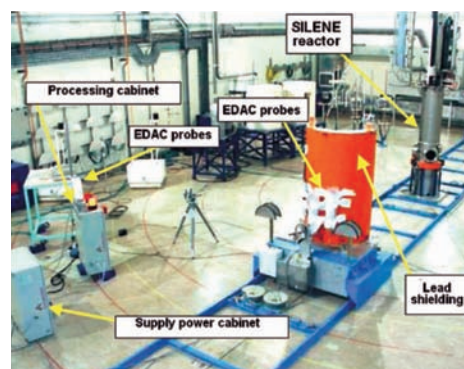
- LENGTH – 510 mm (20.1 in.)
- DIAMETER – 100 mm (3.9 in.).
- MASS – 2.2 kg (4.8 lb).
- MOUNTING – Integrated (extruding from top of Control Unit) or remote (on mounting bracket).

### POWER SUPPLY UNIT:

- DIMENSIONS – 600 x 800 x 300 mm (23.6 x 31.5 x 11.8 in.) (W x H x D).
- MASS – 125 kg (275 lb).
- MOUNTING – Wall mount.

### OPTIONS

- Roller for transport of each cabinet.
- Cable between gamma and/or neutron detector and processing cabinet (max. length 1 km).
- Choice of probe location: Optionally, an expertise can be carried out to determine the best possible number and position of the detectors to ensure reliable detection and emergency functions (please consult us).
- Each system can be tested and qualified on the SILENE reactor.



Test of an EDAC probe on the SILENE criticality facility (CEA facility).



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