

# ANTI-ELECTROMAGNETIC PROTECTIVE SUIT FOR WORK IN ELECTROMAGNETIC FIELDS

ESO **ALEKSANDER**

main themes and most  
important informations

Producer:  
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The electromagnetic fields are very different factors of living environment – from electrostatic or magnetostatic fields with low and high frequency up to microwave radiation (with frequency lower than 300 GHz). There are at the same time alternating fields and modulated fields in very varied forms. Among others parameters types for specification of electromagnetic fields there are used:

- \* sinusoidally alternating fields in time (in Hz)
- \* electromagnetic volume (in V/m)
- \* magnetic volume (in A/m)
- \* exposition time of human organism

*The manner and impacts of action electromagnetic fields of human organism, as well as the materials in working environment, depends on their frequency and power.*

***The electromagnetic fields are not sense perceived, that is why the human body is not possible intuitive align oneself on radiation contamination.***

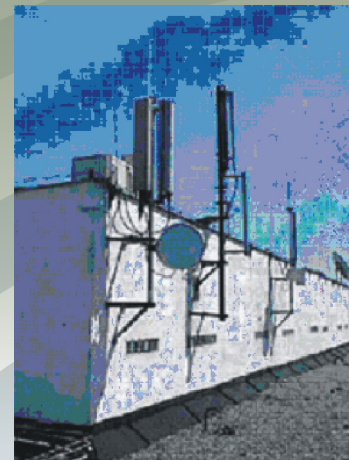
The low frequency electromagnetic fields are used in industry, army, public health and common life.

***The energy of electromagnetic fields absorbed by human organism evokes the inducent current and cell heating. It also can evoke the undesirable biological effects as well as changes of health state, which can take effect even after long time of the first radiation exposition***

fig. 1 - An example of electromagnetic fields resources



a) The high voltage transmission towers



b) The cell phone antenna masts

Together with immediate action on the human organism, the electromagnetic field can endanger the technical infrastructure, because increasing take-off energy can be cause of difficulties:

- dysfunction of automatized working places and electronical medical appliances (e.g. electrostimulators or other medical electronic implants)
- explosion of detonators equipment
- fires and explosions of flammable materials by induction electric sparks or electromagnetic elements

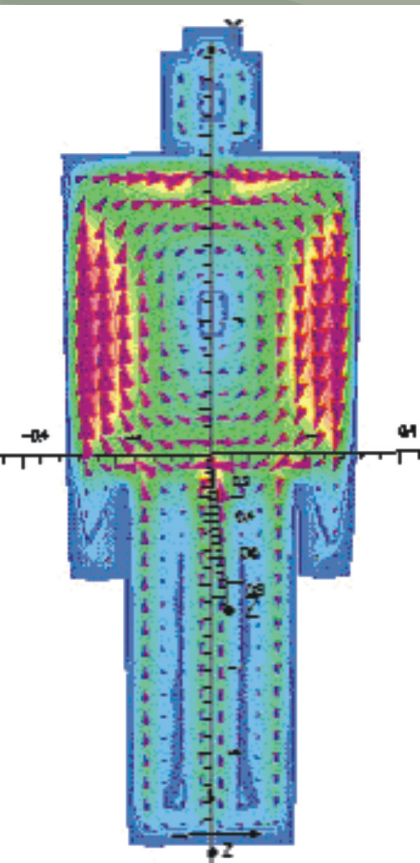


Fig. 2 - Simulation of numeric induced current in human body situated in the magnetic field on horizontal polarization

It takes special importance for workers within the grasp of strong electromagnetic fields

About as good as it the technical and organizational methods for impeding of electromagnetical exposition can be used i. a. by monitoring the electromagnetical load and marking of strong electromagnetical fields; also using the protective suits

## THE MOST DANGEROUS WAVES OCCURING IN OUR ENVIRONMENT

### Microwaves

They are waves in wave-length from  $10^{-4}$  m to 0,3 m (0,1 mm to 30 cm). Microwaves from upper range can be generated in electronic equipment oscillated like radiowaves and they are often included to radiowaves. At present there are many different sources of microwaves, e.g. microwave lamps, klystrons, carcinotrons and magnetrons. In context with development in usage semiconductors there was great growth of microwave sources, e.g. generator Gunna, avalanche photodiode, and also bipolar and polar transistors.

