

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: $T = -10^{\circ}\text{C} \dots +70^{\circ}\text{C} (+158^{\circ}\text{F})$
 - Operating pressure: ambient
- Lengths: up to 20 m (65 ft)
- Humidity: 100 %
- Operational radiation dose: $\leq 160 \text{ kGy} (16 \text{ MRad})$

Accident conditions

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

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.



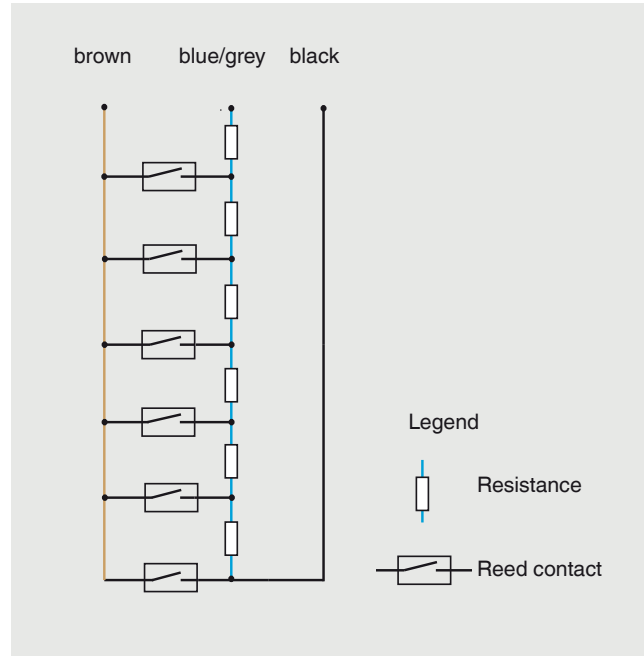
Accident-proof level measurement sensor with reed chain technology, model ALM

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

Internal circuit diagram of the reed sensors



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.

Model overview

Sensor model	Description	Standard				Special Features			
		Reed switch unit (RSU)	Magnetic floater unit (MFU)	Material stainless steel	Floater guide tube unit (FGTU)	Filter box	Temperature sensor PT-100	Redundant measuring equipment	Modular design
ALM-D1	Accident proof Level Measurement Devices	x	x	x	x	x			
ALM-D2	Accident proof Level Measurement Devices	x	x	x					
ALM-D3	Accident proof Level Measurement Devices	x	x	x					x
ALM-D4	Accident proof Level Measurement Devices	x	x	x	x	x	x		
ALM-D5	Accident proof Level Measurement Devices	x	x	x	x	x		x	
ALM-D6	Accident proof Level Measurement Devices	x	x	x	x		x		x

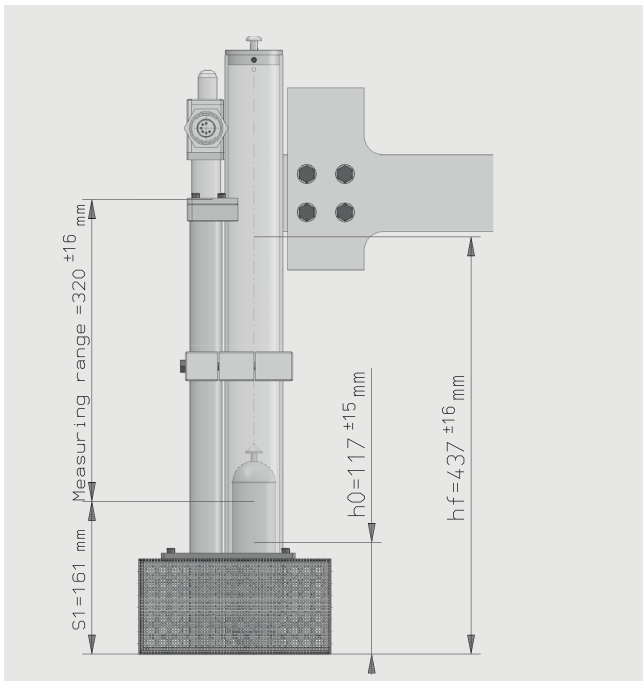
Qualification specifications

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 post-stressing.

