The development of methods to ensure nuclear safety and radiological protection for current and prospective requirements of nuclear power

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The aspects of the air sampling

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"Regional Workshop on Regulatory Control of Radioactive Discharges to the Environment",

17-21 June 2013, Warsaw, Poland

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ASS-500 vs. NASS-500

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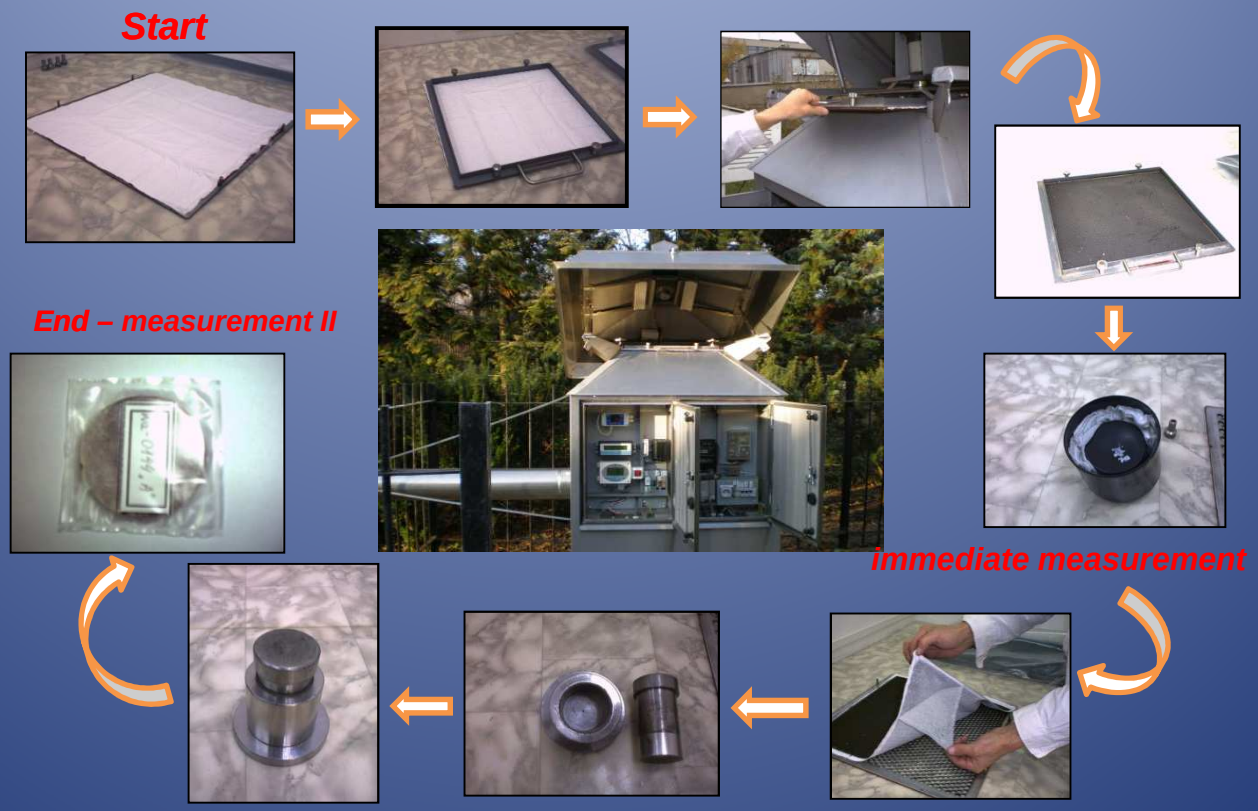
Aerosol sampling procedure



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Petrianov filter

The effective filter area of the standard ASS-500 has the dimensions 0.44 m x 0.44 m.
The efficiency of the Petrianov filter type FPP 15-1.5 for aerosols with diameters between 0.3 and 1.25 μm, at linear air velocities through the filter varying from 0.25 to 4 m/s with pressure drop through the filter Δp from 500 - 9300 Pa, is between 96 % and 99 %.
The collection efficiency for aerosols of diameter of 0.32 μm versus linear velocity of the air passing through the filter is presented in Table 1.

Linear velocity of air [m/s]	**Efficiency [%]**
0.25	96.35
0.50	97.35
1	98.57
2	99.91
3	99.97
4	99.98

Table 1. Collection efficiency versus linear velocity of air passing through FPP-15-1.5 filter for aerosols of 0.32 μm diameter.

