

## Level sensor For Nuclear Power Plants with reed chain technology Model ALM

KSR data sheet ALM



#### **Applications**

- Power generating equipment, power plants, nuclear power plants
- Water basins
- Cooling water tanks/pools

#### Normal operating conditions

- Process- and system-specific solutions possible
- Operating conditions:
  - Operating temperature: T = -10°C ...+70 °C (+158 °F)
- Operating pressure: ambient
- Lengths: up to 20 m (65 ft)
- Humidity: 100 %
- Operational radiation dose: ≤ 160 kGy (16 MRad)

## Accident conditions

- Accident temperature: 156 °C (312 °F)
  - 7 bar (0.7 MPa)
- Accident pressure: Accident mission time: 1 year
- Accident rad. dose:
- Seismic acceleration: up to 5 g on demand)
- integrated 5.05 MGy (505 MRad) up to 2.5 g (higher accelerations

## Description

ALM Level Sensors are used to measure and transmit the level of liquids in conjunction with a customer's control unit outside of the containment area. It is based on the float principle with magnetic transmission in a 3-wire potentiometer circuit. The resistance measuring chain is closely stepped. Due to this assembly the generated voltage is approximately continuous. Signal transmission over large distances and use in hazardous areas are possible.



Accident-proof level measurement sensor with reed chain technology, model ALM





This device was designed without organic materials or active electronic components in any sensor and cabling part that might be affected by described accident conditions. The sensor will continue to function even in case of a Loss of Coolant Accident (LOCA) and can be fitted with a filter for protection against coarse debris. An accident-proof connection using mineral insulated cable is also available and meet the same standards as the integrated sensor units. For less critical applications, a connection using polymer insulated cable can be supplied.

This device is well-suited to retrofit the existing level measurement as part of the wide range of post-accident monitoring systems.

- The purpose of the accident level measurement is to remain functional during and after a severe accident scenario
- All used materials are inorganic and capable to withstand a high dose of gamma radiation

## **Application Area**

In the aftermath of the Fukushima accident, safety margins of nuclear power plants are reassessed in order to develop action plans for possible plant upgrades. One requirement of such a safety analysis is the necessity to enhance the robustness of the storage pool monitoring system. The presented ALM device is well-suited to retrofit the existing level measurement instrument as part of the wide range post-accident monitoring systems. As the device is proven against severe accident conditions inside the containment, it withstands the accident conditions in both the reactor and the fuel building.

# Internal circuit diagram of the reed sensors



#### Model overview

| Sensor<br>model | Description                                    | Standard                     |                                      |                                | Special Feautures                       |            |                                      |   |                   |
|-----------------|--|------------------------------|--------------------------------------|--------------------------------|---|------------|--------------------------------------|---|-------------------|
|                 |  | Reed<br>switch<br>unit (RSU) | Magnetic<br>floater<br>unit<br>(MFU) | Material<br>stainless<br>steel | Floater<br>guide<br>tube unit<br>(FGTU) | Filter box | Tempe-<br>rature<br>sensor<br>PT-100 | Redun-<br>dant mea-<br>suring<br>equip-<br>ment | Modular<br>design |
| ALM-D1          | Accident proof<br>Level Measurement<br>Devices | x                            | x                                    | x                              | x                                       | x          |                                      |   |                   |
| ALM-D2          | Accident proof<br>Level Measurement<br>Devices | x                            | x                                    | x                              |   |            |                                      |   |                   |
| ALM-D3          | Accident proof<br>Level Measurement<br>Devices | x                            | x                                    | x                              |   |            |                                      |   | x                 |
| ALM-D4          | Accident proof<br>Level Measurement<br>Devices | x                            | x                                    | x                              | x                                       | x          | x                                    |   |                   |
| ALM-D5          | Accident proof Level<br>Devices                | x                            | x                                    | x                              | x                                       | x          |                                      | x   |                   |
| ALM-D6          | Accident proof<br>Level Measurement<br>Devices | x                            | x                                    | x                              | x                                       |            | x                                    |   | x                 |

#### **Qualification specifications**

The current qualification is based on KTA 3505. Qualification includes the sensor and the cable-connector, both with electrical safety class 1E. The qualification is based on theoretical analysis and/or physical tests. Major points included in this qualification are following:

- Electromagnetic compatibility
- Shock test
- Functional test
- Behavior upon plugging and unplugging
- Climatic test
- Thermal ageing and Radiological ageing
- Accidental mechanical loads
- Debris test
- Performance during exposure to pressure, temperature and humidity
- Performance during exposure to high dose rates and poststressing.