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

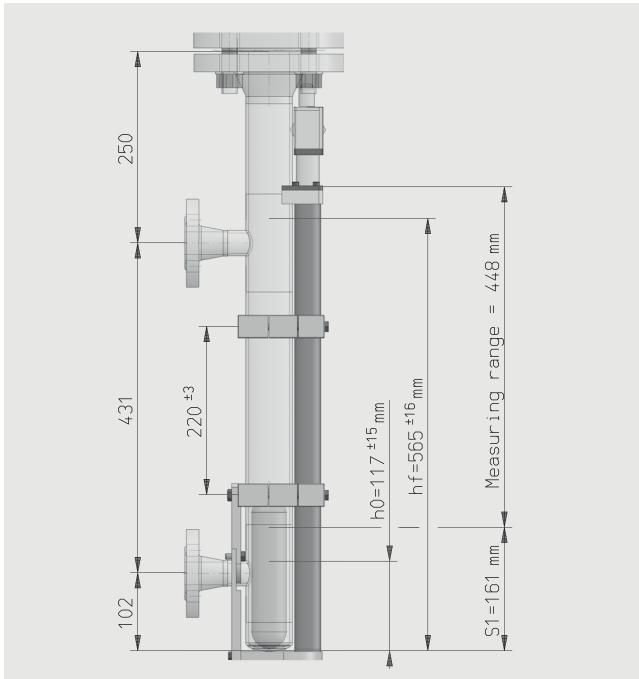


Technical specifications	
Electrical connection	Male plug
Mounting	Welding bracket
Guide tube unit diameter	60.3 mm (2")
Float	Titanium ZTS45/200/SMCO
Contact separation	16 mm (0.63")
Overall resistance of the measuring chain	< 500 Ohm
Connection cable to transmitter	Available on request
Control unit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

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) Dose rate 5kGy/h (0.5 MRad/h) (1 year)
Mechanical stress	Load test 1.68g (3 axis) Excitation type: Sine sweep Frequency: 2..50 Hz Displacement: 10 mm (0.03 ft), 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
Pollution severity	3.0 kg MD2 insulation material for pipes (glass wool material) 53 g concrete particles (<250 μm) 53 g paint and coating particles (solid matter) 80 g Microtherm, microporous insulation material 300 l clear water
Accuracy (for 320 mm measuring range) under accident conditions	30 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 Chloride = 0.2 mg/kg NaOH = 0.5•wt % 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)

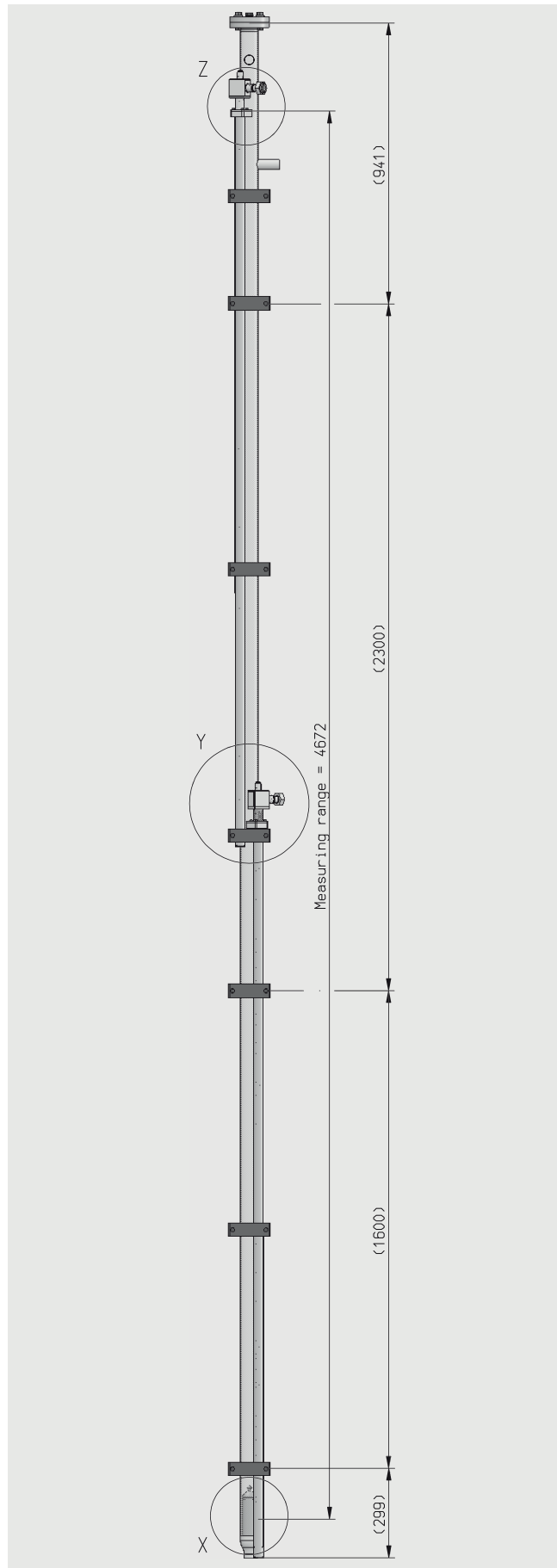
Accident conditions	
Maximum temperature	156 °C (312 °F)
Maximum pressure	5.5 bar (0.55 MPa) abs.
Humidity	100%
Radiation resistance	5.05 MGy (505 MRad) Dose rate 5kGy/h (0.5 MRad/h) (1 year)
Mechanical stress	Load test 1.68g (3 axis) Excitation type: Sine sweep Frequency: 2..50 Hz Displacement: 10 mm (0.03 ft), 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
Pollution severity	No
Accuracy (for 448 mm measuring range) under 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 Chloride = 0.2 mg/kg NaOH = 0.5•wt % Na ₂ S ₂ O ₃ = 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)	≤ 21 mm (0.07 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) Dose rate 5kGy/h (0.5 MRad/h) (1 year)
Mechanical stress	Load test 1.68g (3 axis) Excitation type: Sine sweep Frequency: 2..50 Hz Displacement: 10 mm (0.03 ft), 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
Pollution severity	No
Accuracy (for 4672 mm measuring range) under accident conditions	50 mm (0.16 ft)

