

RESEARCH OF TOPOGRAPHY OF INFLUENCE AND CLASSIFICATION OF THE REQUIREMENTS FOR UNIFORM OF PASSENGER CAR ATTENDANTS

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Abstract: *The article investigates the theoretical foundations of the study of reliability indicators in order to identify priorities in development of efficient uniform for the passenger car attendants with predictable properties. Thus, functional and constructive design is carried out, taking into account the topography of influence by defining zones of influence on different parts of the garment, what enables development of variable constructive and functional solutions for the uniform in accordance with the quality requirements.*

Keywords: *uniform of passenger car attendants, reliability indicators, list of hazardous and harmful operational factors, predictable properties.*

1 INTRODUCTION

At present, departmental uniform is used by the customs officers, taxmen, prosecutors, bailiffs, foresters, transport workers and other officials. The main requirements in design of the uniform of any department have always been and still are the following: aiming for maximum comfort, practicability, versatility and originality. At the same time, development of new and unique collections set an objective for the designers: to promote imaginative perception of the personnel of the departments as professionals, inspiring confidence, whose appearance should inform about respectability and reliability of the company as a whole. That is why the railwaymen, who never take off their uniforms (unlike many departments, which historically diverged from wearing uniforms), are still considered to be a reputable company.

Among the employees of the rolling stock of passenger rail transport passenger car attendants are the largest group, but their working conditions and health status have been poorly examined. Railway professions are classified as hazardous. Work of the passenger car attendants of the railroad passenger service is associated with permanent influence of a number of physical, chemical, biological, psychological and other factors on the body: temperature jumps, noise, vibration, dust, high levels of microbial contamination of air and cars, disturbance of sleep and rest regime, physiological and emotional stress, etc. [1-4].

2 EXPERIMENTAL

Accidents arising in connection with the use of poor quality, out-dated equipment and violation of the procedure for carrying out hazardous works, etc., pose threat to work and health of the personnel and passengers. The analysis of the operating activity of the passenger car attendants resulted in development of the list of hazardous and harmful occupational factors (HHOF). Development of industrial technologies enhances the influence of the HHOF, what requires increased level of protection of a person through the use of new structural and technological solutions and materials for clothes. Therefore, it is advisable to constantly improve the design and manufacturing process of the uniforms in order to improve its quality.

Based on the analysis of professional activity and developed list of hazardous and harmful occupational factors, the topography of their influence on the uniform of the passenger car attendants has been studied (Figure 1).

The topography of influence includes the effect of perspiration, light weather, residual deformation (stretching, bending), industrial pollution, wearing in the plane, destruction of materials and joint places of clothes (breaking), what requires extra attention in the process of design of reliable and durable articles.

