

# Equipment for Measuring of the Boron Concentration (AMKB)

## VISION

Improve the safety of nuclear power plants, especially during outages and changes of operating states.

### Basic Functions:

Measurement of the isotope  $^{10}\text{B}$  concentration and boric acid  $\text{H}_3\text{BO}_3$  concentration, complemented by metrological compliance methods.

### Instrument Types:

**Calibration Boron Meter (BM)** – Intended for measurement of the isotope  $^{10}\text{B}$  or boric acid concentration in g/kg and atomic representation of the isotope  $^{10}\text{B}$  in %:

- In aqueous boric acid samples for adjustment and calibration of operating boron meters;
- In boric acid samples during NPP receiving inspection; and
- In samples of unknown solution taken from NPP technological systems.

**Operating BM** – Intended for continuous measurement of the isotope  $^{10}\text{B}$  or boric acid  $\text{H}_3\text{BO}_3$  content (concentration) in g/kg. Available models are **Flow**, **Suspension** and **Submersible** for different placement in technology.

## BENEFITS

- High precision measurement
- Continuous fluid analysis of NPP technological systems
- Optional concentration measurement in  $^{10}\text{B}$  or v  $\text{H}_3\text{BO}_3$
- Display and archival of measured values

### Calibration Boron Meter BorAn PN160-VKB

The BorAn PN160-VKB instrument is designed for use in laboratory conditions and it is a reference standard for metrological compliance. It consists of three main parts:

- Sensor with commutating adjustment and measurement cells
- Electronic part of calibration boron meter
- Calibration boron meter workstation (PC KB) - Industrial notebook



Metrological Parameters	Isotope $^{10}\text{B}$ Concentration	Boric Acid $\text{H}_3\text{BO}_3$ Concentration	Isotope $^{10}\text{B}$ Atomic Representation *)
Measurement Range (MR)	0 to 1,6 g/kg	0 to 50 g/kg	15 to 25 % atomic
Standard Extended Uncertainty	Less than 0,32 g/kg $\pm 0,0019$ g/kg	Less than 10 g/kg $\pm 0,06$ g/kg	2 $\div$ 4 g/kg $\pm 0,6\%$
	0,32 to 1,6 g/kg $\div$ MR g/kg $\pm 0,6\%$ of MV	10 to 50 g/kg $\div$ MR g/kg $\pm 0,6\%$ of MV	4 $\div$ 7 g/kg $\pm 0,4\%$
			7 $\div$ 50 g/kg $\pm 0,3\%$

\*) Subject to  $\text{H}_3\text{BO}_3$  concentration measurement with uncertainty  $\pm 1.0\%$  of measured value (MV)

### Flow Boron Meter BorAn PN160

Flow boron meter type BorAn PN160 is a connection of flow sensor with the technological part. It provides measurement in fluid samples of NPP technological systems flowing through the boron meter sensor. The technological part is used for adjustment and measurement of parameters of the fluid sample flow and for alignment and calibration of the boron meter.



#### Operating Parameters of Boron Meters

Fluid temperature - 15  $\div$  90 °C      Fluid nominal pressure - max. 18 MPa (tested up to 25 MPa)

Metrological Parameters	Isotope $^{10}\text{B}$ Concentration	Boric Acid $\text{H}_3\text{BO}_3$ Concentration
Measurement Range (MR)	0 to 1,6 g/kg	0 to 50 g/kg
Standard Extended Uncertainty	Less than 0,32 g/kg $\pm 0,0032$ g/kg	Less than 10 g/kg $\pm 0,1$ g/kg
	0,32 to 1,6 g/kg $\div$ MR g/kg $\pm 1\%$ of MV	10 to 50 g/kg $\div$ MR g/kg $\pm 1\%$ of MV

## Suspension Boron Meter BorAn PN160-N

Suspension boron meter type BorAn PN160-N is used in NPP technological systems without the need to interfere with pipelines. Measurement is carried out directly through pipeline walls. Both horizontal and vertical installation is possible. Sensor type is based on the specific pipeline design (DN108, 159, 325, 630).



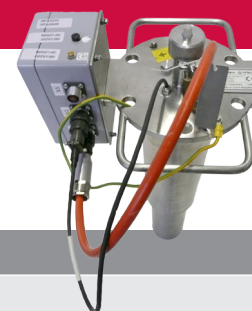
### Operating Parameters of Boron Meters

Fluid temperature - 15 ÷ 90 °C

Metrological Parameters	Isotope <sup>10</sup> B Concentration	Boric Acid H <sub>3</sub> BO <sub>3</sub> Concentration
Measurement Range (MR)	0 to 1,6 g/kg	0 to 50 g/kg
Standard Extended Uncertainty	Less than 0,1920 g/kg ±0,0058 g/kg	Less than 6 g/kg ±0,18 g/kg
	0,1920 ÷ MR g/kg ±3% of MV	6 ÷ MR g/kg ±3% of MV
Max. Standard Extended Uncertainty	±2,5% of MR	±2,5 %of MR

## Submersible Boron Meter BorAn PN160-P

Submersible boron meter type BorAn PN160-P is intended for continuous measurement of the isotope <sup>10</sup>B and boric acid H<sub>3</sub>BO<sub>3</sub> concentration in NPP technological tanks provided with measurement wells. Sensor type is based on the specific measurement well design (128 × 04, 146 × 13, 153 × 16.5).



### Operating Parameters of Boron Meters

Fluid temperature - 15 ÷ 90 °C

Metrological Parameters	Isotope <sup>10</sup> B Concentration	Boric Acid H <sub>3</sub> BO <sub>3</sub> Concentration
Measurement Range (MR)	0 to 1,6 g/kg	0 to 50 g/kg
Standard Extended Uncertainty	Less than 0,1920 g/kg ±0,0058 g/kg	Less than 6 g/kg ±0,18 g/kg
	0,1920 ÷ MR g/kg ±3% of MV	6 ÷ MR g/kg ±3% of MV
Max. Standard Extended Uncertainty	±2,5% of MR	±2,5% of MR

## System of Control and Diagnostics of the Boron Meters (SKDB)

- Communication and connection with all physically connected boron meters
- System of control and diagnostics of boron concentration measurement
- Maintenance and display of archives of alarms and measurement values
- Automated process of boron meters setting and adjustment from the place of installation



## REFERENCES

Mochovce NPP	SK	Supply of 21 units	1999, 2008, 2012, 2017
Jaslovske Bohunice NPP	SK	Supply of 1 units	2014
Zaporizhia NPP	UA	Supply of 8 units	2012
Loviisa NPP	FIN	Supply of 2 units	2012
Rivne NPP	UA	Supply of 9 units	2005 – 2007
South Ukraine NPP	UA	Supply of 7 units	2006
Paks NPP	HU	Supply of 1 units	2006
Khmelnitskiy NPP	UA	Supply of 3 units	2005 – 2006
Dukovany NPP	CZ	Supply of 15 units	2002

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