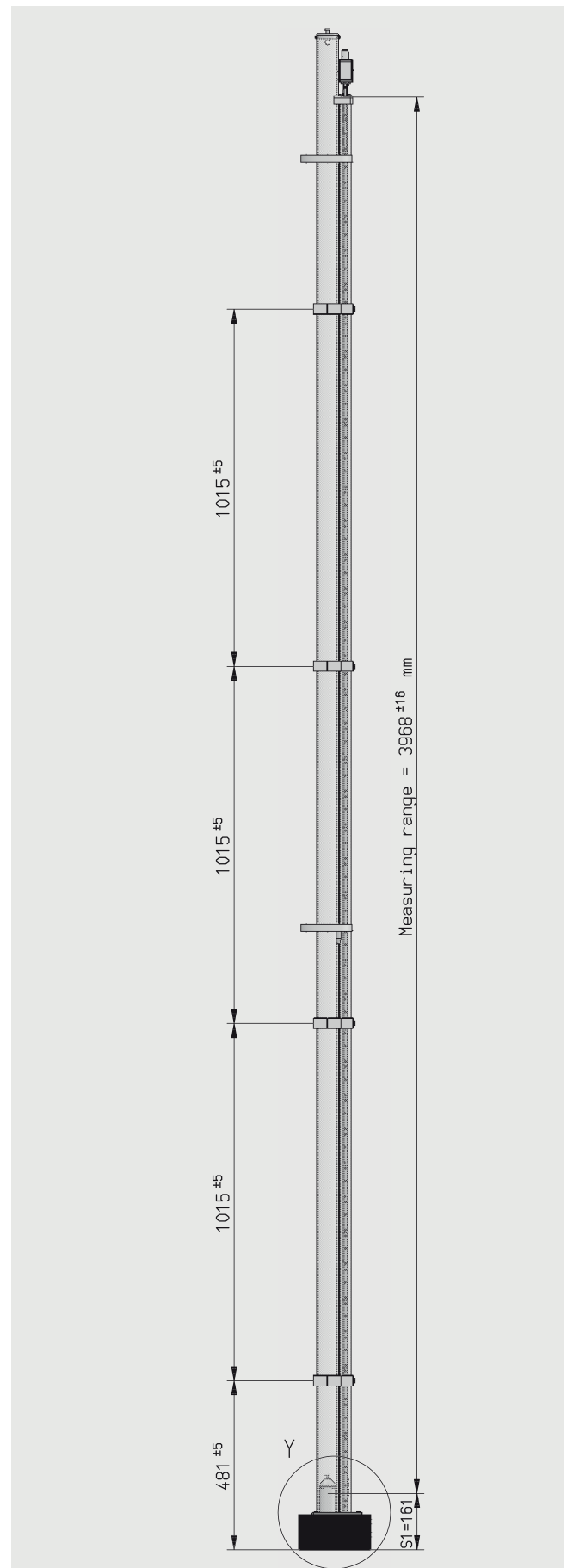


Accident-proof Level Measurement Device, model ALM-D4 Internally mounted for fuel pools

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 Chloride = 0.2 mg/kg NaOH = 0.5•wt % Na ₂ S ₂ O ₃ = 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) Dose rate 5kGy/h (0.5 MRad/h) (1 year)
Mechanical stress	Load test 1.68g (3 axis) Excitation type: Sine sweep Frequency: 2..50 Hz Displacement: 10 mm (0.03 ft), 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
Pollution severity	3.0 kg MD2 insulation material for pipes (glass wool material) 53 g concrete particles (<250 μm) 53 g paint and coating particles (solid matter) 80 g Microtherm, microporous insulation material 300 l clear water
Accuracy (for 3968 mm measuring range) under accident conditions	30 mm (0.1 ft)