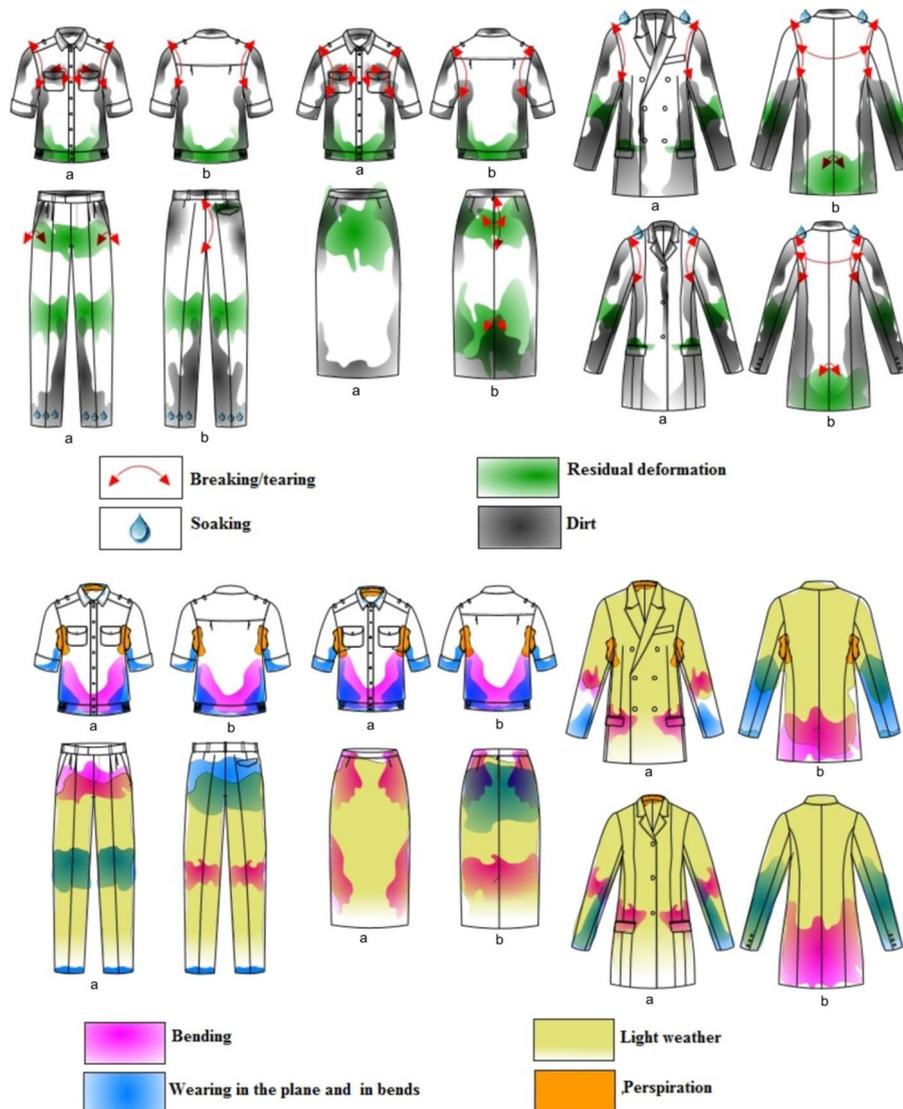


Figure 1 The topography of influence of the HHOF on women's and men's uniform (shirt, trousers, jacket, blouse, skirt, coat) of the Ukrzaliznytsia passenger car attendants: a - front view, b - back view

The data provided in Figure 2 have been obtained by the research wearing of the uniform by the customers; the analysis has been carried out by the expert estimation method. The results have been processed by application of the mathematical statistics methods. A range of disadvantages have been revealed; the demand of the employees has been studied for the purpose of further application of the results of the survey in the course of designing the reliable and comfortable clothing.

The main requirements to be met by the uniform include protection from hazardous and harmful occupational factors (HHOF) (Figure 2), ensuring occupational safety, maintenance of normal functional state of a human and his/her performance, and, of course, clothing must not have a toxic effect on a human body while its use and production. The content of the questionnaire also

included the issues of the main and additional requirements for the materials, model and technological peculiarities of clothing, and requirements for the design and ergonomics, as well.

The survey results have showed that the current uniform has a range of disadvantages: the construction of armhole (creates discomfort during moves) and neck hole (quickly becomes dirty) do not meet the requirements for comfort; are not comfortable (at the placement) and have unreliable pockets (tear off quickly); insufficient number of pockets in clothing; deficient tailoring of longitudinal sections (vent); lower sewn underplacket (in a blouse) creates inconveniences; materials are unpleasant to the touch, air-impermeable and electrifiable.