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NASS-500 station

- **Power inverter controlling the fan – much smaller power consumption**
- **Atmospheric parameters measurement circuit (temperature and humidity) for controlling the filter heating unit**
- **Air flow stabilization – the air flow rate through filter is constant throughout the whole sampling period (week)**
- **Special container for the scintillation detector used for on-line measurements enabling the efficient temperature stabilization**

NASS-500 station (2)

- **Additionally the flow rate can be programmed within the range of 100 to 500 m3/h (and more, but it is not recommended due to the usage of Petrianov type filter)**
- **Cylindrical silencer considerably eliminated the air flow resistance in the station and thus minimized the noise generated by the station**
- **Ceramic infrared heaters with directed beam allowing more efficient filer drying**
- **Circuits responsible for air flow measurements are temperature stabilized**

NASS-500 station (3)

- **Single-phase fan (replacing 3-phase fans) having much smaller dimensions and power consumption;**
- **Construction including external mantle is made of acid-resistant steel sheets**

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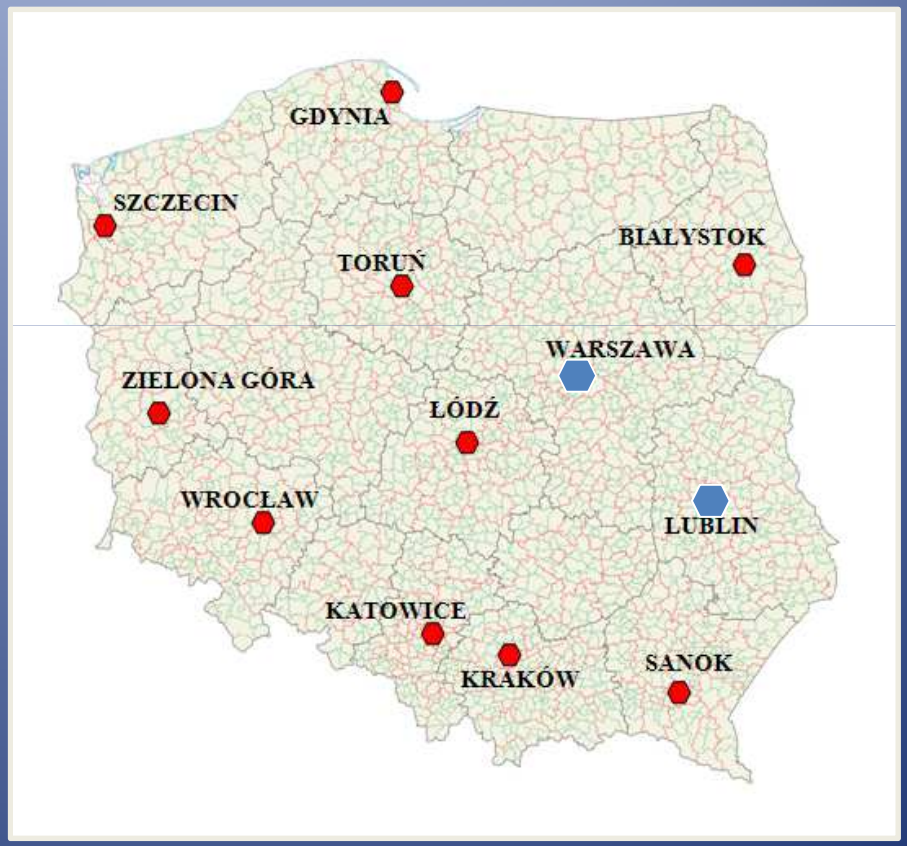
ASS-500 stations in Poland