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 Chloride = 0.2 mg/kg NaOH = 0.5•wt % Na2S2O3 = 3.5•wt %

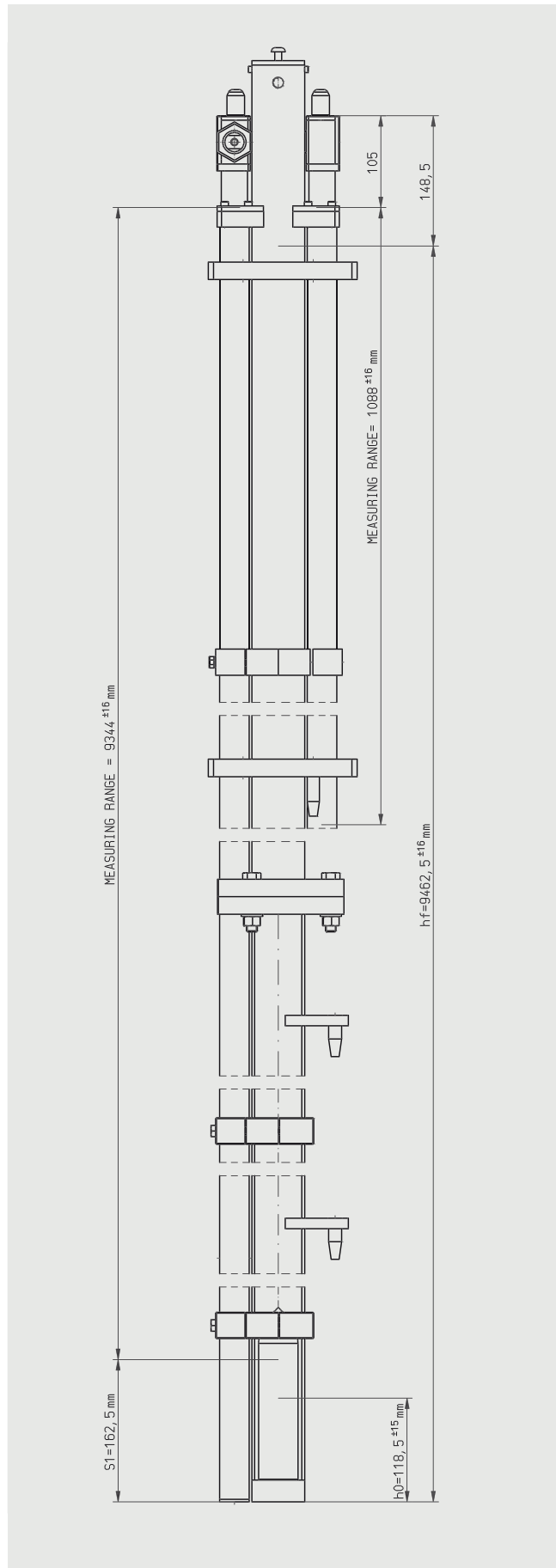
Normal operating conditions

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	
Long Range/Short Range	107 mm / 19 mm (0.35 ft / 0.06 ft)

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) Dose rate 5kGy/h (0.5 MRad/h) (1 year)
Mechanical stress	Load test 1.68g (3 axis) Excitation type: Sine sweep Frequency: 2..50 Hz Displacement: 10 mm (0.03 ft), 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
Pollution severity	3.0 kg MD2 insulation material for pipes (glass wool material) 53 g concrete particles (<250 µm) 53 g paint and coating particles (solid matter) 80 g Microtherm, microporous insulation material 300 l clear water

Accuracy (for 9344 mm / 1088 mm measuring range) under accident conditions
Long Range/Short Range 481 mm / 68 mm (1.58 ft / 0.22 ft)