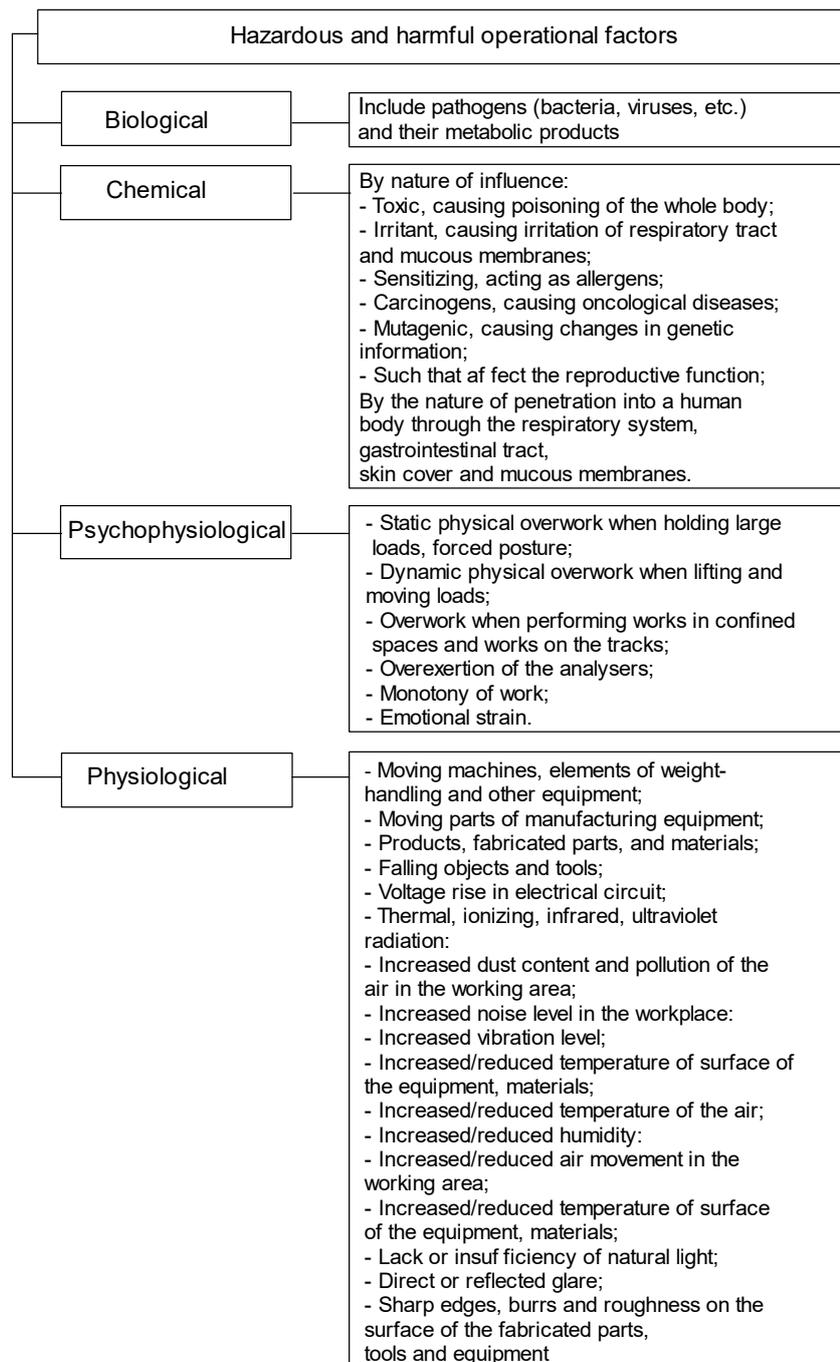


Figure 2 List of hazardous and harmful operational factors

Specificity of working environment and climatic conditions, HHOFF types, their intensity, frequency became the basis for development of the theoretical foundations of the study of reliability indicators in order to identify priorities in development of efficient uniform for the passenger car attendants with predictable properties. Thus, functional and constructive design is carried out, taking into account the topography of influence by defining zones of influence on different parts of the garment, which enables the development of variable structural and functional solutions for the uniform in accordance with the quality requirements.

A critical review of the current state of the problem of development of the current uniforms revealed the necessity for its improvement. Before starting to design the uniforms, it is necessary to develop scientifically grounded requirements for such design [5-7]. The requirements for the uniforms must satisfy certain aspects of consumption and manufacturing. In this relation, they may be divided into consumer and manufacturing. Feasibility of manufacturing and marketing of an article determines social qualities of such article.

3 RESULTS AND DISCUSSION

The uniform of the passenger car attendants shall meet a set of stringent and contradictory requirements, conditioned by its functional use. Analysis of the current uniforms of the Ukrzaliznytsia passenger car attendants allowed to establish that it does not fully take into account the actual working conditions and hinders movements. It should also be noted that the current package of the materials has not been differentiated in accordance with the topography of influence of different HHOF and their intensity, etc. A key component of the design process for new types of the uniform of the Ukrzaliznytsia passenger car attendants shall be development of constructive and technological solutions in each project case. So, uniform of the Ukrzaliznytsia passenger car attendants shall have ergonomic and aesthetic design in order to ensure the highest possible level of protection, convenience and good appearance.

The uniform of the Ukrzaliznytsia passenger car attendants must: ensure adequate protection level against all types of hazards; have such structure that would provide the maximum possible level of ergonomics and aesthetics; not to create obstacles for the person performing the work; ensure "harmlessness", i.e. will not create additional risk factors; ensure the highest possible level of comfort; have a maximum permissible limitation of movements, position or sensory perception of the passenger car attendant and not cause movements that may pose a threat to him or passengers; provide perfect fitting of the garment and fixation on the body in the process of its use regardless of environmental conditions, movements and posture of the passenger car attendant; be compatible with other existing articles; carry information about the position, field of application; provide easy recognition among the employees; ensure extension of the period of its use, provided by the possibility of reparability or replacement of separate components of the uniform, provide fixed sizes and shape for a given period of use; have such structure that would provide its easy and correct wearing; provide comfortable microclimate and space under clothes. Compliance with these requirements in the process of design and manufacturing of the uniform for the Ukrzaliznytsia passenger car attendants provides high efficiency of work and reduces negative impact of environmental factors on a person. Uniform of the passenger car attendants shall conform to its functional use, not hinder the movements, ensure easy care (laundry); fabric shall be resistant to abrasion, mechanical damage, etc.