Fig. 3 - Anti microwave overalls before head protection (front view)





Microwaves are used in radiolocation (radar) for speed measurement (and so they are called radar microwaves). We can also find them in microwave ovens, radiolocation and monitoring systems in army and also in civil broadcasting traffic.

Not long ago there was discovered method of monitoring water reservoirs and bridges at risk from the earthquake. The canisters with pipes are dislocated in the critical sites. The microwaves are emitted by these pipes and high sign beeps when the resonance frequency is changed, which means that there is a danger of the earthquake.

## Airwaves

are the electromagnetic waves, whose wave length is higher then 10-4 m (0,1 mm).

In reference to the wave length (or frequency) there are two sorts - conventional and decade waves.

Airwaves are generated by antenna radiation. According the environment of broadcasting we distinct between the earth-guided waves, the tropospheric waves, the ionospheric waves and the cosmic radiation waves.

The wave length has an influence on the wave propagation. There are various effect, e.g. defraction, refraction and ionospheric reflection.

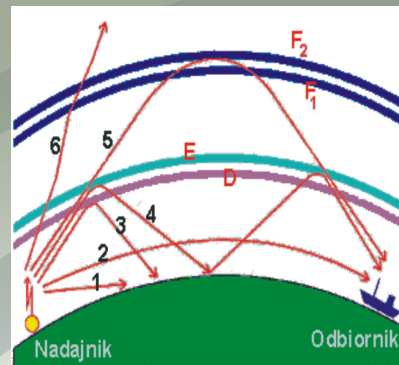
**The Ionosphere** is maningful for broad-casting and receiving airwaves. It is the upper part of Earth's atmosphere, which is ionized by ultraviolet and X-radiation of the Sun. Its' lower part has several levels: Level D (60 to 90 km), level E (about 120 km), level F1 (180 to 240 km), level F2 (220 to 300 km).

**The long waves** are lightly diffracted and they can became long earths' wave (marked Nr. 2 in the picture) and they are reflected from the level D (Nr. 3 in the picture). They are not absorbed by ionosphere and so they have the longest range and they are not dependent on the day/night time.

**The middle waves** are reflected from the level E (Nr. 4 in the picture). They have night time range longer then day time ranger.

**The short waves** generate the earthbound wave (Nr. 1 in the picture) and they are reflected from levels F1 and F2. (Nr. 5 in the picture exists only in the summer) and also from the Earth's surface and that is why they are catchable for a long distace.

**The ultra-short waves** and microwaves (Nr. 6 in the picture) are reflected from ionosphere and they wear off in aerospace. These waves are used by telecommunication systems (UKV) or satellite communication (microwaves)





## Traditional distribution of airwaves and their usage

Traditional distribution	Wave-length [m]	Frequency [MHz]	Release notes	Usage
Ultra long waves	100 000 - 10 000	0.003 - 0.03	lightly damped Earth's surface wave and ionospherical waves	radio-navigation, radio-teleggraphy of long range
Long waves	10 000 - 0001	0.03 - 0.3	damped Earth's surface wave, and ionospherical waves	radio-teleggraphy, radio beacons
Middle waves	1000 - 75	0.3 - 4	in the day-time: Earth's surface wave in the night-time: ionospherical wave, elements of interference	radio-teleggraphy
Short waves	75 - 10	4 - 30	dominating ionospherical wave, many times reflected	radio-ponia and radio-telecommunication
Ultra-short waves	10 - 0.3	30 - 1000	Overground wave at the range of visibility the transmitter	TV, radio-ponia, radio-telecommunication, space-communication
Microwaves	0.3 - 0.0001	1000 - 3 000 000	tropospherical wave	radiolocation, space-communication