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

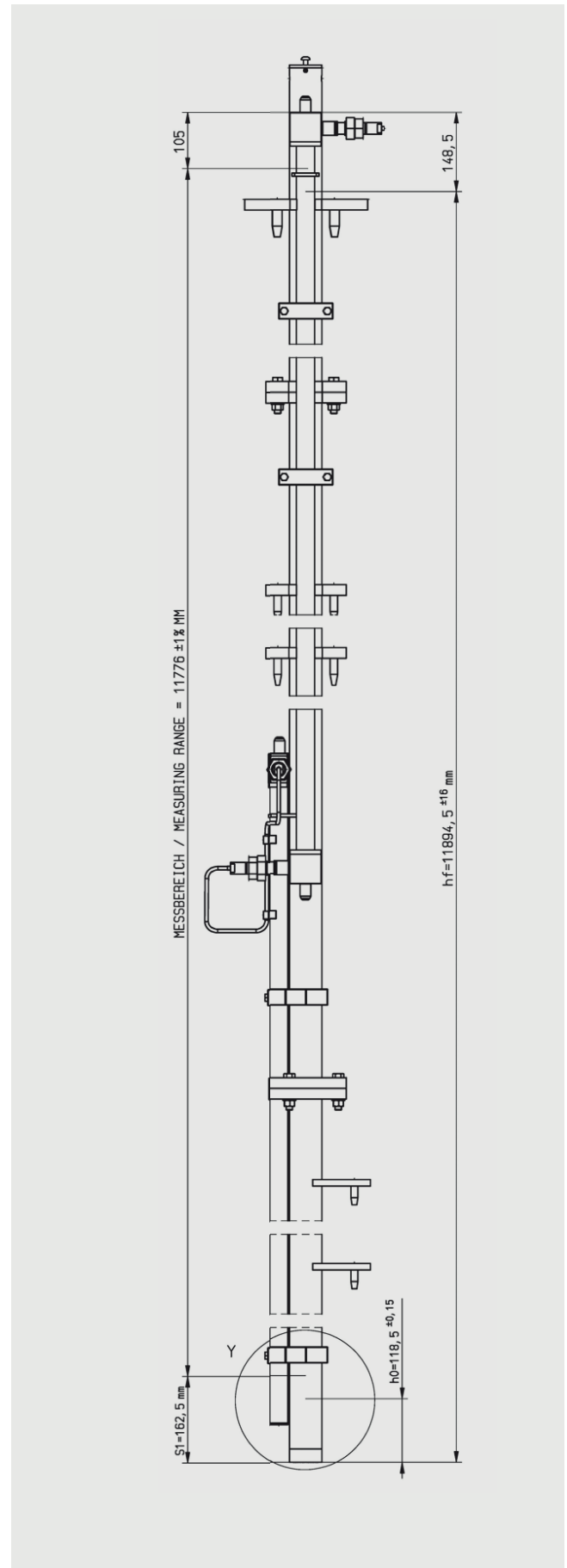
Technical specifications	
Electrical connection	Male plug
Process connection	Welding bracket
Guide tube unit diameter	60.3 mm (2")
Float	Titanium ZTS45/200/SMCO
Contact separation	16 mm (0.63")
Overall resistance of the measuring chain	< 500 Ohm
Connection cable to transmitter	Available on request
Control unit	Available on request
Mounting position	Vertical
Material	Stainless steel
Chemical resistance	Boron (B-10 32%) = 1750 ppm Chloride = 0.2 mg/kg NaOH = 0.5•wt % 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 Long Range	107 mm (0.35 ft)

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) Dose rate 5kGy/h (0.5 MRad/h) (1 year)
Mechanical stress	Load test 1.68g (3 axis) Excitation type: Sine sweep Frequency: 2..50 Hz Displacement: 10 mm (0.03 ft), 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
Pollution severity	3.0 kg MD2 insulation material for pipes (glass wool material) 53 g concrete particles (<250 µm) 53 g paint and coating particles (solid matter) 80 g Microtherm, microporous insulation material 300 l clear water

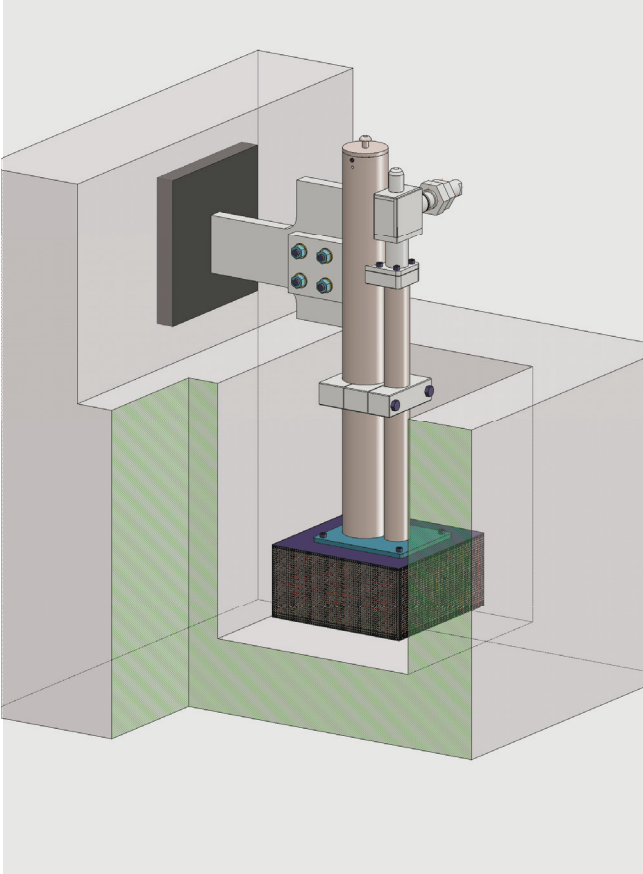
Accuracy (for 11776 mm measuring range) under accident conditions
Long Range/Short Range