Analysis of uniforms and requirements made it possible to establish product range, which consists

of jackets, coats, blouses, shirts, trousers, skirts, etc. Depending on the conditions, these products are used as a particular set of clothes. On the basis of the carried out analysis, the list of the quality indicators of men's and women's uniform of the passenger car attendants has been suggested separately for the upper body garments and lower body garments. According to the results of the previous calculations, we singled out 19 significant indicators for the upper body garments (jacket, coat) (Table 1) out of 39 suggested indicators, 16 significant indicators out of 38 – for blouse and shirt, 16 out of 30 – for men's lower body garment (trousers), 15 out of 29 - for women's lower body garment (skirt).

The reliability indicators characterize the ability of the material or clothing to perform the specified functions while keeping their operational indicators within the set limits for a specified period of time.

Ergonomics indicators characterize the system "worker – uniform – occupational environment" containing the elements that interact with each other, namely, a person, set of the uniform and environment in which the worker carried out his activity. Structural and technological indicators determine manufacturability of design of the article, labour costs and terms for manufacturing of the article. Manufacturability of the clothes is determined by the possibility of using optimal, economic and technological methods during manufacturing process, the most efficient techniques and articles processing methods. Aesthetics indicators play an important role in assessing the appearance, artistic and coloristic decoration of the material or uniform.

The following indicators should be noted among the cost effectiveness indicators: product cost and expenses for garment care. Based on these very indicators, the railway personnel limited imagination of the designers: only assemblies of summer and winter clothes and cost of the materials and accessories of suitable quality. Therefore, we proposed a list of the quality indicators of men's and women's uniform for the passenger car attendants (Table 2).

Among consumptive qualities of a set of the uniform, significance of the indicator or requirement is characterized by the coefficient. Value of the coefficients of the significance indicators is established by the expert assessment method by significance ranking n of the indicator (requirement). The most significant indicator is denominated with a rank $R = 1$, and the least significant – $R = n$. Having analysed the obtained coefficients of significance and statistic criteria we established the ranking of significance of the quality indicators, represented in Table 2.

Table 1 List of the quality indicators of the uniform of the passenger car attendants

| Group of requirements significance [%] | Property | Quality indicator and means for its ensuring (M*, S*, T*) | |
|--|---|---|---|
| 1 | 2 | 3 | |
| 1. Ergonomic 33% | Sanitary conformance | 1.1 Water permeability coefficient, M | |
| | | 1.2 Water-absorption quality, M | |
| | | 1.3 Air permeability coefficient, M | |
| | | 1.4 Thermal conductivity coefficient, M | |
| | | 1.5 Content of natural fibre in raw material components, M | |
| | Psychophysiological conformance | 1.6 Ease of using, S, T | |
| | | 1.7 Surface resistivity, M | |
| | Anthropometric conformance | 1.9 Dynamic conformance, S | |
| | | | 1.10 Static conformance, S |
| | 2. Reliability 27% | Durability of materials and structures | 2.1 Dyeing fastness (dry-cleaning, wet processing, light weather, perspiration) M |
| 2.2 Number of lint, M | | | |
| 2.3 Breaking strength of seam, T | | | |
| 2.4 Number of cycles of wearing in the plane and in bends, M | | | |
| 2.5 Dust content coefficient, M | | | |
| 2.6 Change in linear dimensions after wet processing and dry-cleaning, M | | | |
| 2.7 Thread shifting, M | | | |
| 2.8 Number of launderings and dry-cleanings before loss of market condition, M | | | |
| 2.9 Remaining strain, M | | | |
| 3. Aesthetic 20% | Composition perfection degree | 3.1 Availability of distinguishing features, S, M | |
| | | 3.2 Conformance of decoration to appearance, S, M | |
| | | 3.3 Artistic and coloristic decoration of fabrics, M | |
| | Market condition | 3.4 Conformity to structural and harmonious image and aesthetics, S, M | |
| | | 3.5 Level of technical performance of the garment, T | |
| | | 3.6 Degree of bleaching, M | |
| | | 3.7 Crease resistance coefficient, M | |
| | | 3.8 Fitting, S | |
| | | 3.9 Dimensional stability of the garment, S, T | |
| 4. Economic 13% | Conformance of the finished product to the proposed price | 4.1 Product cost, M, T, S | |
| | | 4.2 Expenses for garment care, M | |
| | | 4.3 Expenses for repair, M, T, S | |
| | | 4.4 Garment quality/price ratio, M, T | |
| 5. Structural and technological | Conformance to structural and technological solution | 5.1 Total labour intensity, S, T | |
| | | 5.2 Flaking of cuttings, M | |
| | | 5.3 Availability of lining, S, M | |
| | | 5.4 Structural segmentation of the form, S | |
| | | 5.5 Maintainability, S, M | |
| | | 5.6 Availability of elements for fixation of belt and differentiating marks, S, T | |
| | | 5.7 Quality of processing treatment S, T | |
| | | 5.8 Elasticity of busting seam, T | |
| | | 5.9 Direction and position of segmentation lines, S, T | |
| | | 5.10 Availability of inside pockets T | |
| | | 5.11 Quality of fabric-to-fabric bonding, T | |