## The typical sources of electromagnetical exposure in work places

### The energetical devices

I The high-voltage transmission lines, transformers and generators are working in 50 Hz frequency and they can generate a strong electromagnetic field. The highest endangering becamas in work with overground electric lines - the force of electrical field is more then 100kV/m (the hazard zone) and the force of the magnetic field is about mT (the danger zone). The diver-gence of power in electric fields are in several kV/m and the divergence of power in magnetic fields are about several tens  $\mu$ T. According to regulations in force is necessary to get the restriction of level B in the workplaces with magnetic field force less then  $1\mu$ T.

Fig. 4 - Anti microwave coverall after head protection (front view)



# The telecommunication devices

**Long-wave and middle-wave transmitters** with frequency 0,1 to 2 Mhz and force 100 000 kW to 1-2 MW. The sources of the fields esp. electrical, are the antennas and fiders (danger zone) and interior transmitters devices , antenna masts

**Short-wave transmitting objects** (frequency 3-30 MHz and force less then 100 kW) - areas under antenna fields, areas under fider switches inside transmitters (danger zone)

**UKV/TY transmitting objects** (frequency 50 to 1000 MHz and force to 40 kW) - antenna masts and antennas IV/V (danger zone)

**Radar stations** - frequency more then 1 GHz, force up to several MW. Danger zone can ensue on the open waveguides and there is necessary to require utmost dilligence and observance of the safety rules.

**Mobile phones and radiotelephones** (frequency 27 MHz to 1.000 MHz) - (safe distance more then 10 cm from antenna). Using these devices with separate antenna (or antenna situated on vehicle top) is recommended.

## Exposure to hazard by electromagnetical fields on workplaces

### Electromagnetic field (EMF) can endanger workers

- immediately - ill-effect of electromagnetic radiation energy incoming into the human body
- transmissioned - alternating current evokes an electrical inductions in body organs
- Endangering of systems electromagnetic energy sensitives dedicates for monitoring vital functions of human.

### EMF effect on human organism

**The biological activity is complex of functions, that are affected by frequency and force of fields. It depends especially on**

- quantity of field energy absorbed by human organism, level of induced force and quantity of heat-producing
- the electrical property of body tissues (electrical conductivity and dielectrical penetration) that may cause heating of tissues
- character of cell membranes that determine real image of the inside of the cells (for frequency 1-10 Mhz) - they are submerged to intercellular liquids. Probably the permeability of cell-walls and their selectivity for various elements of radiation can be modified by electromagnetic field.

Fig. 4: Anti-micro coverall after head protecting (side-view)

A field energy absorption by human body is the basic and best knowledged effect. It depends on frequency, mutual orientation of field and human body, relation of body height and wave-length, factor of ground isolation. It is a section of classic electrodynamic, which is the base of theoretic dosimetry that allowed denotation of EMF quantity energy absorbed by human body. The result of this research is size of SAR (Specific absorption rate), that determines force emitting on hundreddweight of human body in specified conditions of field polarization.

This quantity is shaped in W/100 g. The force absorption is maximum in the range 30 - 400 MHz, when the human body acts like frequency tuned antenna. The most important moment occurs when frequency quivers the whole human body. According Korniewicz there is possibility to express:

$$Fr[\text{MHz}] = 75 [\text{MHz m}] / h [\text{m}]$$

when h - body height in metres

In higher frequency there is possibility of local resonances in short parts of human body (e.g. body, head, limbs etc). In the frequency higher than 2 GHz there is surface absorption of microwaves that may be very dangerous for poorly vascular organs (eyes, testicles).