Products are developed for and with AREVA GmbH. The accident-proof level measurement device is part of the standard instrumentation in a recent project of AREVA.

# Accident-proof Level Measurement Device, model ALM-D1 Internally mounted for sumps



|   | Technical specifications                            |                      | Accident conditions   |  |
|---|---|----------------------|---|--|
| Electrical connection                     | Male plug   | Maximum temperature  | 156 °C (312 °F)   |  |
| Mounting                                  | Welding bracket                                     | Maximum pressure     | 5.5 bar (0.55 MPa) abs.   |  |
| Guide tube unit diameter                  | 60.3 mm (2 ")                                       | Humidity             | 100%  |  |
| Float                                     | Titanium ZTS45/200/SMCO                             | Radiation resistance | 5.05 MGy (505 MRad)   |  |
| Contact separation                        | 16 mm (0.63 ")                                      |                      | Dose rate 5kGy/h (0.5 MRad/h) (1 year)  |  |
| Overall resistance of the measuring chain | < 500 Ohm   | Mechanical stress    | Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.                             |  |
| Connection cable to transmitter           | Available on request                                |                      |   |  |
| Control unit                              | Available on request                                |                      | Load test 2.6g (3 axis)   |  |
| Mounting position                         | Vertical  |                      | Excitation type: Sine sweep<br>Frequency: 2100 Hz   |  |
| Material                                  | Stainless steel                                     |                      | Displacement: 10 mm (0.03 ft),<br>10 Oct./min.  |  |
| Chemical resistance                       | Boron (B-10 32%) = 1750 ppm<br>Chloride = 0.2 mg/kg | Response time        | < 30 s  |  |
|   | NaOH = 0.5•wt %<br>Na2S2O3 = 3.5•wt %               | Pollution severity   | 3.0 kg MD2 insulation material for pipes (glass<br>wool material)<br>53 g concrete particles (<250 μm)<br>53 ο paint and coating particles (solid matter) |  |
|   | Normal operating conditions                         |                      | 80 g Microtherm, microporous insulation   |  |
| Temperature range                         | 0 °C to 70 °C (32 °F to 158 °F)                     |                      | 300 I clear water   |  |
| Pressure                                  | 7 bar (0.7 MPa) abs.                                | Accuracy (for 320 mm | 30 mm   |  |
| Operating life time                       | min. 16 years                                       | accident conditions  |   |  |
| Humidity                                  | 100%  |                      |   |  |
| Radiation resistance                      | 2.5 kGy (250 kRad) per year                         |                      |   |  |
| Response time                             | <1s   |                      |   |  |

Accuracy (for 200 mm measuring range)

≤ 16 mm

## Accident-proof Level Measurement Device, model ALM-D2 Externally mounted



|   | Technical specifications   |
|---|--|
| Electrical connection                     | Male plug  |
| Process connection                        | Clamp  |
| Guide tube unit diameter                  | 60.3 mm (2 ")  |
| Float                                     | Titanium ZTS45/200/SMCO  |
| Contact separation                        | 16 mm (0.63 ")   |
| Overall resistance of the measuring chain | < 500 Ohm  |
| Connection cable to transmitter           | Available on request   |
| Control unit                              | Available on request   |
| Mounting position                         | Vertical   |
| Material                                  | Stainless steel  |
| Chemical resistance                       | Boron (B-10 32%) = 1750 ppm<br>Chloride = 0.2 mg/kg<br>NaOH = 0.5•wt %<br>Na2S2O3 = 3.5•wt % |

|                                       | Normal operating conditions     |
|---------------------------------------|---------------------------------|
| Temperature range                     | 0 °C to 70 °C (32 °F to 158 °F) |
| Pressure                              | 7 bar (0.7 MPa) abs.            |
| Operating time                        | 16 years                        |
| Humidity                              | 100%                            |
| Radiation resistance                  | 2.5 kGy (250 kRad) per year     |
| Response time                         | < 1 s                           |
| Accuracy (for 200 mm measuring range) | ≤ 16 mm (0.05 ft)               |

|   | Accident conditions   |
|---|---|
| Maximum temperature   | 156 °C (312 °F)   |
| Maximum pressure  | 5.5 bar (0.55 MPa) abs.   |
| Humidity  | 100%  |
| Radiation resistance  | 5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)   |
| Mechanical stress   | Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min. |
| Response time   | < 30 s  |
| Pollution severity  | No  |
| Accuracy (for 448 mm<br>measuring range) under<br>accident conditions | 38 mm (0.12 ft)   |