481 mm (1.58 ft)



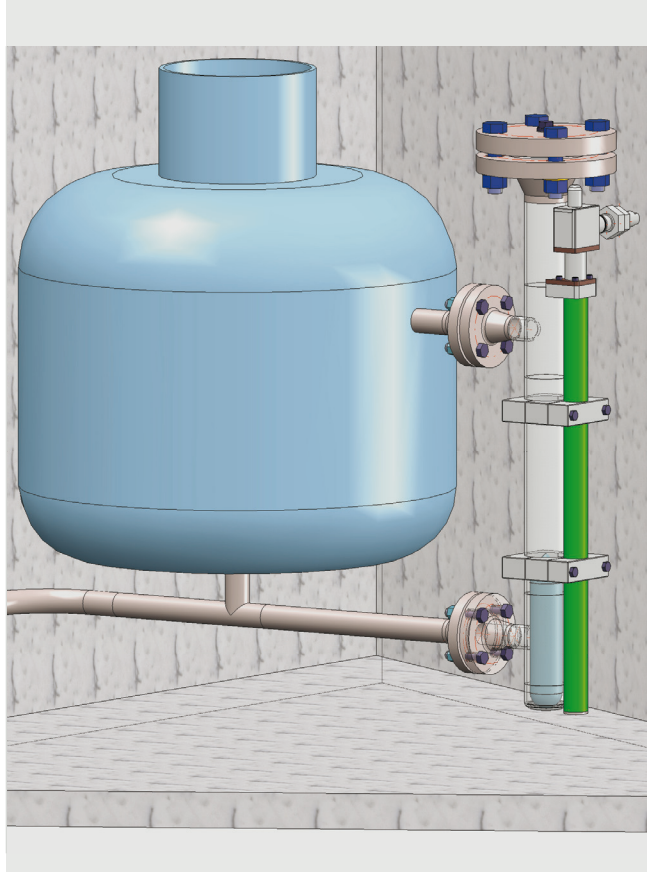
Application examples

Example for ALM-D1



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.

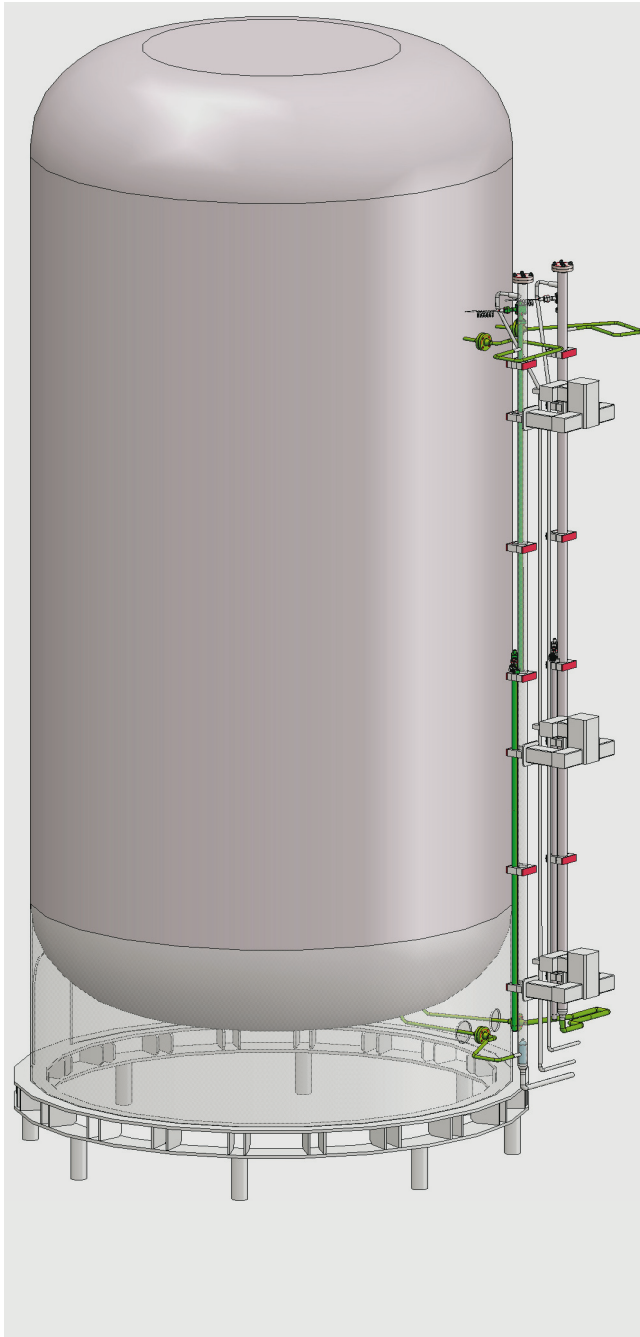
Example for ALM-D2



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.