Old ASS-500

New NASS-500

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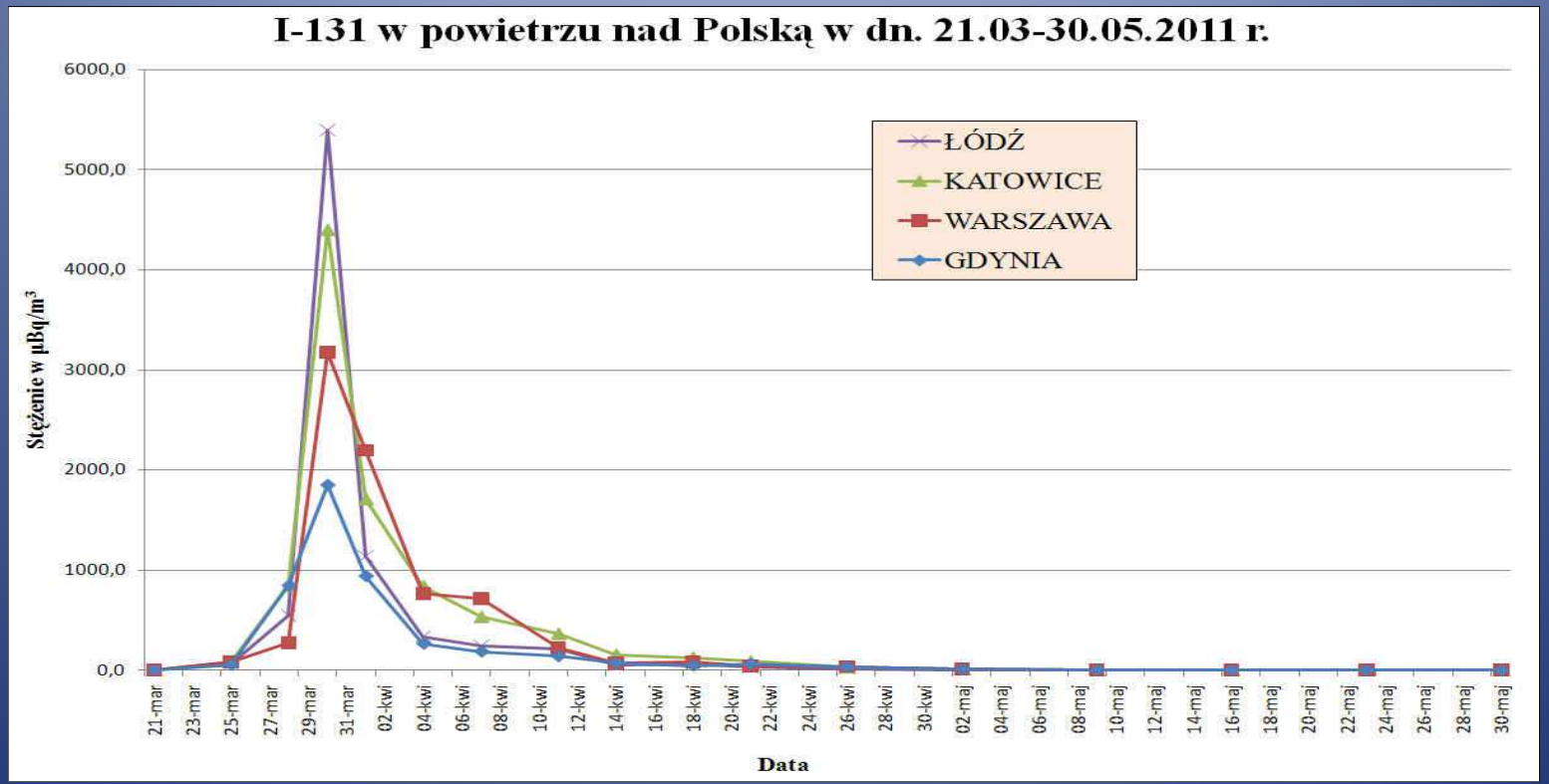
The example of the results – Fukushima

I-131 concentration



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The example of the results – Fukushima

I-131 concentration

End date of exposure	Radioactive concentration of iodine ^{131}I in air [µBq/m^3]							
	GDYNIA		WARSZAWA		ŁÓDŹ		KATOWICE	
	Concentr.	Error	Concentr.	Error	Concentr.	Error	Concentr.	Error
21-Mar	< 0.6		0.7	0.2	< 0.22		< 0.57	
25-Mar	52.9	2.6	83.9	2.0	65.1	3,2	86,3	3,6
28-Mar	845.2	20.6	271.3	5.5	542.6	9,1	847,3	43,6
30-Mar	**1849.8**	**40.9**	**3173.0**	**57.5**	**5400.0**	**95,0**	**4400,0**	**226,1**
01-Apr	939.4	25.0	2196.9	40.2	1139.0	19,0	1709,6	87,9
04-Apr	265.5	9.7	763.1	14.2	338.2	5,6	837,9	43,1
07-Apr	186.3	4.1	712.6	13.4	243.6	5,1	532,7	27,5
11-Apr	139.7	6.2	222.5	4.4	215.6	3,7	365,6	18,8
14-Apr	70.5	3.9	72.1	1.7	52.5	1,0	157,1	8,1
18-Apr	47.1	2.6	81.9	1.9	60.0	2,4	126,3	6,6
21-Apr	63.0	3.3	42.2	1.5	33.7	0,7	89,1	4,6
26-Apr	31.6	1.8	36.9	1.1	16.5	0,5	28,4	1,6
02-May	7.8	0.7	13.9	0.6	6.2	0,3	12,4	0,8
09-May	2.3	0.3	2.9	0.2	1.8	0,1	4,3	0,5
16-May	< 0.7		< 0.75		0.4	0.1	1.3	0,3
23-May	< 0.7		< 0.57		< 0.19		1.4	0.3
30-May	< 0.6		1.7	0.2	< 0.19		< 0.36	

