Level sensor with reed-chain technology
For nuclear power plants
Model N-ALM

KTA 3505
IEC/IEEE 60780-323:2016
RCC-E edition 2019

Applications

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

Special features

- Process- and system-specific solutions possible
- Functional under LOCA conditions
- High resistance to temperature, pressure, radiation and humidity
- Seismic qualification up to 2.5g (up to 5g on request)

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

Description

The model N-ALM level sensor is 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.

This instrument was designed without any organic materials or active electronic components in the sensors or cabling that could be affected by the accident conditions described. 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 metal-sheathed cable is also available and meets the same standards as the integrated sensor units.

This instrument is ideal for retrofitting the existing level measuring instrument as part of a wide range of post-accident monitoring systems.

The purpose of accident level measurement is to ensure functionality during and after a severe accident scenario. All materials used are inorganic and capable of withstanding a high dose of gamma radiation.

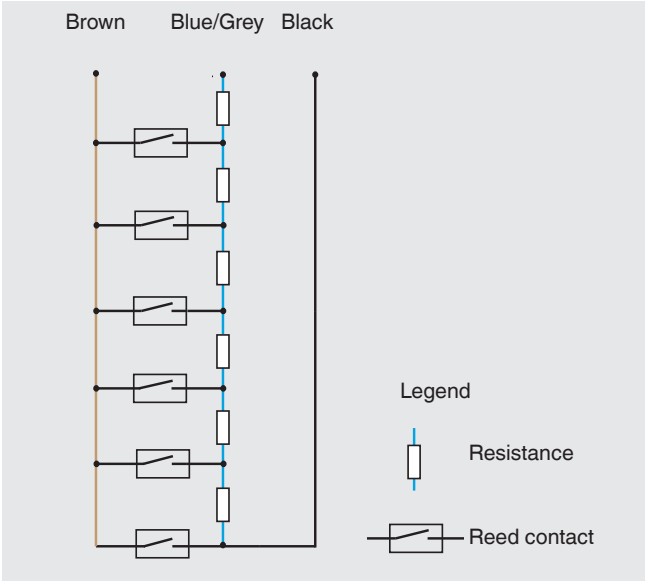
Application area

Following the Fukushima accident, the safety margins of nuclear power plants were reassessed to develop action plans for potential plant upgrades. One requirement of such a safety analysis is the necessity to enhance the robustness of the storage pool monitoring system. The N-ALM level sensor presented here is well-suited to retrofitting the existing level measuring instrument as part of a wide range of post-accident monitoring systems. As the instrument has been proven to withstand is proven against severe accident conditions inside the containment, it can also withstand the accident conditions in both the reactor and the fuel building.

Normal operating conditions	
Operating temperature	T = -10 °C ... +70 °C [14 ... 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	250 °C [482 °F]
Accident pressure	10.5 bar [1.05 MPa]
Accident mission time	1 year
Accident radiation dose	Integrated 5.05 MGy [505 MRad]
Seismic acceleration	Up to 2.5g (higher accelerations up to 5g on demand)

Internal circuit diagram of the reed level sensor



Specifications

Overview of versions								
Model [1)]	**Reed Switch Unit (RSU)**	**Magnetic Float Unit (MFU)**	**Stainless steel material**	**Float Guide Tube Unit (FGTU)**	**Filter box**	**Pt100 temperature sensor**	**Redundant measuring equipment**	**Modular design**
ALM-D1	x	x	x	x	x	-	-	-
ALM-D2	x	x	x	-	-	-	-	-
ALM-D3	x	x	x	-	-	-	-	x
ALM-D4	x	x	x	x	x	x	-	-
ALM-D5	x	x	x	x	x	-	x	-
ALM-D6	x	x	x	x	-	x	-	x
BLR-ALM	x	x	x	x	x	-	-	-
BLR-NK	x	x	x	x	x	-	-	-

1) Accident-proof level measuring instruments

Qualification	
ALM-D1	IEC/IEEE 60780-323:2016, KTA 3505
ALM-D2	
ALM-D3	
ALM-D4	
ALM-D5	
ALM-D6	
BLR-ALM	RCC-E edition 2019
BLR-NK	IEC/IEEE 60780-323:2016