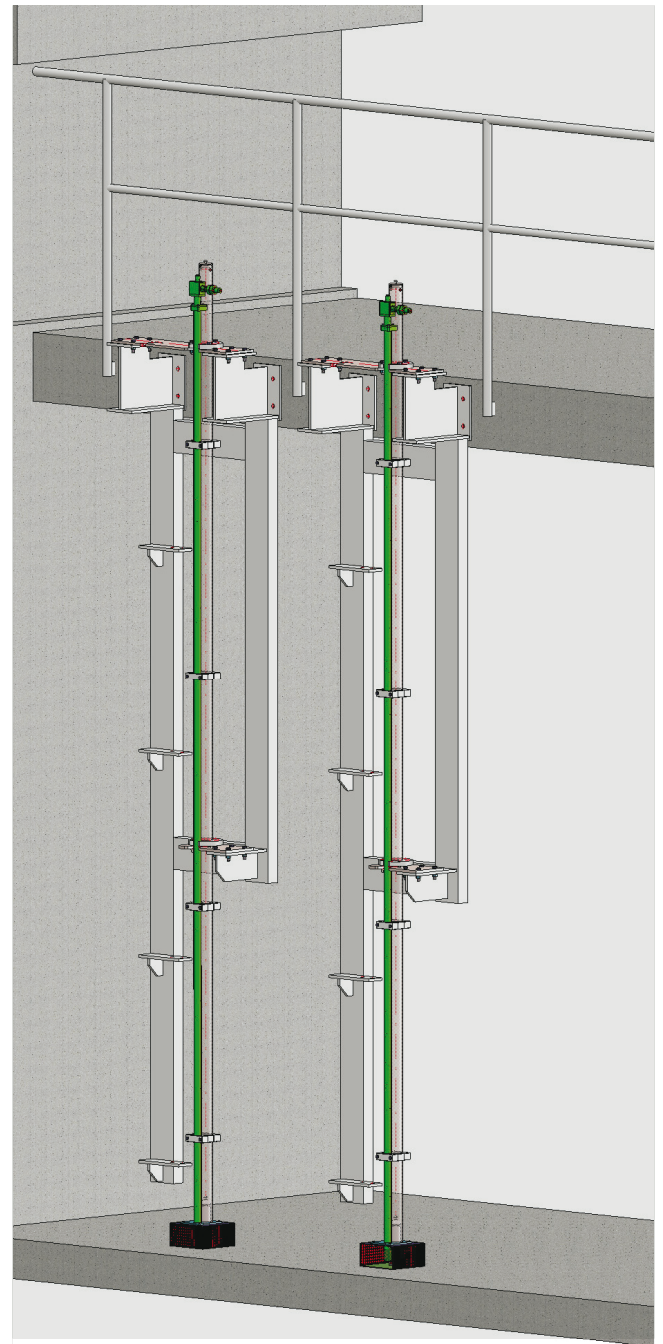
Application examples

Example for ALM-D3



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.