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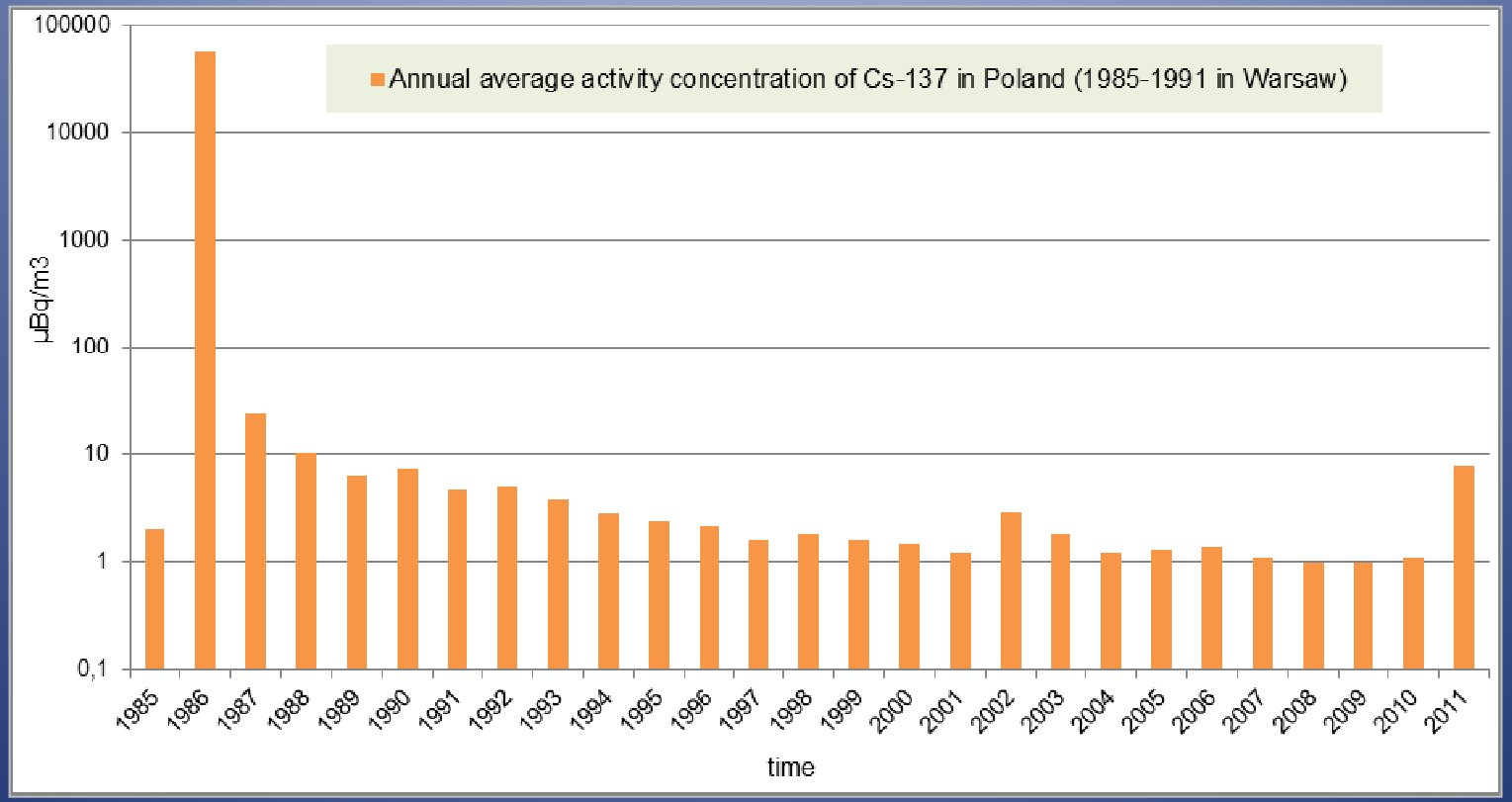
The example of the results