Qualification specifications

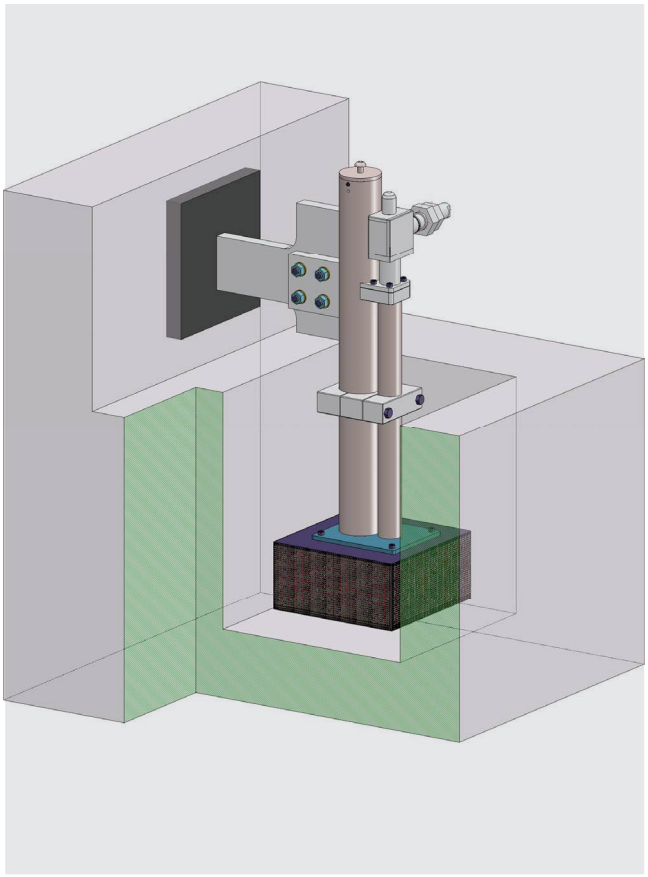
The current qualification is based on KTA3505, IEC/IEEE 60780-323:2016 and RCC-E edition 2019. Qualification covers the sensor and the cable connector, both of which have electrical safety class 1E. Qualification is based on theoretical analysis and/or physical tests. The major points included in this qualification are as follows:

- Electromagnetic compatibility
- Shock test
- Functional test
- Behaviour upon plugging and unplugging
- Climatic test
- Thermal and radiological ageing
- Accidental mechanical loads
- Debris test
- Performance during exposure to pressure, temperature and humidity
- Performance during exposure to high dose rates and post-stressing

Products are developed for and with Framatome GmbH. The accident-proof level measuring instrument is part of the standard instrumentation used in a recent Framatome project.