*M – materials, *S – structure, *T - technology

Table 2 shows that 19 significant indicators have been identified out of 39 suggested indicators for the upper body garments (jacket, coat); similar calculations have been carried out for all items used in a set of the uniform. 16 significant indicators have been identified out of 38 indicators for blouses and shirts in the course of the analysis, 16 out of 30 – for men's lower body garment (trousers), 15 out of 29 – for women's lower body garment (skirt).

Analysis of the estimates obtained from the experts required concordance of their opinions by a number of factors affecting the final result. It was suggested to estimate the concordance of the expert opinions through the concordance coefficient W , which is common rank correlation coefficient for the group consisting of m experts. The sequence of calculation involves first calculating the sum of the grades (ranks) for each separate factor obtained from all

experts, and then calculating the difference between this sum and the average sum of the ranks. For this purpose, it is necessary to calculate the sum of the estimates (ranks) for each factor obtained

from all experts $\sum_{j=1}^m x_{ij}$, and then calculate the difference between this sum and the average sum of the ranks

$$\Delta_i = \sum_{j=1}^m x_{ij} - T \quad (1)$$

where the value T shall be calculated by the following formula:

$$T = \frac{\sum_{i=1}^n \sum_{j=1}^m a_{ij}}{n} \quad (2)$$

and separate estimations a_{ij} shall be calculated by:

$$a_{ij} = -\frac{1}{2}m(n+1) \quad (3)$$

Further calculation provides for determination of the parameter S by the following formula:

$$S = \sum_{i=1}^n \left\{ \sum_{j=1}^m x_{ij} - \frac{1}{2}m(n+1) \right\}^2 \quad (4)$$

The value S is considered to be maximum if all experts put the same ranks. Under these conditions, the average square deviation for total ranking factors in case of the best match is considered to be the maximum value if all experts give the same estimates.

$$S_{\max} = \frac{1}{12}nm^2(n^2-1) \quad (5)$$

The concordance coefficient W shall be determined as the ratio of the actual obtained value to its maximum value:

$$W = \frac{S}{S_{\max}} \quad (6)$$

Value of the calculated concordance coefficients have been calculated within $W=0.54\div 0.93$ for all indicators, pointing out to the level of concordance of the expert opinions. Under these conditions the table value of Pearson fitting criterion χ^2_P is less than the calculated χ^2_P , namely $\chi^2_T = 1.1\div 19.7 < \chi^2_P = 19.24\div 73.59$. Thus, as a result of the expert estimation a number of indicators of reliability, ergonomics and aesthetics have been singled out for further research.

Table 2 Ranking of significance of the quality indicators of the uniform for passenger car attendants