Cs-137 concentration



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Mobile aerosol sampling station

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Mobile sampling station – technical parameters

- **Controlled sampling of the aerosols on the filter (up to 1000 m^3/h);**
- **On-line measurement of γ-radioactive isotopes contained in the ground-level atmosphere;**
- **Remote control of the station and measurement results (Wi-Fi connection);**
- **Power supply form the public electrical network (230 V/60 Hz) or portable power generator;**
- **Full scope measurement of the sampled air parameters;**
- **Filter dimensions 50 x 50 cm – cylindrical positioning of the filter;**
- **Collection of the meteorological parameters (e.g. wind speed and direction, temperature, humidity) during aerosol sampling – results in graphical form;**
- **Station preparation time is up to 10 minutes.**

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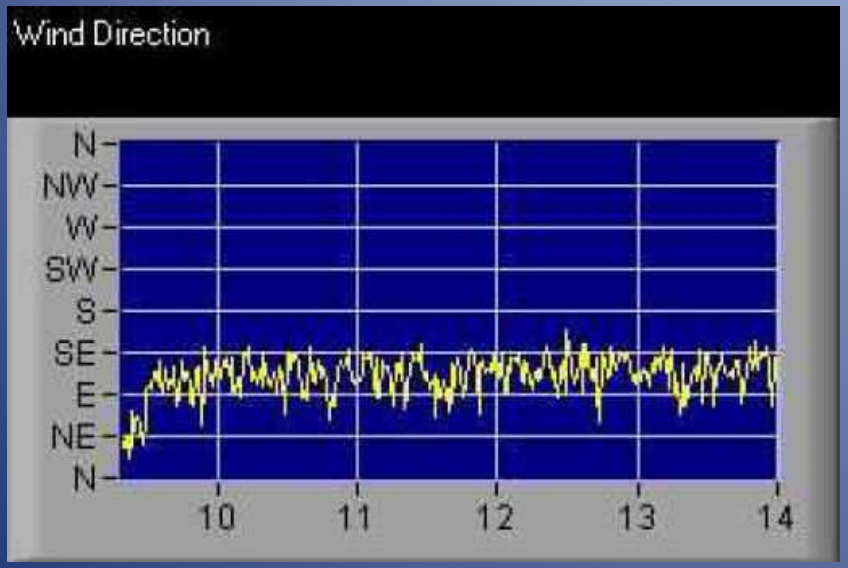
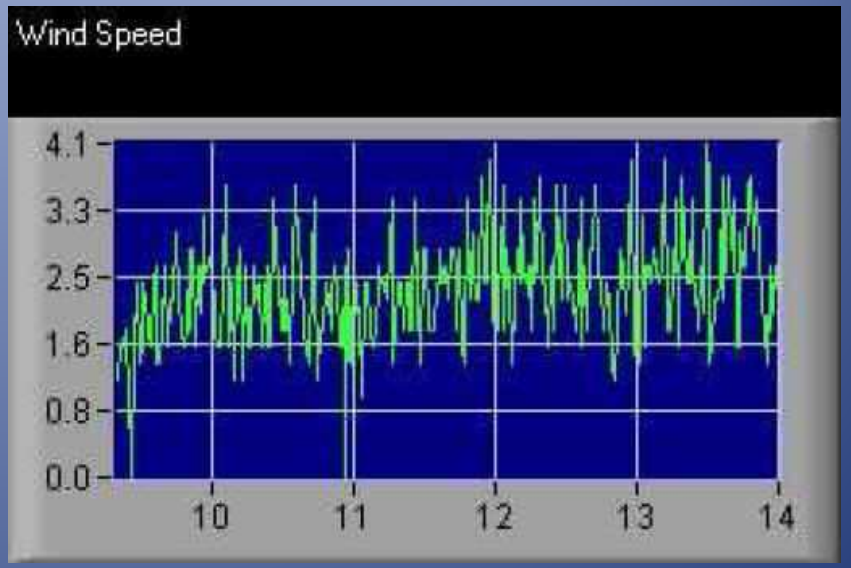
The example of the meteorological parameters





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Mobile aerosol sampling station use

The mobile aerosol sampling station is used for collection of the big volume ground-level air simultaneously with the γ-spectrometric analysis. It can be used to control the aerosols around nuclear facilities, industrial compounds, etc.. It is mobile, easy to deploy in the field and gives the possibility to measure the radionuclide content of the collected aerosols.