## In biological human body attack we can see

\*

The thermic effect occurred in consequence of transformation part of energy EMF to heat. It can evoke the pathological changes and physiological reactions (increasing of body temperature)

The non-thermic effect created by radiation without increasing temperature, accompanying with pathological and physiological symptoms

\*

**The electromagnetic radiation can take effect to human body objective and subjective symptoms:**

### **The subjective symptoms:**

- global weakening of human organism, upset of concentration, weakening of memory, sleepiness during the day, headache and giddiness, decrease of sexual potency, menstrual malfunctions

### **The objective symptoms:**

- reactions of central nervous system - neurastenic symptoms, hands' shake, changes of bioelectrical brain function fixed by EEG, enhanced dermographism.  
- visual organs changes - small iris changes  
- blood and hearth circulation changes - bioelectrical activity changes fixed by EKG  
- haematogenesis changes  
- hormonal changes (menstrual disturbance)

Since the eighties there was intensively screened context of increase appearance of rare tumors (lymphatic circulation, childrens' leucemia and brain tumors) with magnetic field activity with frequency 50 to 60 Hz. In many cases we can see increasing of illness risk in human categories that lived or worked near electric lines.

**Very important! There are not known any sensual receptors EMF. Exposed human is not able detect his exposition level till he is not informed about, not even stopp it.**

We can say that in many cases with adherence to EMF safety rules no problems originate. These problems are caused by lack of informations about bioelectro-magnetism and changing the character of radiation from microwave radiation to ionising radiation. It is necessary to warn for frequent neighbourhood of inhabitances with great industrial and telecommunication sources EMF that may mean grave peril of health damage.



## The methods of limitation danger and exposure

The electromagnetic exposure is very special imperilment. Due to invisibility an impossibility locate existence this effect there is hearty social interest and feared.

Virtually all of radio stations with strong output have became the object of interest and wild protests. In this regard the medical research costs have increased. It is not possible totally foreclose or uphold the influence of EMF to health statement of long term working people in danger zones. We have to appreciate that only good work organisation incl. using protective apparel in danger zones and dislocation of workplaces out of range EMF are the basic and per cheapest road to limitate possibilities of exposure EMF. We have to awake to these factors:

- 1) In most of cases the workers are located in near zones, where the EMF forces are proportionate to  $1/r^2$  ( $r$  = distance from the source). Due to this fact there is possible displaced endangered worker to safe zone. The worker's displacing enables radiation decrement (e.g. increasing of distance from 0,5 to 1 m causes 4-times decreasing radiation exposition) It is very important for work teams that exercise only supplementary works.
- 2) The EMF sources have to be situated for places that are not used work teams or busy crossing. All devices or work stations should be displaced from the zone of protection.

■ If there is necessary to adjust the device product EMF, the radiation force level have to be decreased

*Fig. 5 - Double layer coverall  
before cape mounting  
(front view)*



## Monitoring

It is the goal-directed decreasing of field force in selected place by using substances having what they take de-escalate field force or absorb its energy (e.g. substance named SCREENTEX 3).

The monitoring effect means the rate of field force in the specific point before using the monitor to the field force in the same point after using the monitor. In context of the microwaves the proportion of determined measured values and the result is determined in decibels.

***The subjects working in the range of protective zones must engage the input and prevential medical examinations and also the safety training in the EMF. In case of staying in the range of EMF there it is necessary to use the protective means for decreasing treatment of a harmful consequences to human organism.***

## The protective apparel

Using of the individual anti-electromagnetic protection has only small-scale effect, because the immediate influence of dangerous radiation to an object is relatively invisible. Also there are an insufficiency of professional literature relevant the harmfulness of the EMF radiation

Company ESO is a sole producer of this apparel in our territory.

The protective suits ESO 3 ALEKSANDER record radiation absorbing in the level smaller than 18 dB for the crotch, 15 dB for heart area and 18 dB for shoulders

It is the hundredfold decreasing of primary radiation source. They are characterized by small weight (about 2 kg) accordingly the size and number of levels of the surface cloth

The suit includes overalls and cape with the net in the face area. This suit type must be electrical impermeable in order not to be able wave intruding and possibility of resonance increasing force EMF inside the overalls

There are special materials used for manufacturing these suits, made from copper fibres according to the standard SCREENTEX

These protective suits can be used for anti-electromagnetical wave and EMF protecting in the range of frequency VHF (30 MHz to 300 Mhz) and L,S,C,X frequency band.