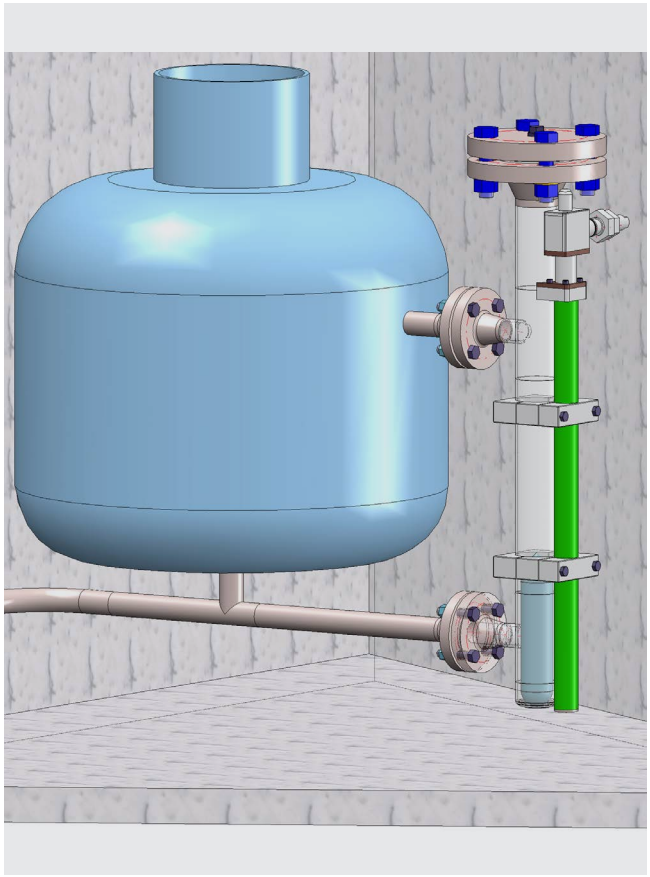
Application examples

Example for ALM-D1



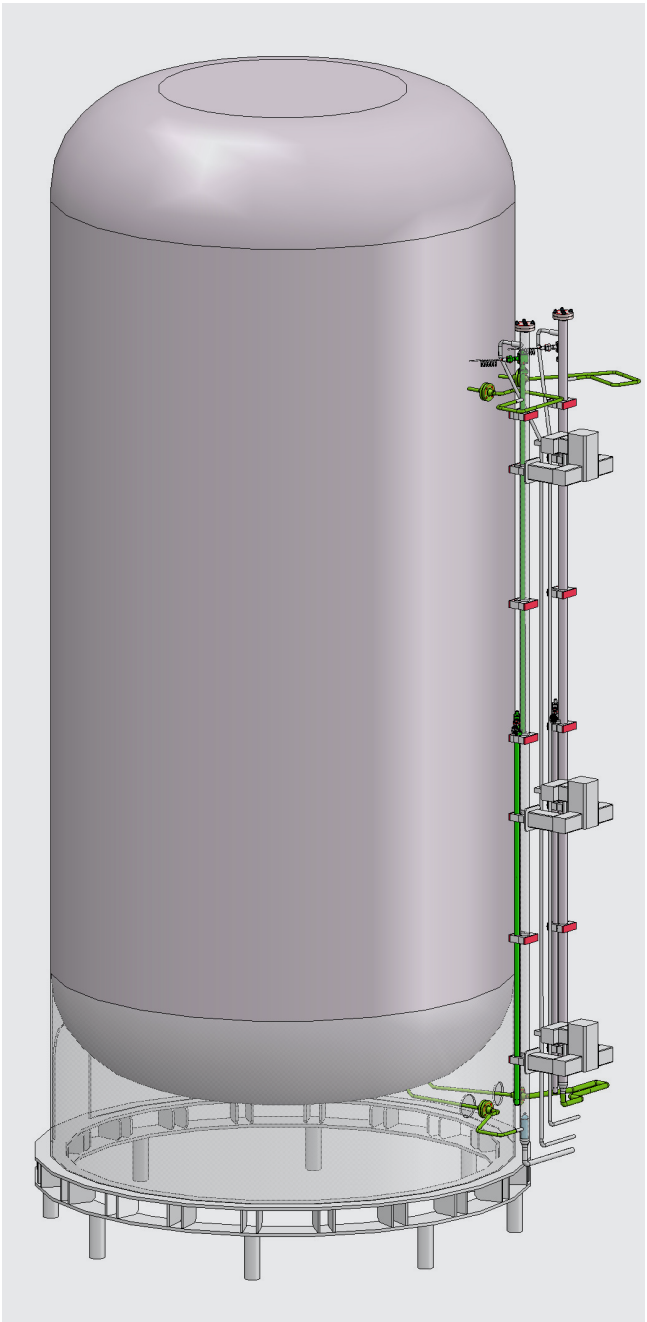
The ALM-D1 level measuring instrument is used to detect breaks in pipes or leaks on valves and pumps of the Residual Heat Removal System and Containment Heat Removal System during normal operation, outages and accidents throughout the entire Nuclear Power Plant (NPP) life cycle.