# Accident-proof Level Measurement Device, model ALM-D3 Externally mounted with cascaded sensors

|  | Technical specifications  |
|--|---|
| Electrical connection  | Male plug   |
| Process connection   | Clamp   |
| Guide tube unit diameter   | 60.3 mm (2 ")   |
| Float  | Titanium ZTS45/200/SMCO   |
| Contact separation   | 16 mm (0.63 ")  |
| Overall resistance of the measuring chain  | < 500 Ohm   |
| Connection cable to transmitter  | Available on request  |
| Control unit   | Available on request  |
| Mounting position  | Vertical  |
| Material   | Stainless steel   |
| Chemical resistance  | Boron (B-10 32%) = 1750 ppm<br>Chloride = 0.2 mg/kg<br>NaOH = 0.5•wt %<br>Na2S2O3 = 3.5•wt %  |
|  |   |
|  | Normal operating conditions   |
| Temperature range  | 0 °C to 70 °C (32 °F to 158 °F)   |
| Pressure   | 7 bar (0.7 MPa) abs.  |
| Operating time   | 16 years  |
| Humidity   | 100%  |
|  |   |
| Radiation resistance   | 2.5 kGy (250 kRad) per year   |
| Radiation resistance<br>Response time  | 2.5 kGy (250 kRad) per year<br>< 1 s  |
| Radiation resistance<br>Response time<br>Accuracy (for 200 mm<br>measuring range)  | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)   |
| Radiation resistance<br>Response time<br>Accuracy (for 200 mm<br>measuring range)  | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)   |
| Radiation resistance<br>Response time<br>Accuracy (for 200 mm<br>measuring range)  | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)<br>Accident conditions  |
| Radiation resistance<br>Response time<br>Accuracy (for 200 mm<br>measuring range)<br>Maximum temperature   | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)<br>Accident conditions<br>156 °C (312 °F)   |
| Radiation resistance         Response time         Accuracy (for 200 mm measuring range)         Maximum temperature         Maximum pressure                    | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)<br>Accident conditions<br>156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.  |
| Radiation resistance<br>Response time<br>Accuracy (for 200 mm<br>measuring range)<br>Maximum temperature<br>Maximum pressure<br>Humidity                         | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)<br>Accident conditions<br>156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%  |
| Radiation resistance<br>Response time<br>Accuracy (for 200 mm<br>measuring range)<br>Maximum temperature<br>Maximum pressure<br>Humidity<br>Radiation resistance | 2.5 kGy (250 kRad) per year<br>< 1 s<br>≤ 21 mm (0.07 ft)<br>Accident conditions<br>156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year) |

 1 Oct./min.

 Load test 2.6g (3 axis)