The protective suit has good manufacture qualities. It is lightweight, does not protect work ability, transmits water vapours, matches the highest anthropometric standards. Using these suits in danger zones warrants improvement of workers' safety in microwave effect radiation.

The protective suit matches the standard specifications for special protective suit described by Ministry of Defence.

This protective suit have got an usage licence by Military Institute of Work Hygiene and Epidemiology in Warsaw, metrological site.

The electromagnetic radiation V/H/E has an accreditation PCA Nr. AV 366 in a branch of electromagnetic field measurement for security of work and environmental protection and also for the absorptiveness of materials.

## The main rules of security of work in EMF

The workers - operators in EMF or in the surrounding have to observe this rules:

- Acquittance with EMF location and range of protective zones
- Learn to signification of single caution marks
- Strictly adhere the no entrance in danger zones, reduce staying in danger zones, abide with enabled exposition time, specificated by rules and orders
- Not switch on device untill the shields are mounted
- In the case of aditional monitoring control conection rigidity and attend connection of monitor or cover not to be cover over or vision-proof by impurity
- Disallow using these devices by unqualified person, esp. in protective zones
- In microwave devices attend to conectivity tightness, not let the waveguide and covers open. Use protective suit when work in exponed zones. Not stay near radiolocators' antennas
- There is possible to take advantage the consultation with specialist from several state institutions that have multiyear experiences with fighting to electromagnetical imperillment, like:

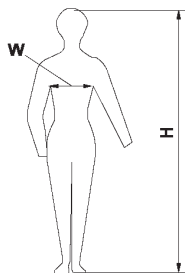
*Fig. 6 - Anti-microwave coverall before the cape mounting (side-view)*



1. The Central Institute of Security of Work - the main rule-writer of hygienic rules in electromagnetic imperilments. It has an experience with electromagnetical monitoring, measuring EMF and development of the measuring instruments. It provides measuring of imperilment EMF in the work places, identification of biological bases of activity EMF and the theoretical dosimetry incl. computers' monitoring EMF.
2. The Institute of Medicina of Work in Lodž - specialisation in interpretation of health influences EMF, biological effects research, measurement force EMF and source fields registration
3. The Military Institute of Hygiene and Epidemiology in Varsaw - specialisation in monitoring biological microwave influences, measuring and antimicrowave radiation protection

## CLOTHING SIZES

	US-SIZE	Increase <sub>min. - maks.</sub>	Waist <sub>min. - maks.</sub>
170/96	S	168 - 174	88 - 96
174/100	M	174 - 177	96 - 100
180/104	L	177 - 182	100 - 108
186/112	XL	182 - 186	108 - 120



## Suppressing ACTION CLOTHES

ESO 3 Aleksander clothing is made from a special fabric with conductive fibers - copper braid according to the standard NAPTEX - SCREENTEX3 - SILOTEX and suppresses electromagnetic waves incident on the human body. Its use may therefore be useful in moving workers in the vicinity of the above-mentioned sources of strong electromagnetic fields, as will secure them against breaching the above exposure limits to what could be without its use in such cases. The attenuation measurements to provide a garment that is suitable for use in the band 260 MHz - 4 GHz. The following table lists included, in which the maximum electric field intensities person dressed in clothes that can move, without exposing the fact that it comes to exposure limits.

