Profile Competencies for Training Welding Specialists in Higher Education Institutions

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Abstract. The article presents a methodology that allows to substantiate professional competencies in the profile training of welding specialists in higher education institutions. The provisions of the methodology are based on professional and international standards. The substantiation of the number and essence of profile competencies is based on the process approach of quality management.

1. Relevance
Currently, Russian higher education institutions are switching to the new educational standards of FSES 3++. One of the main tasks of this transformation is to combine educational programs with professional standards in order to prepare graduates in accordance with the needs of employers and the state.

These needs and expectations in the new educational standard are presented in the form of three groups of competencies: universal, General professional and professional. All these groups of competencies in accordance with the requirements of the standard FSES 3++ as a result of mastering the training program of a graduate of an educational institution must be formed. However, the educational standards for various areas of training provide lists of only universal and General professional competencies. The number and nature of professional competencies necessary for a University graduate to successfully perform specific production tasks in a narrow professional field, the profiling departments should justify themselves on the basis of the provisions of professional standards, the requirements of employers, professional associations, generalization of domestic and international experience.

At the same time, it should be emphasized that the number and nature of professional competencies (which each University sets independently due to the lack of common approaches) determines the number and content of disciplines in the variable part of the educational program, which is the Foundation of profile professional training.

Therefore, the development of a methodology that would allow you to justify the number and nature of professional competencies in the training of specialists in welding production is an actual task.

2. Basic provisions of the methodology
The proposed methodology is based on the following basic provisions:
• Professional competence of welding specialists must meet the requirements of a wide range of industries and be based on the provisions of professional standards.
• Requirements for professional competencies should take into account the accumulated international experience, in particular the requirements of international standards for professional training of specialists in the field of design, manufacture and quality management of welding products, which creates confidence in the quality of educational services.

• The number and essence of professional competencies should logically and unambiguously interpret the content of the disciplines of the educational program of profile training.

• Professional competencies must ensure that the specialist successfully completes the main stages (processes) of welding production, so it is advisable to justify the number and nature of professional competencies on the basis of a process approach.

It should be emphasized that given the importance of the welding process in the issue of reliability of responsible structures, the world community has developed special basic international standards:

- ISO 14731:2006E. Welding coordination. - Tasks and responsibilities [1]. This standard provides a clear and unambiguous description of the tasks and responsibilities of those who supervise welding operations.

- ISO 3834:2005. Quality requirements for fusion welding of metallic materials [2]. The standard regulates supervision and management mechanisms at all stages of the product life cycle.

Recently, the Ministry of labor and social protection of the Russian Federation approved the professional standard "Welding Specialist", which presents the generalized labor functions of a specialist.

3. The number and essence of the competencies

The question of justifying the necessary and sufficient number of professional competencies remains open. Among the various methods for determining the number and list of competencies, the most practical application is found in the questionnaire method, which has certain disadvantages. Therefore, in the lists of professional competencies presented by various universities, due to the subjectivity of the approach, their number varies widely. The international TUNING project, aimed at harmonizing training programs, and various literature indicate only that the number of competencies should preferably be minimal.

In our opinion, the justification of the number of competencies seems appropriate and promising to implement from the position of the process approach, which is one of the key principles of the quality management system. World experience has clearly demonstrated that the desired result is achieved much more effectively when professional activities are managed as processes.

The effectiveness of professional activity of the employee in General, is determined by the efficiency of implementation of individual stages of work. If a person effectively performs each stage of professional activity and as a consequence of the work as a whole, it can be characterized as a competent employee. Therefore, if we justify the number of stages of professional activity as relatively independent, but interrelated processes, the implementation of which requires specific competencies, it is possible to justify the number of basic competencies.

The analysis of production and technological activities of a welding specialist, taking into account the provisions of professional and international standards, allows us to identify the following key relatively independent, but interrelated stages of professional activity of a specialist:

1. Technical analysis of the structure and capabilities of the organization.
2. The assessment of the suitability of the parent material and welding consumable.
3. Planning of welded structure production.
4. Preparatory activities for welding.
5. Performance of welding works.
6. Product quality inspection.
7. Assessment of the results and take corrective actions.

It seems that this division of the production cycle of welded structures into processes is reasonable and sufficient, since it covers all 22 basic indicators, verification and documentary confirmation of which is required in accordance with the certification procedure of the enterprise according to the
international standard ISO 3834. And it should be emphasized that the number of production processes determines the number of profile competencies, and the essence of the processes - the content of professional competencies.