Example for ALM-D2



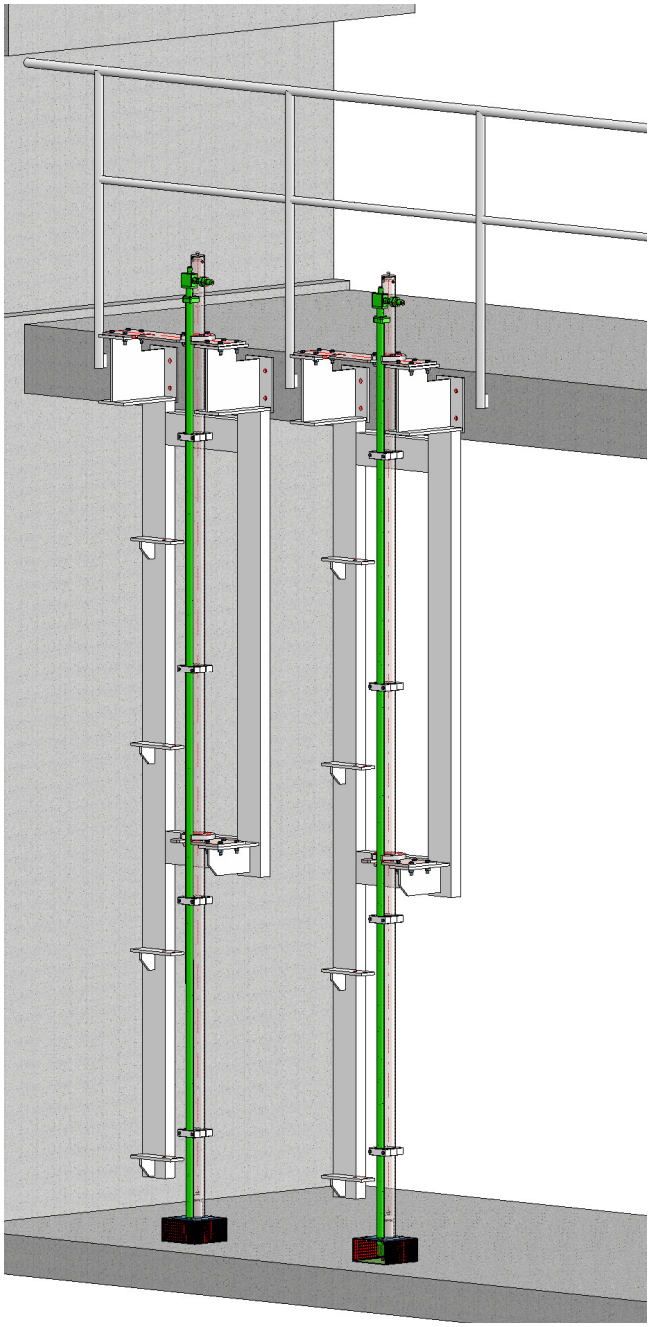
The ALM-D2 level measuring instrument at the Flooding Valve Outlet is designed to reliably detect any leakage and accidental or intentional triggering of the passive flooding instrument valves. The valves discharge the water from the IRWST into the containment's spreading area. The premature presence of water must be avoided during normal operation of the plant due to the risk of hydrogen generation should the molten core flow into the already flooded spreading area. During a severe accident, the passive flooding valve is essential for cooling any corium melt that has escaped into the spreading area.