| Code and name of the requirement, name of the indicator | Ranking by the expert | Coefficient of significance | Mentioned coefficient of significance |
|--|-----------------------|-----------------------------|---------------------------------------|
| 1 | 2 | 3 | 4 |
| 1. Reliability | 2 | 0.27 | |
| 1.1 Resistance to light weather | 5 | 0.17 | 0.0459 |
| 1.2 Crease resistance coefficient | 3 | 0.21 | 0.0567 |
| 1.3 Pilling | 8 | - | - |
| 1.4 Seam strength | 9 | - | - |
| 1.5 Number of cycles of wearing in the plane | 4 | 0.18 | 0.0486 |
| 1.6 Resistance to ripping at seams | 2 | 0.21 | 0.0567 |
| 1.7 Change of linear dimensions after wet processing | 7 | - | - |
| 1.8 Thread shifting | 10 | - | - |
| 1.9 Number of launderings before loss of market condition | 1 | 0.23 | 0.0621 |
| 1.10 Remaining strain | 6 | - | - |
| 2. Ergonomic | 1 | 0.33 | |
| 2.1 Water permeability coefficient | 6 | - | - |
| 2.2 Textile porosity | 7 | - | - |
| 2.3 Breathability | 4 | 0.18 | 0.0594 |
| 2.4 Water penetration | 9 | - | - |
| 2.5 Permissible terms for continuous use | 3 | 0.21 | 0.0693 |
| 2.6 Vapour permeability coefficient | 5 | 0.17 | 0.0561 |
| 2.7 Ease of using | 1 | 0.23 | 0.0759 |
| 2.8 Surface resistivity | 8 | - | - |
| 2.9 Dynamic conformance | 2 | 0.21 | 0.0693 |
| 2.10 Static conformance | 10 | - | - |
| 3. Aesthetics | 3 | 0.2 | |
| 3.1 Availability of distinguishing features | 2 | 0.29 | 0.058 |
| 3.2 Colouring and decoration | 4 | 0.15 | 0.03 |
| 3.3 Artistic and coloristic decoration of fabrics | 5 | - | - |
| 3.4 Conformity to structural and harmonious image and aesthetics | 1 | 0.35 | 0.07 |
| 3.5 Quality of processing treatment | 3 | 0.21 | 0.042 |
| 4. Structural and technological | 5 | 0.07 | |
| 4.1 Complete set | 3 | 0.2 | 0.014 |
| 4.2 Flaking of cuttings | 5 | 0.11 | 0.0077 |
| 4.3 Availability of lining | 4 | 0.15 | 0.0105 |
| 4.4 Structural segmentation of the form | 6 | - | - |
| 4.5 Maintainability | 2 | 0.25 | 0.0175 |
| 4.6 Availability of elements for fixation of clothes | 1 | 0.29 | 0.0203 |
| 5. Economic | 4 | 0.13 | |
| 5.1 Product cost | 1 | 0.5 | 0.065 |
| 5.2 Expenses for garment care | 2 | 0.33 | 0.0429 |
| 5.3 Expenses for repairmen | 3 | 0.17 | 0.0221 |

The main feature of the developed list is a summary and content of all requirements of the consumer, characterized by a set of parameters defined as directly social and individual values for the consumer. Functional and ergonomic substantiation of the design solutions plays dominant role in the bringing the uniform of the passenger car attendants into conformity with the conditions of its use. In the process of development of the requirements we applied an approach, that took into account the study of existing types of domestic and foreign analogues, distinctive features of operating activity, nature of injuries and occupational diseases, working conditions, existing hazardous and harmful factors that directly affect the employee.

The list of quality indicators is represented separately for upper body garments and lower body garments. Such approach makes it possible to determine the level of quality indicators during project design of the sets of the uniform.

4 CONCLUSION

Hazardous and harmful operational factors which play dominant role in bringing the uniforms in conformity with the conditions of its use have been examined and systematized. In the process of development of the requirements we applied an approach, that took into account the study of existing types of domestic and foreign analogues, distinctive features of operating activity, nature of injuries and occupational diseases, working conditions, existing hazardous and harmful factors that directly affect the employee.

Significance of quality indicators and means for their ensuring in the uniforms of the passenger car attendants has been assessed. The necessity of theoretical research of reliability indicators has been substantiated by establishing integrated ranking of the indicators in accordance with their incommensurability and lack of standards for comparisons. An expert assessment has been carried out; reliability, ergonomics and aesthetics indicators, among which requirements for quality of the materials and process and design solutions of the articles is of top priority, has been determined.

Prospects of relevant researches highlight the fact that at present there is a necessity to develop uniforms for the employees of the postal departments, some of which are separate legal

entities. In the process of work each of them shall give its employees a particular workwear, which differs from the workwear of the personnel of the state-owned post service "Ukrposhta". Development of generalized requirements for this type of uniform requires creation of its own corporate style of the employees of postal departments of Ukraine. However, centralization of the tasks in relation to design, materials, complete sets and traditions by categories of the officers, standards and terms of usage will allow to reduce its cost. These issues are also quite urgent for private transport companies, where the uniforms are in the first place most widely used by aviation companies that are the subject of some further scientific researches.

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