 Excitation type: Sine sweep

 Frequency: 2..100 Hz

 Displacement: 10 mm (0.03 ft),

 10 Oct./min.

 Response time
 < 30 s</td>

 Pollution severity
 No

Accuracy (for 4672 mm 50 mm (0.16 ft) measuring range) under accident conditions



## Accident-proof Level Measurement Device, model ALM-D4 Internally mounted for fuel pools

|  | Technical specifications   |
|--|--|
| Electrical connection  | Male plug  |
| Process connection   | Mounting flange  |
| Guide tube unit diameter   | 60.3 mm (2 ")  |
| Float  | Titanium ZTS45/200/SMCO  |
| Contact separation   | 16 mm (0.63 ")   |
| Overall resistance of the measuring chain  | < 500 Ohm  |
| Connection cable to transmitter  | Available on request   |
| Control unit   | Available on request   |
| Mounting position  | Vertical   |
| Material   | Stainless steel  |
| Chemical resistance  | Boron (B-10 32%) = 1750 ppm<br>Chloride = 0.2 mg/kg<br>NaOH = 0.5•wt %<br>Na2S2O3 = 3.5•wt %   |
|  | Normal operating conditions  |
| Temperature range  | 0 °C to 70 °C (32 °E to 158 °E)  |
| Prossure   | 7  bar (0.7  MPa)  abs   |
| Operating time   | 16 years   |
| Humidity   | 100%   |
| Radiation resistance   | 2.5 kGv (250 kRad) per vear  |
| Response time  | <1s  |
| Accuracy (for 200 mm<br>measuring range)   | ≤ 16 mm (0.05 ft)  |
|  |  |
|  | Accident conditions  |
|  |  |
| Maximum temperature  | 156 °C (312 °F)  |
| Maximum temperature<br>Maximum pressure  | 156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.   |
| Maximum temperature<br>Maximum pressure<br>Humidity  | 156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%   |
| Maximum temperature<br>Maximum pressure<br>Humidity<br>Radiation resistance  | 156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)  |
| Maximum temperature<br>Maximum pressure<br>Humidity<br>Radiation resistance<br>Mechanical stress   | 156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.   |
| Maximum temperature<br>Maximum pressure<br>Humidity<br>Radiation resistance<br>Mechanical stress   | 156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min.           |
| Maximum temperature       I         Maximum pressure       I         Humidity       I         Radiation resistance       I         Mechanical stress       I         Mechanical stress       I         Response time       I | 156 °C (312 °F)<br>5.5 bar (0.55 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min.<br>< 30 s |
| Maximum temperature Maximum pressure Humidity Radiation resistance Mechanical stress Response time Pollution severity  | 156 °C (312 °F)5.5 bar (0.55 MPa) abs.100%5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.< 30 s                          |



## Accident-proof Level Measurement Device, model ALM-D5 Internally mounted with redundant sensor

|   | Technical specifications   |
|---|--|
| Electrical connection   | Male plug  |
| Process connection  | Mounting flange  |
| Guide tube unit diameter  | 60.3 mm (2 ")  |
| Float   | Titanium ZTS45/200/SMCO  |
| Contact separation  | 16 mm (0.63 ")   |
| Overall resistance of the measuring chain                                     | < 500 Ohm  |
| Connection cable to transmitter   | Available on request   |
| Control unit  | Available on request   |
| Mounting position   | Vertical   |
| Material  | Stainless steel  |
| Chemical resistance   | Boron (B-10 32%) = 1750 ppm<br>Chloride = 0.2 mg/kg<br>NaOH = 0.5•wt %<br>Na2S2O3 = 3.5•wt %   |
|   |  |
|   | Normal operating conditions  |
| Temperature range   | 0 °C to 70 °C (32 °F to 158 °F)  |
| Pressure  | 7 bar (0.7 MPa) abs.   |
| Operating time  | 16 years   |
| Humidity  | 100%   |
| Radiation resistance  | 2.5 kGy (250 kRad) per year  |
| Response time   | < 1 s  |
|   |  |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)   |
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| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft) Accident conditions   |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)   |
| Accuracy<br>Long Range/Short Range<br>Maximum temperature<br>Maximum pressure | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.  |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%  |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)   |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.  |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min.  |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min.<br>< 30 s  |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>< 30 s<br>3.0 kg MD2 insulation material for pipes (glass<br>wool material)<br>53 g paint and coating particles (solid matter)<br>80 g Microtherm, microporous insulation<br>material<br>300 l clear water                                       |
| Accuracy<br>Long Range/Short Range  | 107 mm / 19 mm (0.35 ft / 0.06 ft)<br>Accident conditions<br>156 °C (312 °F)<br>7.5 bar (0.75 MPa) abs.<br>100%<br>5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)<br>Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.<br>Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min.<br>< 30 s<br>3.0 kg MD2 insulation material for pipes (glass<br>wool material)<br>53 g concrete particles (<250 μm)<br>53 g paint and coating particles (solid matter)<br>80 g Microtherm, microporous insulation<br>material<br>300 I clear water |