Example for ALM-D3



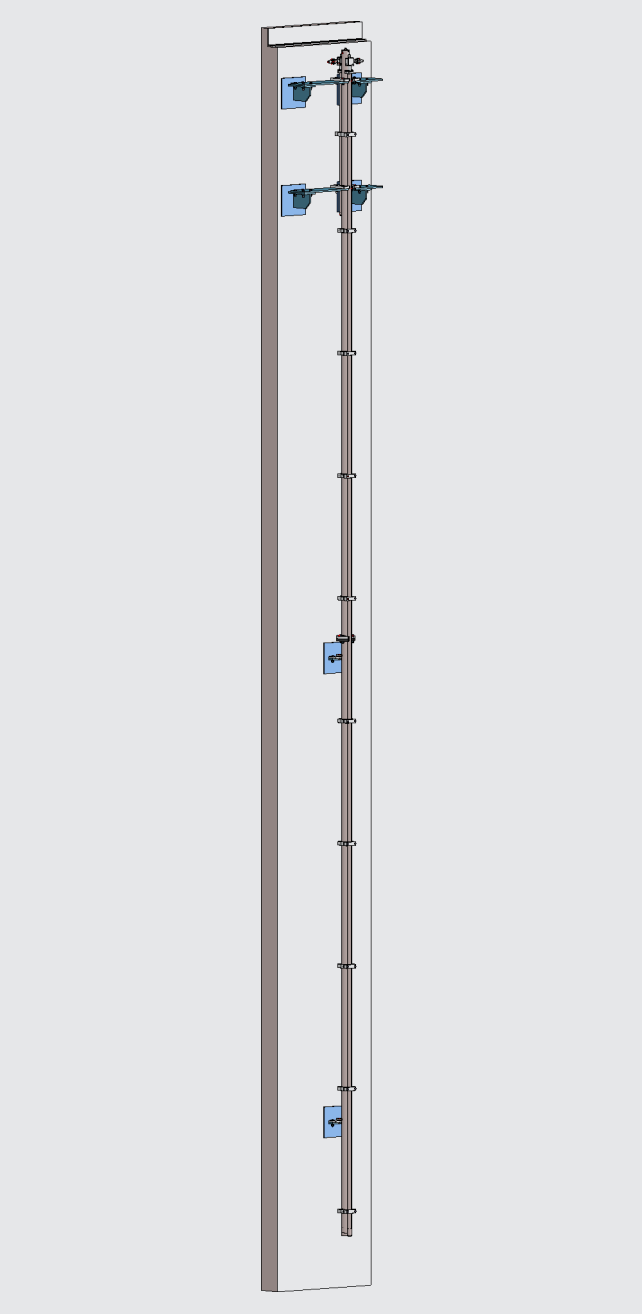
The ALM-D3 level measuring instrument is used to monitor the level of scrubbing liquid in the Venturi scrubber vessel during normal operation, outages and accidents throughout the complete NPP life cycle.

Example for ALM-D4



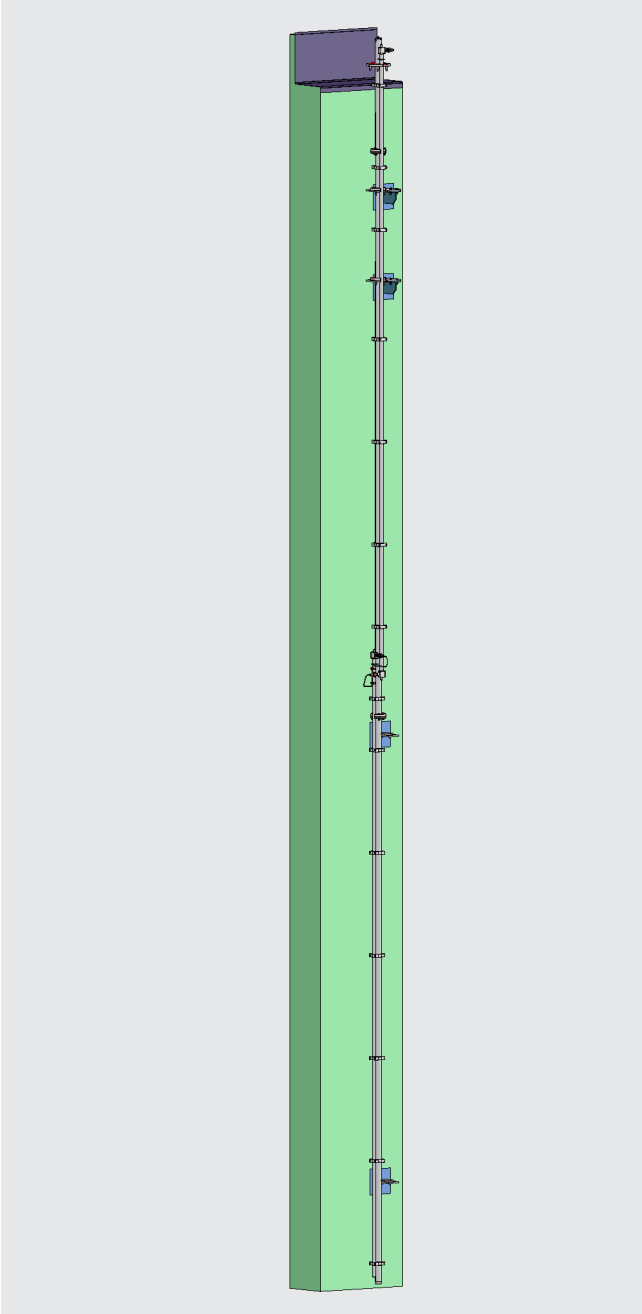
The ALM-D4 accident-proof level measuring instrument is designed to reliably monitor the IRWST water level during outages, normal plant operations and in case of DBC events or severe accidents. Furthermore the system must provide means of calibration and verification during maintenance periods.