Frequency range [MHz]	Maximum intensity electric field (staff) [V/m]
< 260	dress fields do not suppress
260-300	61
300-400	85
400-500	110
500-600	140
600-700	160
700-800	180
800-900	220
900-1000	230
1000-1500	320
1500-2000	470
2000-2500	490
2500-3000	550
3000-3500	1400
3500-4000	940
>4000 until the wavelength comparable to the size of the seams and connections clothes	probably several hundreds to thousands of volts / m

# FRONT VIEW

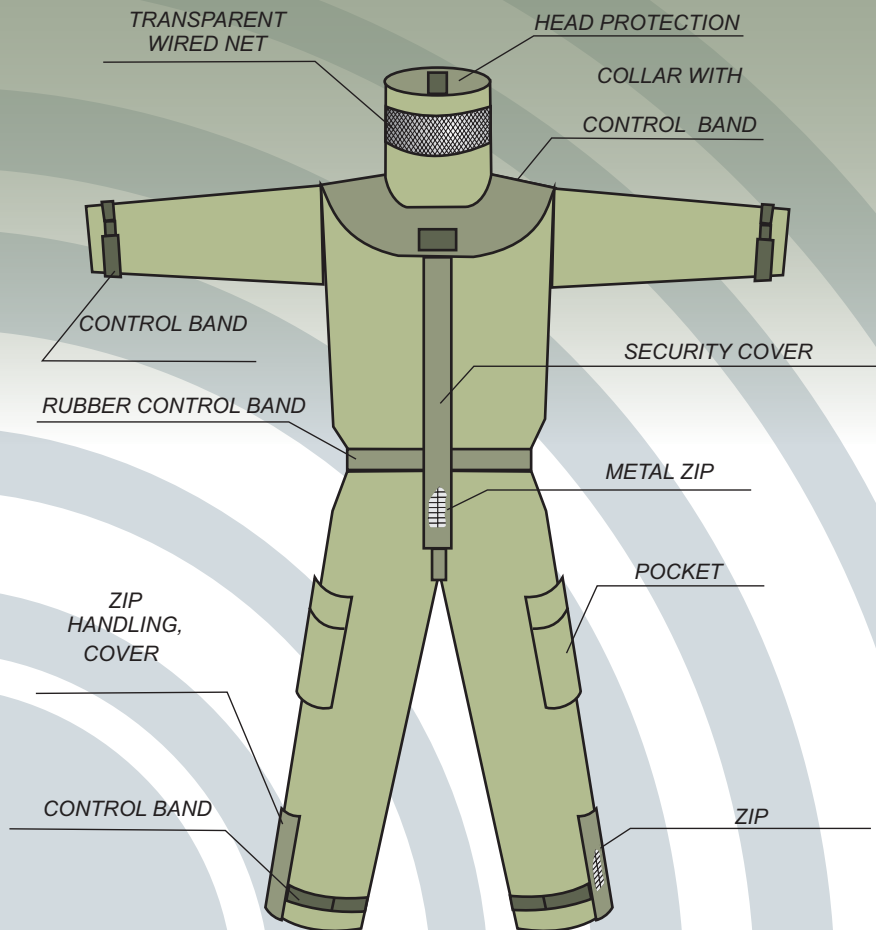


Fig. 7 - Antimicrowave coverall Three-ply coat  
(filler - cotton liner)  
basic part - antimicrowave cloth  
surface cloth - camouflage cloth)  
before mounting (front view).







Dear Sirs

**PHU „ESO”** as by now the only company in Poland and southern-western Europe which, in 2005, started working over production of clothes that protect people against electromagnetic waves. After almost three years of technical and research work, the company worked out its own pattern of overalls (**Polish Clothes**). The product was widely acknowledged by the customers in Poland and abroad.

**For a year PHU „ESO” has been producing protective overalls - ESO ALEKSANDER**, for work in electromagnetic fields, destined for workers whose profession involves being in fields that are under the influence of frequency bands VHF, S, L, X, and C, (for an attendance of broadcasting appliances, radio stations, base station transmitters, cellular telephony, radiolocation stations, radar stations, radio navigation, satellite systems).