Given that the international standard ISO 14731 presents the tasks of a specialist for production and technological activities more clearly and concretely than in the professional standard (which was developed according to the same layout for all professional standards), it seems more appropriate to base the essence of professional competencies on the provisions of the international standard. Therefore, in Table 1 for the above-mentioned list of stages (processes) of professional activity (column (a)), the tasks of the personnel supervising the welding operations (column (b)) are placed in accordance with the international standard ISO 14731.

| No. stage | Tasks of welding coordination personnel (ISO 14731) | Professional competencies |
|-----------|---------------------------------------------------|----------------------------|
| 1         | Review of requirements: - the product standard to be used, together with any supplementary requirements; - the capability of the manufacturer to meet the prescribed requirements. **Technical review:** - the product standard to be used, together with any supplementary requirements; - the parent material(s) specification and welded joint properties; - the joint location with relation to the design requirements; - quality and acceptance requirements for welds; - the location, accessibility and sequence of welds, including accessibility for inspection and nondestructive testing; - the dimensions and details of joint preparation and completed weld. **Sub-contractor** - suitability of any sub-contractor for welding fabrication. | 1. Ability to carry out technical analysis of the structure and the organization’s ability to welding fabrication |
| 2         | Materials. **Parent material:** - weldability of the parent material, - any supplementary requirements in the material purchasing specifications, including the type of inspection document for the material; - the storage and handling of parent material; - the identity of the parent material; - traceability. **Welding consumables:** - compatibility; - delivery conditions; - any supplementary requirements in the welding consumable purchasing specifications, including the type of welding consumable inspection document; - the identity of welding consumables; - the storage and handling of welding consumables. | 2. Ability to assess the suitability of parent material and welding consumables, to organize their storage and handling |
| 3         | Production planning: - the suitability of the welding procedure specification; - essential welding parameters; - the sequence in which the welds are to be made; | 3. Ability to plan the production of welded design, taking into account the factors |
- the suitability and validity of welders' and welding operators' qualification certificates;
- equipment for preheating and post-heat treatment, including temperature indicators;
- environmental conditions (e.g. protection from wind, temperature and rain);
- health and safety.

**Equipment:**
- the suitability of welding and associated equipment;
- equipment maintenance;
- auxiliaries and equipment supply, identification and handling;
- equipment validation;
- safety equipment.

4 Technological process:

**Preparatory activity:**
- provision of working documentation,
- joint preparation (e.g. shape and dimensions), the cleaning of surface; - fit-up, jiggling and tacking;
- the suitability of working conditions for welding, including the environment.

5 Welding:
- the issuing and use of work instructions;
- preheating; - the welding sequence;
- any intermediate examination;
- post-heat treatment.

6 Inspection. Visual inspection:
- the use of visual inspection (for completeness of welding, weld dimensions, the form, shape, tolerance and dimensions of the construction);

**Destructive testing and non-destructive testing:**
- the use of non-destructive testing;
- the use of destructive testing.

7 Quality assessment:
- assessment of the results;
- weld repairs, re-assessment of repaired welds,
- corrective actions.

**Records:**
- the preparation and assessment of the results of the necessary records (including subcontractors’ activities).

4. Ability to carry out technical supervision over the preparation of edges for welding and Assembly work

5. Ability to organize the welding process and supervise the implementation of welding works

6. Ability to assess compliance with acceptance criteria by visual inspection, destructive and non-destructive testing methods

7. Ability to analyze the mismatches of welding results and propose corrective actions, to prepare the necessary records

It should be noted that in the international standard ISO 14731:2006 the list of tasks of the personnel is presented practically in the sequence corresponding to the basic stages (processes) of welding production justified above.

Based on the above list of production tasks for welding specialists it is possible to justify the number and formulate the essence of professional competencies by training profile “Equipment and technology of welding production”, which are presented in column (c) of table 1, taking into account the provisions of international and professional standards.
4. Conclusion
The methodology is developed that allows to substantiate the number and essence of professional competencies in the training of welding specialists in higher education institutions.

5. References
[1] ISO 14731:2006(E) Welding coordination - Tasks and responsibilities (Moscow: Standartinform) 2010
[2] ISO 3834-2:2005 Quality requirements for fusion welding of metallic materials Part 2: Comprehensive quality requirements (Moscow: Standartinform) 2007