Example for ALM-D5



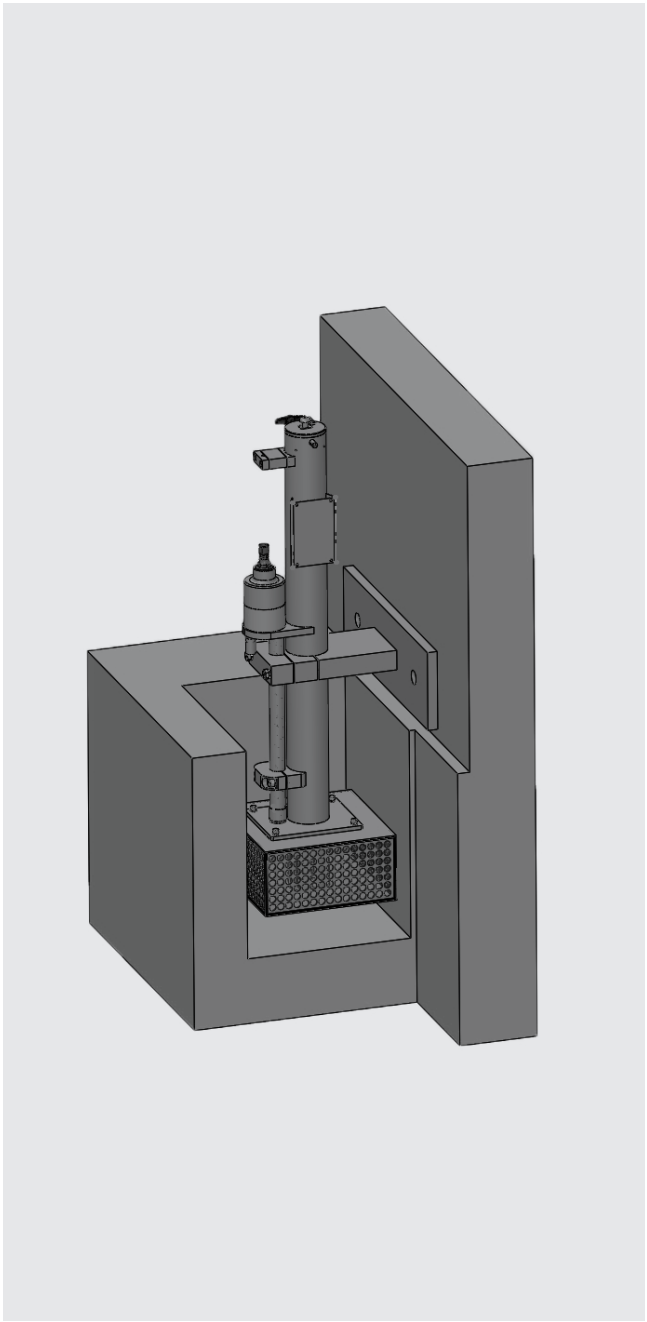
The ALM-D5 accident-proof level measuring instrument reliably monitors the level of coolant in the fuel pools. Level measuring instruments will be installed in the fuel pools, which will then be flooded and will never be emptied again. These instruments should function reliably throughout the complete NPP life cycle, including during normal operations, as well as during and after a severe accident.