**Overalls** is light, it lets the water steam through, it does not make the work difficult, and matches up with the body. It fulfils the demands of Ministry of Defence which concern special protective clothes and additional guidelines as far as the observing of safety and hygiene of work at use of appliances that emit electromagnetic radiation is concerned (enclosure to the decision nr. 98/MON 31/3/06)

**Protective overalls has got qualifying Decision nr. 19/2007 and Report nr. 54/2007 PMPE/T from 25.07.2007, issued for the producer PHU „ESO” Stanisław Osajda**, by the Military Institut of Hygiene and Epidemiology named gen. Karol Kaczkowski, Kozielska 4 street, 01-163 Warszawa, Laboratory of Metrology and Electromagnetic Radiation. WIHiE has got the accreditation PCA nr. AB 366 in the range of measuring electromagnetic fields in terms of Safety and Hygiene at Work, Environment Protection, and possibility to level the electromagnetic waves.

**The Research and Safety of Work Institut V.V.i  
116 52 PRAGUE 1, The Czech Republic  
11/6/09 issued a certificate CE nr. 235/E-017/2009  
for the producer P.H.U. ESO.**

Accreditation nr. 1/2007 from 27/1/2007, authorized person 235, notified person 1024 – concerning the protective clothes, type ESO 3 ALEKSANDER.

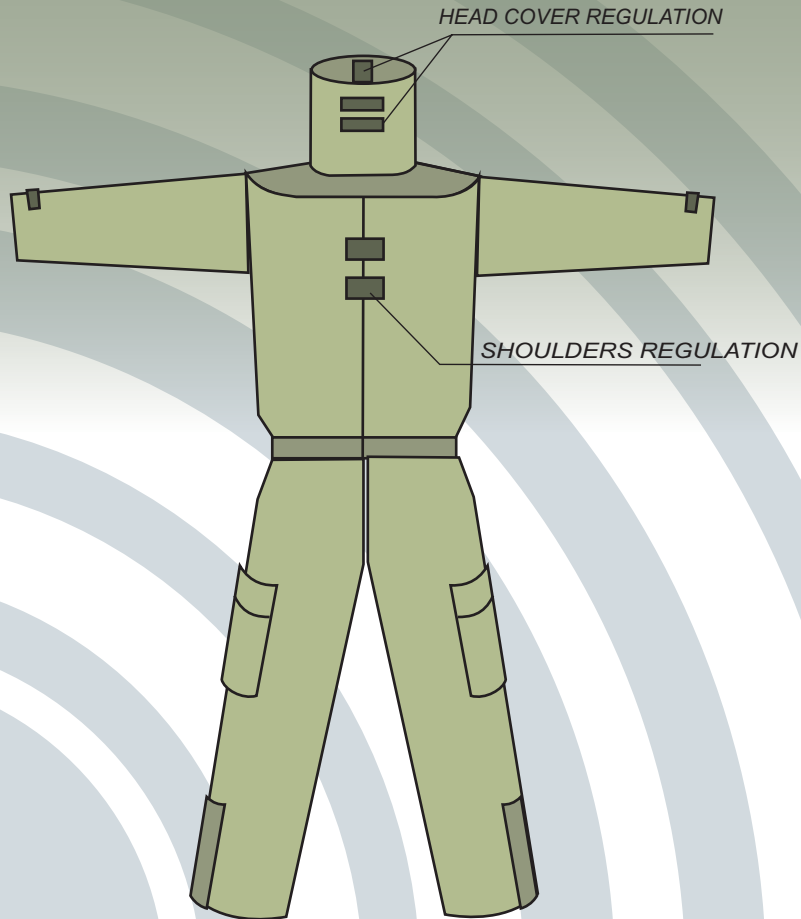
**PHU ESO works for the uniform services of the Republic and is their member. The product came within protection of intellectual property (nr. 000884317).**

The European Union Pattern from 22/2/2008 contains:

- for military version – mask colour – nr. 0001,
- for military and TV version – khaki colour – nr. 0002,
- for civil version (cellular telephony) – orange colour – nr. 0003.

Yours faithfully,  
Stanisław Osajda  
Tel. GSM +48 502 651 671

**REAR VIEW**



*Fig. 8 - Antimicrowave coverall with unslung cap (rear view).*





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