Nuclear CIDAS® MkXI

Probability of Failure and Spurious Alarm Rate

The probability of failure to alarm when required is strongly dependent on the proof test interval i.e. the time between full system tests. In addition to a high probability of alarming when required the system requires a low probability of alarming spuriously as this will cause unnecessary evacuation of the monitored area. Comprehensive reliability studies have been undertaken on the CIDAS® Mk XI and the probability of failure to alarm and the rate of spurious alarm calculated and shown in the table below.

<table>
<thead>
<tr>
<th>CIDAS</th>
<th>Probability of Failure to Alarm On Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>2.2E-3</td>
</tr>
<tr>
<td>1 month</td>
<td>2.0E-4</td>
</tr>
</tbody>
</table>
| Spurious CID alarm | 9.7E-06 per hr (≈0.08 per year) for a typical large system (144 pairs of loudspeakers, 9 rings of detectors with 40 detectors each) the reliability and false alarm rate are calculated above.

For smaller systems with fewer components, the figures improve.

Reliability and False Alarm Rate

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Radiation Tolerance

The CIDAS® MkXI system has undergone testing to assess the tolerance of its components to radiation, an essential requirement to ensure that the system will operate at the high dose rates which occur during a criticality. The system was tested in a Fast Burst Reactor (FBR), an unmoderated, unreflected bare critical assembly of the Godiva II type at the White Sands Missile Range in New Mexico.

Building Evacuation Systems

The PAGA sub-system of the CIDAS® system can be supplied as a Building Evacuation System, either as a simplex or duplex system.

Lifetime Support

Babcock has nearly 50 years of experience and expertise in the design and supply of CIDAS® systems giving customer access to a highly responsive and adaptable team of experts in criticality incident detection. Babcock works closely with its customers to provide the most cost-effective and practical solution, encompassing project management, system configuration, design, installation including integration with other alarm systems, commissioning, training, service, maintenance and parts. With a large and growing customer base Babcock is committed to providing long term support to all CIDAS® users, providing the resources and personnel to ensure that installed systems remain fully functioning at their optimum level throughout their lifetime.

CIDAS® is supported by fully trained service and maintenance teams, based in the UK and USA. They can supply individually tailored service, maintenance and technical support packages geared to individual plants and budgetary requirements.

Babcock offer formal training services with the objective of ensuring that customers are fully capable of providing front line maintenance and identification of faults. Training packages can be configured to meet individual needs.

Nuclear CIDAS® MkXI

Criticality Incident Detection & Alarm System

50 years experience in criticality incident detection and alarm systems

Babcock is a world-leading provider of criticality incident detection and alarm systems with more than 60 CIDAS® systems installed in major nuclear facilities in the UK, USA and Canada.

The first Criticality Incident Detection systems were developed and installed in the 1950s and have evolved as better technology became available. The latest model is CIDAS® MkXI, which builds on the performance-proven CIDAS® concept incorporating comprehensive automatic self-testing and diagnostic routines. The result is a versatile system offering exceptionally high reliability and a comprehensive detection and alarm capability that can be tailored to meet the individual requirements of any plant, large or small, where a criticality may occur.

Features and Benefits

- Proven high reliability in the detection of criticality incidents
- Rapid time to alarm and extremely low spurious alarm rates
- Simple detector placement allows cost-effective wide area coverage
- Design readily adapts to large or small facilities
- Redundant detector and alarm circuits for increased reliability
- Three detectors per monitoring area
- Low cost, low maintenance, reliable gamma detectors
- Use of digital electronics provides easy setup and configuration
- High fault tolerance and low maintenance
- Status information available for each detector
- Warning lights to prevent re-entry to evacuated areas
- Integrated building evacuation system with audio and visual alarms
- Complete ‘turnkey’ packages with lifetime service and support
- Proven to function in a criticality (reactor testing)
- Compliant with all relevant international standards

Performance-proven highly reliable and uniquely adaptable to meet your individual criticality detection needs

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**CIDAS® MkXI**

**How CIDAS® works**

Gamma detectors are deployed which are designed specifically to detect the excessive radiation dose which occurs during all types of criticality events. These detectors are arranged in triplicate rings around the areas to be monitored where a criticality is deemed possible. Once in position the detectors are wired back to the CIDAS® logic panel. Trip signals from the detectors are processed by the CIDAS® solid state based logic system, with no software used in the alarm path.