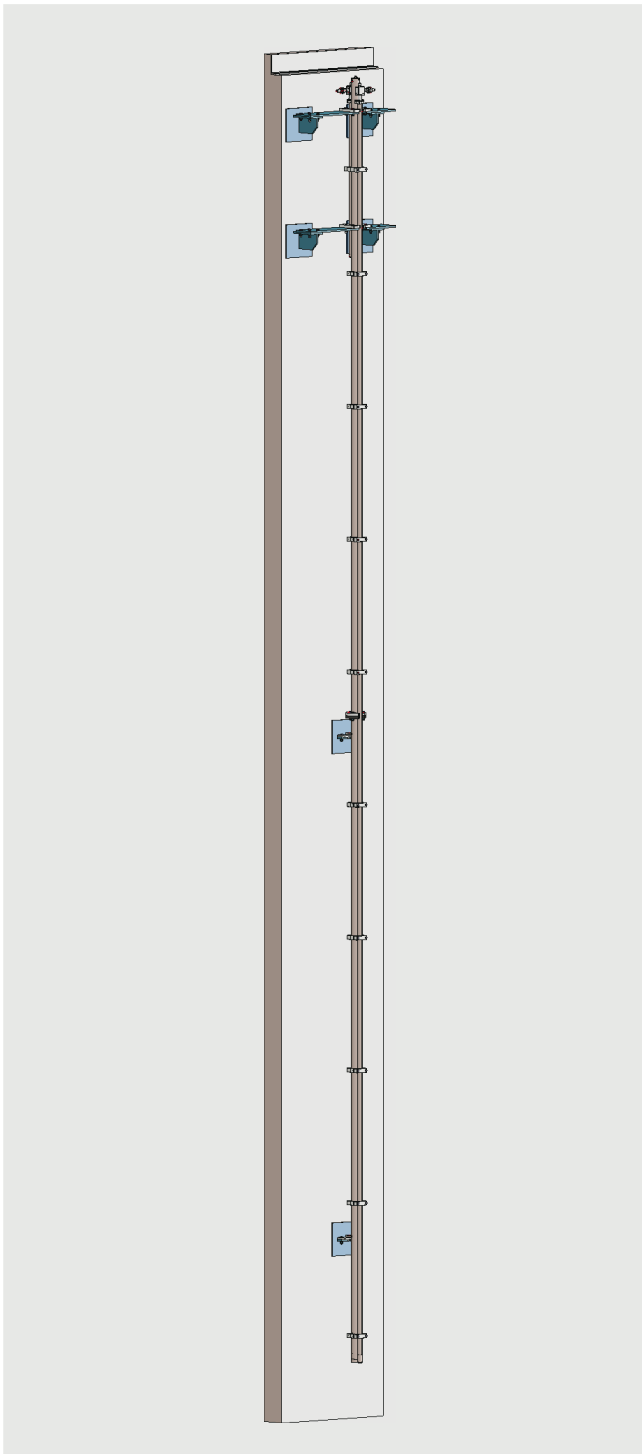
Example for ALM-D4



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.

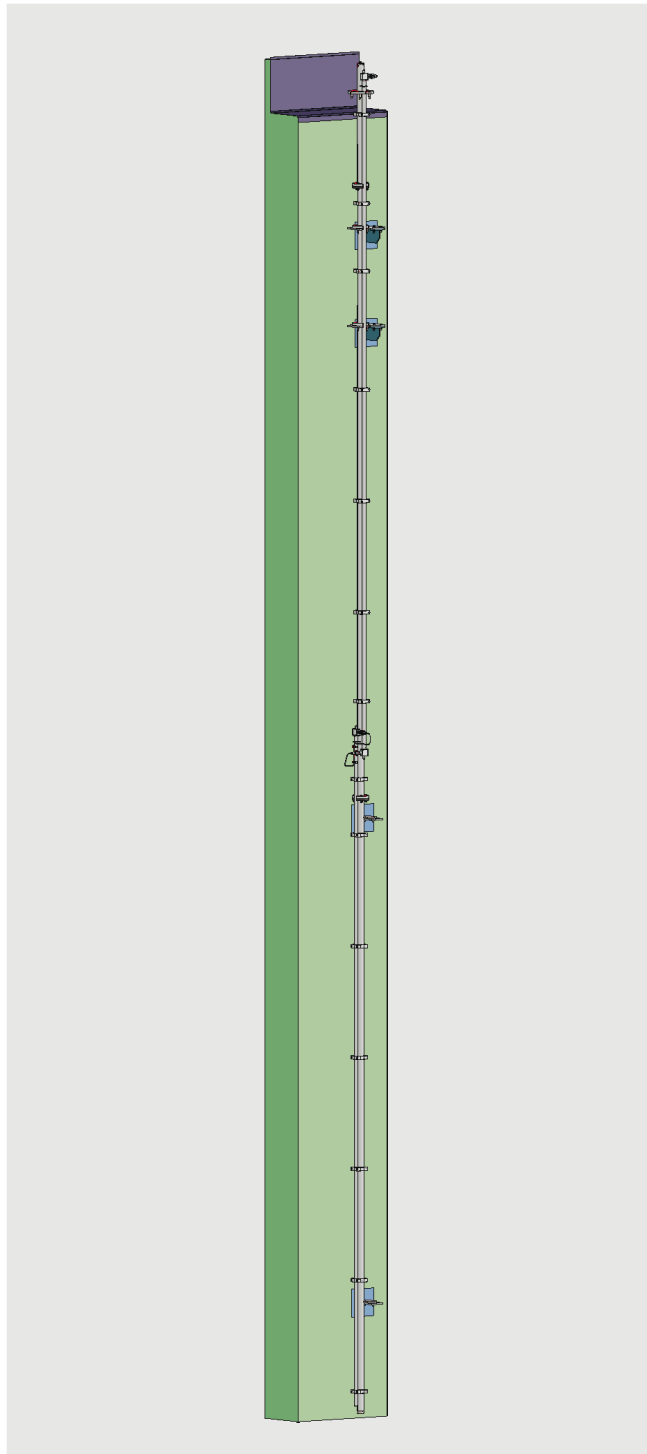
Application examples

Example for ALM-D5



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.

Example for ALM-D6



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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