## Accident-proof Level Measurement Device, model ALM-D6 Internally mounted with cascaded sensors

|   | Technical encoifications   |
|---|--|
|   | rechnical specifications   |
| Electrical connection   | Male plug  |
| Process connection  | Welding bracket  |
| Guide tube unit diameter  | 60.3 mm (2 ")  |
| Float   | Titanium ZTS45/200/SMCO  |
| Contact separation  | 16 mm (0.63 ")   |
| Overall resistance of the measuring chain   | < 500 Ohm  |
| Connection cable to transmitter   | Available on request   |
| Control unit  | Available on request   |
| Mounting position   | Vertical   |
| Material  | Stainless steel  |
| Chemical resistance   | Boron (B-10 32%) = 1750 ppm<br>Chloride = 0.2 mg/kg<br>NaOH = 0.5•wt %<br>Na2S2O3 = 3.5•wt %   |
|   |  |
|   | Normal operating conditions  |
| Temperature range   | 0 °C to 70 °C (32 °F to 158 °F)  |
| Pressure  | 7 bar (0.7 MPa) abs.   |
| Operating time  | 16 years   |
| Humidity  | 100%   |
| Radiation resistance  | 2.5 kGy (250 kRad) per year  |
| Response time   | <1s  |
| Accuracy  |  |
| Long Range  | 107 mm (0.35 ft)   |
|   | Accident conditions  |
|   | Accident conditions  |
| Maximum temperature   | 156 °C (312 °F)  |
| Maximum pressure  | 7.5 bar (0.75 MPa) abs.  |
| Humidity  | 100%   |
| Radiation resistance  | 5.05 MGy (505 MRad)<br>Dose rate 5kGy/h (0.5 MRad/h) (1 year)  |
| Mechanical stress   | Load test 1.68g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 250 Hz<br>Displacement: 10 mm (0.03 ft),<br>1 Oct./min.  |
|   | Load test 2.6g (3 axis)<br>Excitation type: Sine sweep<br>Frequency: 2100 Hz<br>Displacement: 10 mm (0.03 ft),<br>10 Oct./min.   |
| Response time   | < 30 s   |
| Pollution severity  | <ul> <li>3.0 kg MD2 insulation material for pipes (glass wool material)</li> <li>5.3 g concrete particles (&lt;250 μm)</li> <li>5.3 g paint and coating particles (solid matter)</li> <li>80 g Microtherm, microporous insulation material</li> <li>300 l clear water</li> </ul> |
| Accuracy (for 11776 mm<br>measuring range) under<br>accident conditions<br>Long Range/Short Range | 481 mm (1.58 ft)   |



## **Application examples**

#### Example for ALM-D1

#### Example for ALM-D2



The level measurement devices ALM-D1 is used to detect breaks in the pipes or leaks on valves and pumps of the Residual Heat Removal System and Containment Heat Removal System during normal operation, outages and accidents throughout the complete NPP life cycle. The purpose of the level measurement device ALM-D2 at the Flooding Valve Outlet is to reliably detect any leakage and accidental or intentional triggering of the passive flooding device valves. The valves discharge the water from the IRWST into the containment's spreading area. Premature presence of water must be avoided during normal operation of the plant due to the risk of generation of hydrogen should the molten core flow into the already flooded spreading area. During a severe accident, the passive flooding valve is essential for cooling the escaped corium melt in the spreading area.

#### **Application examples**

Example for ALM-D3



Example for ALM-D4



Level measurement devices ALM-D3 serve to monitor the level of scrubbing liquid in Venturi Scrubber Vessel during normal operation, outages and accidents throughout the complete NPP life cycle.

The task of the accident-proof level measurement devices ALM-D4 is to reliably monitor the IRWST water level during outages, normal plant operations and in case of DBC events or severe accident. Furthermore the system has to provide means of calibrations and verification during maintenance periods.

### **Application examples**

#### Example for ALM-D5

Example for ALM-D6



Accident-proof level measurement devices ALM-D5 reliably monitor the level of coolant in the fuel pools. Level measurement devices will be installed in the fuel pools and the pools will be flooded and at no stage be emptied again. These devices should function reliably during normal operations as well as during and after a severe accident throughout the complete NPP life cycle. The purpose of the level measurement device ALM-D6 is to supply a continuous measurement of the water level during refueling outage in normal plant operating conditions as well as during the LUHS-accident in empty and flooded RCAV.

#### **Ordering information**

Model / Version Special features Measuring range M (span 0 % - 100 %) Safety class Seismic category (Please include seismic spectra) Description of installation conditions

#### Normal operating conditions

Temperature Pressure Humidity Radiation dose

#### Accident conditions

Temperature Pressure Humidity Radiation dose Pollution severity

Please include drawings or schematic illustration of area where the sensor will be installed.

For additional information please contact our application specialist:

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