Tripping of at least two out of the three detector rings automatically initiates the building evacuation system’s audible and visual alarms throughout the criticality evacuation area to allow immediate evacuation of personnel in compliance with the plant’s own emergency procedures. Optional “Keep Out” warning lights (KOWLs) are located at entrances to deter re-entry and “Noisy Area Warning Lights” (NAWLs) in areas with high noise levels such as plant rooms are available.

The building evacuation system is a dual redundant system with loudspeakers and lights on two ring circuits. Each circuit operates independently but one loudspeaker and one NAWL from each circuit are co-located at each location.

During normal plant operating conditions an optional confidence pip tone can be sounded to indicate that the system is operational. If a system fault is detected the pip tone will be silenced, providing an instant indication that the system diagnostics have detected an abnormal condition. Alternatively, this tone can be muted and only sound when there is a system fault, or it can be disabled and not play a role in the system diagnostics.

**System Configuration**

CIDAS® is a versatile modular system with a range of components which can be selected and configured to meet the requirements of individual facilities, whether large or small. A system can readily be increased or reduced in size by the addition or removal of detectors, loudspeakers and lights. All components of the CIDAS® Mk XI system are modular in concept. Discrete units such as detectors, speakers, lights and the control panel can be installed independently of each other and allows installation to progress in a way that minimises interference with the activities of the plant.

The system consists of the following modules:

- Detectors
- Logic and Control System
- Output devices such as loudspeakers, optional Noisy Area Warning Lights (NAWLs), optional Keep Out Warning Lights (KOWLs).
- Uninterruptible Power Supplies (UPS)

Additional features:

- PA system can operate via the CIDAS loudspeakers, but the alarm tone takes precedence.
- Other alarm function can be routed through the CIDAS system, for example activity in air and fire alarms.

**Detector Placement Determination**

Accurate positioning of the detectors is necessary to ensure they do not trigger during normal plant operations, but are guaranteed to trigger in the event of an incident. Where required Babcock will identify experts to accurately determine the number and position of detectors, which involves modelling of a plant to prove detectors would trigger should a criticality occur. Under normal circumstances detectors will be placed out of cell enabling easier testing and maintenance.

**Detector Features**

- Identification of which detector or group of detectors has tripped
- Constant checking that the detector is still functional. This requires additional circuitry on the detector board and the installation of a small “keep alive” source in the detector case.

The design provides the following trip characteristics:

<table>
<thead>
<tr>
<th>Trip Characteristics</th>
<th>Dose Rate</th>
<th>Time to Respond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; 150 \mu Gy/hr$</td>
<td>does not trigger*</td>
</tr>
<tr>
<td></td>
<td>$1 mGy/hr$</td>
<td>$&lt; 1$ sec</td>
</tr>
<tr>
<td></td>
<td>$1 Gy/hr$</td>
<td>$&lt; 1$ mAs</td>
</tr>
</tbody>
</table>

*CIDAS® is designed not to trigger at dose rate $< 150 \mu Gy/hr$, so normal plant operations can be undertaken.

**System Reliability**

CIDAS® has the built in capability to provide checks on its system parameters. These include detector, NAWL and loudspeaker cables, power supply continuity status, building evacuation tone generator faults, amplifier faults and fuse failures. The system includes a “hot spare” amplifier so in the event that an amplifier fails the hot spare automatically replaces the failed amplifier. These extensive diagnostics ensure excellent system availability with fewer plant shutdowns due to loss of protection and false alarms. Any faults revealed by the self-checking will be annunciated on the main panel and silence the confidence pip tone, if present, ensuring that personnel are alerted.