Example for ALM-D6



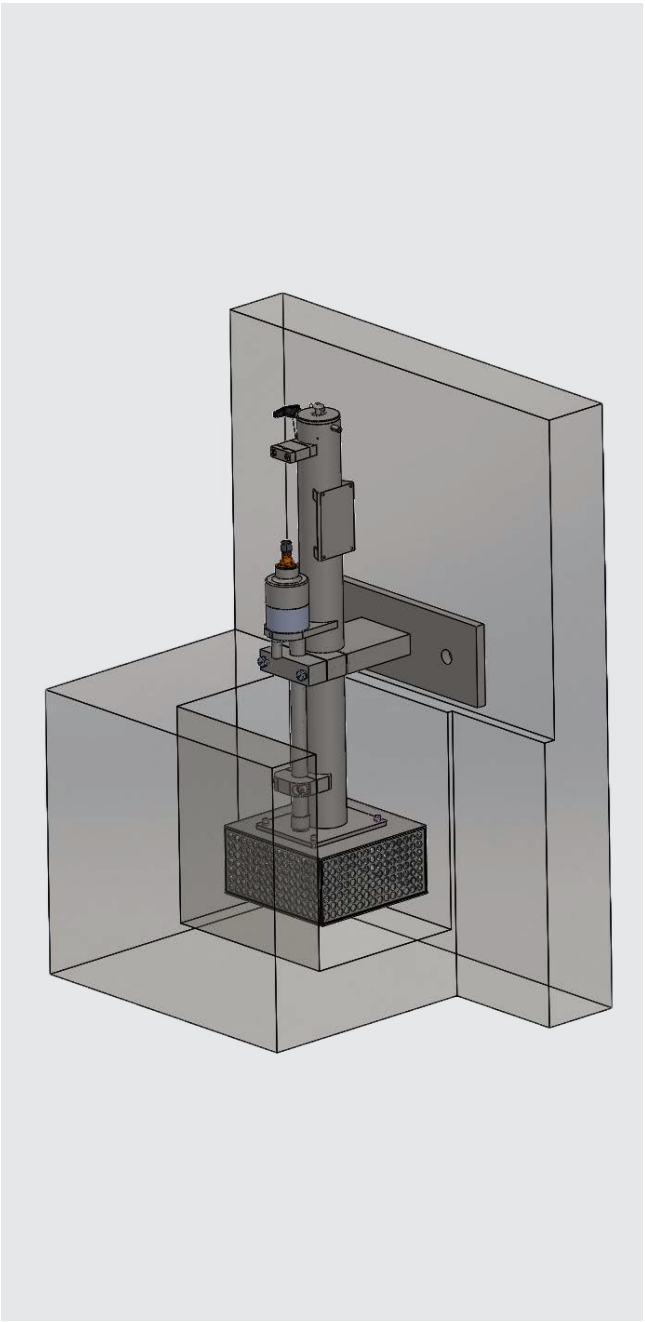
The ALM-D6 level measuring instrument is designed to provide a continuous measurement of the water level during refueling outages in normal plant operating conditions as well as during an LUHS accident in an empty or flooded RCAV.

Example for BLR-NK



The BLR-NK instrument provides information on the water level at the bottom of the Reactor Building (RB), enabling the control of a possible direct water injection into the RB, in particular in the event of loss of the ultimate emergency cooling system (containment spray system – spray recirculation), under accident conditions.

Example for BLR-ALM



The BLR-ALM instrument provides information on the water level at the bottom of the reactor building (RB) to support potential direct water injection, particularly in the event of a loss of the ultimate emergency cooling system, under Fukushima-type accident conditions.

Ordering information

Model / Version / Special features / Measuring range M (span 0 % - 100 %) / Safety class / Seismic category (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.

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