

# Anthropomorphic radiodosimetric whole body phantom "BODY"



## Purpose

The Phantom can be used for calibration of the whole body counter (WBC) for measuring the activity of radionuclides incorporated in human body.

The Phantom can be used for measurement of the absorbed dose of X-ray, bremsstrahlung and gamma-radiation in the organs and tissues of phantom from external ionizing radiation sources using thermoluminescent detectors(TLDs).

The Phantom can be used in radiation medicine centers, nuclear power stations, research institutes, industrial hospitals and other institutions performing radiation monitoring of personnel and population, as well as by the Federal Agency for Technical regulation and metrology in order to comply with the Traceability Law.

## Description

Phantom is a set of solid models of organs and tissues made of plastic materials imitating bone, soft (muscle) and pulmonary biological tissues. Phantom is designed as a collapsible model of an adult 18-20-year-old man in the standing / resting position.

### *Anthropometric parameters*

Parameters	Value
Height, cm	177
Total weight of the background set, kg	79
Total weight of soft tissues of the background set, kg	68.4
Weight of skeleton (bone tissues) of the background set, kg	9.3
Weight of pulmonary tissues of the background set, kg	1.3

The Phantom set includes 6 anthropometric models (phantoms) of the body parts, which are independent assembly units: head phantom, neck phantom, torso phantom, lower body phantom , left and right hand phantoms.

Head phantom consists of five separate parts (frontal bone with soft tissues, two parietal bones with soft tissues, brain, skull base with facial bones, including face soft tissues). The brain can be integrated with the skull base (glued).

Neck phantom consists of three separate parts (body of larynx, thyroid body, neck soft tissues with cervical spine).

Human torso phantom simulates the thoracic, lumbar, pelvic-abdominal torso parts and consists of 10 separate units (torso stroma, soft tissues of chest with the front part of rib shirt, left and right lungs, heart, liver, stomach, upper part of intestinal tract, pancreas simulator with connective tissue, the aggregate tissue of esophagus, trachea, aorta, vena cava).

Lower body phantom (pelvis with legs) simulates the soft tissue of groin and soft tissue of lumbus with buttocks, bladder, hip bones, sacrum; muscle tissue of thigh and lower leg of left and right legs, thighbones, cannon bones, knee caps and left and right feet.

Arm phantoms simulate the hand, soft tissue of arm, humeral, ulnar and radial bones.

*Standard values of activity*

Model	Activity, Bq			
	Barium-133	Caesium-137	Cobalt-60	Americium-241
Thyroid	30000	-	-	-
Liver	-	2000	-	-
Stomach	-	1700	-	-
Heart	-	1100	-	-
Pancreas simulator with connective tissue	-	300	-	-
Beacon, central body (the aggregate tissue of esophagus, trachea, aorta, vena cava and other tissues of thorax)	-	700	-	-
The upper part of intestinal tract	-	3500	-	-
Lung, left	-	-	14000	14000
Lung, right	-	-	16000	16000
Total	30000	9300	30000	30000

*Metrological characteristics of the Phantom (density, mass attenuation coefficient)*

Characteristic under calibration	Units of physical values	Calibrated values	Relative error of calibrated value (P=0.95), %
Density of the material simulating: - bone tissue; - soft tissue; - pulmonary tissue.	$g/cm^3$	1.303 1.056 0.261	3 3 6
Mass attenuation coefficient of photon radiation with energy 17.74 keV in the material simulating: - bone tissue; - soft tissue; - pulmonary tissue.	$cm^2/g$	3.00 1.10 1.15	4 4 4
Mass attenuation coefficient of photon radiation with energy 26.34 keV in the material simulating: - bone tissue; - soft tissue; - pulmonary tissue.	$cm^2/g$	1.08 0.47 0.49	4 4 4
Mass attenuation coefficient of photon radiation with energy 59.54 keV in the material simulating: - bone tissue; - soft tissue; - pulmonary tissue.	$cm^2/g$	0.251 0.200 0.208	4 4 4
Error from density variation: - bone tissue; - soft tissue; - pulmonary tissue.	%	3 3 6	- - -

## Materials

Models of organs and body parts have been manufactured using materials which simulate biological tissues adequate to those of human body respective the interaction with ionizing radiation.

The Phantom components have been made of plastic material compositions based on epoxy resin with fillers.

Components of composition include epoxy resin used as a binder base, hardener, as curing speed regulator, plasticizer, as plasticity regulator, chromium oxide III ( $\text{Cr}_2\text{O}_3$ ), calcium carbonate, as the mass attenuation coefficient regulator, microspheres, as density regulator, starch as thickener and uniformity regulator, chrome oxide III ( $\text{Cr}_2\text{O}_3$ ), ion exchange resin, as radionuclide carriers.

The Phantom includes auxiliary items for working with separate assembly units, fasteners and components for mounting of assembly units and the phantom as one whole.