Iodine - Sampling

The filtering is two-stage:

- **Petrianov filter – is used to eliminate the radioactive aerosols present in the air and thus to protect the activated carbon filter from the radioactive contamination.**
- **Carbon filter – is used to capture and bind the gaseous iodine present in the air.**

The two-stage filtering system limits the choice of the fans to be used. The fan has to be low-power consuming, single-phase, possibly the highest underpressure – to maximize the air-flow through filer. On the other hand it is known that the iodine has to stay on/in the filter for at leas 0.2 seconds to be fully absorbed.

Radioactive iodine

The radioactive iodine, which is released to the atmosphere in the volatile form has the gaseous and aerosol fractions having the ratio of about 3:1. The gaseous fraction is not deposited on the filter, thus there is a need to collect is by other absorbent.

The gaseous iodine has two forms:

- inorganic mainly I_2, HI, IO_x and,
- organic CH_3I

The crucial issue is to choose the proper absorbent and to set its dimensions. These two factors affect the absorption efficiency of the gaseous iodine and the nominal airflow through the filter. In consequence it is possible to determine limits of detection and credibility of the results.

The iodine station principles

The absorber used in the station is the impregnated active carbon TEDA (1,5-2%) (triethylene di-amine) with potassium iodide KI (1,5-2%) with the granularity 8x16 mesh, characterized by high absorption efficiency for the CH_3I.

The carbon filter having the mass of 220g and volume 450ml (typical Marinelli volume suitable for fast measurements) has the cylinder geometry (75 mm in diameter and 107 mm in height). Filter cartridge is made of acid-resistant steel, which does not react with iodine and its compounds.

The iodine station principles (2)

The influence of the air humidity is suppressed by the filter thickness.
The thickness of the carbon filter allows maintaining the iodine residence time in the cartridge for 0.2 seconds (airflow - 10 m^3/h) – the absorption efficiency is 90- 100%.

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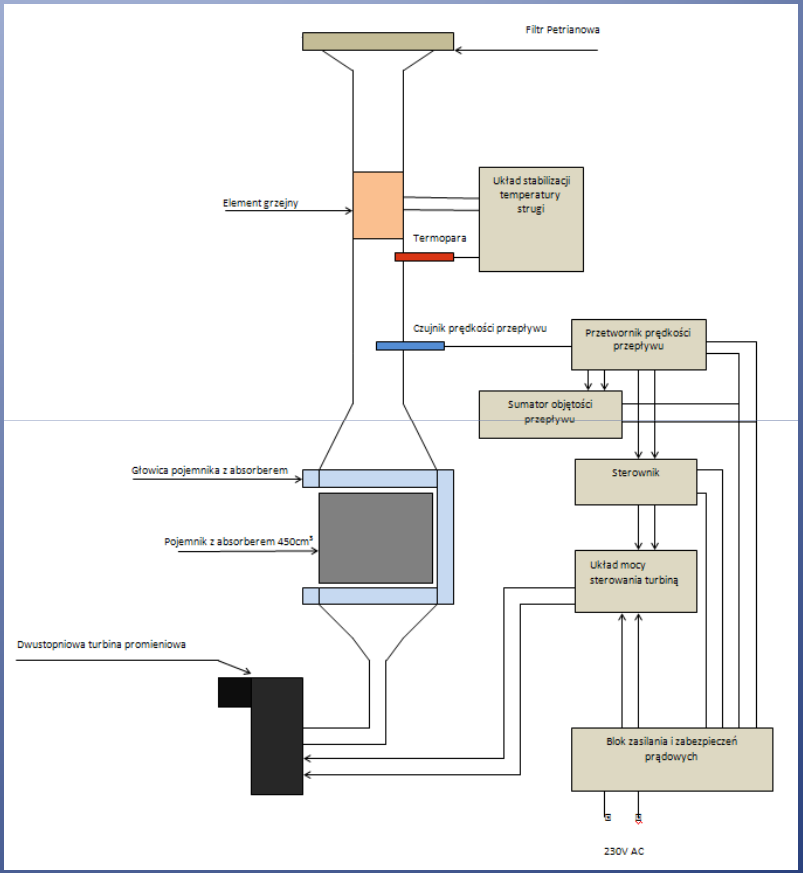
Block diagram



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Station details

Petrianov filter head (aerosol filter)

TEDA carbon filter

Air flow meter and air heating.