T. KARKOSZKA, M. SOKOVIĆ

ISSN 0543-5846
METABK 53(4) 545-548 (2014)
UDC – UDK 621.78:658.562.004.4:502=111

RISK BASED ON QUALITY, ENVIRONMENTAL AND OCCUPATIONAL SAFETY IN HEAT TREATMENT PROCESSES

Received – Prispjelo: 2013-11-11
Accepted – Prihvaćeno: 2014-04-25
Original Scientific Paper – Izvorni znanstveni rad

Growing competition on the market forces the organisations to be more technological and organisational flexibility, both in the range of ensuring the products' quality and minimising the affect the surrounding environment as well as limiting the threats of the work safety. The studies proposed the way of consistent risk management of the operational discrepancies, based on the operational control, aiming at confirming the consistency of the key characteristics with the fixed operational criteria. The applied method guarantees avoiding the estimated risk, as unaccepted, and supervising and keeping on the even level the risk classified as the accepted one, which was used in the processes of the heat treatment.

Key words: heat treatment, quality, environment, occupational safety, integrated risk

INTRODUCTION

In the nowadays organisations it is impossible to fulfil the quality, environmental and work safety requirements in a coherent way exclusively by integration of the normalised management systems. The complex tools for shaping the quality in the technical, ecological as well as the social-economic meaning are written in the range of the contemporary commodity science.

Directing the commodity science towards realisation of the strategy of the balanced development enables: defining its main goal as ensuring the quality of the products deciding directly about the quality of life, running the environmental activity as well as taking care of the workers and their work environment.

Although the survey concerning the risk of the human activity currently are perceived as one of the most crucial systemic survey, they do not represent the integrated character, however, they are attributed to the educational discipline, within which the potential loss is analysed [1].

This is usually taken as a reason of lack of consistent and coherent approach towards the risk [2,3]. Within that range, one should notice the need of managing the risk, which finally will lead to its limitation or elimination [4-10].

NEW INTEGRATED METHODOLOGY IN THE OPERATIONAL PROCESSES

Risk proceedings

Independently on the nature of the identified risk, the management of it should include (Figure 1): identification of the processes, risk estimation as well as implementation of the proper activities, which allow for effective risk limitation. These can have pro-active or re-active character.

The "input" factors are described by the integrated requirements of the interested sides and integrated resources, whereas the "output" factors include the integrated products as well as the conformity degree with the integrated requirements.

During the risk acceptability evaluation it should be assumed that low risk (described by the small values of the Integrated Risk Ratio) is always acceptable. The high risk (described by very high values of the Integrated Risk Ratio) is always unacceptable. Evaluation of acceptability of the integrated risk described by the medium values of the Integrated Risk Ratio (IRR) is based on the ALARP rule - *"as low as reasonably practicable"*.

Pro-active approach uses the risk transfer consisting in the assignment of the responsibility for the realised process the risk connected with it on the other entity or avoidance of the risk by the resignation of the risky processes.

Re-active approach accepts the making use of system solutions, also the procedural ones, in the range of both the monitoring the integrated risk management based on the quality criterion and the operational control.

Planning the risk makes the element of improvement in the risk management and is based on the results of operational control.

Operational control based on the integrated quality, environmental and occupational safety consists and it is the fundamental part of the integrated risk management. Scheme of the feedback realised as the operational control based on the quality, environmental and occupational criterion has been proposed on the Figure 2.

T. Karkoszka, Faculty of Mechanical Engineering, Silesian Technical University, Gliwice, Poland; M. Soković, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia

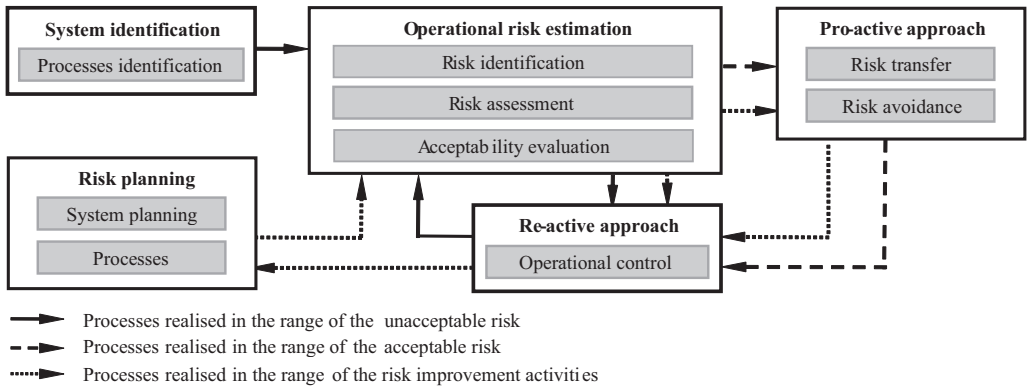

Figure 1 Scheme of the integrated risk management

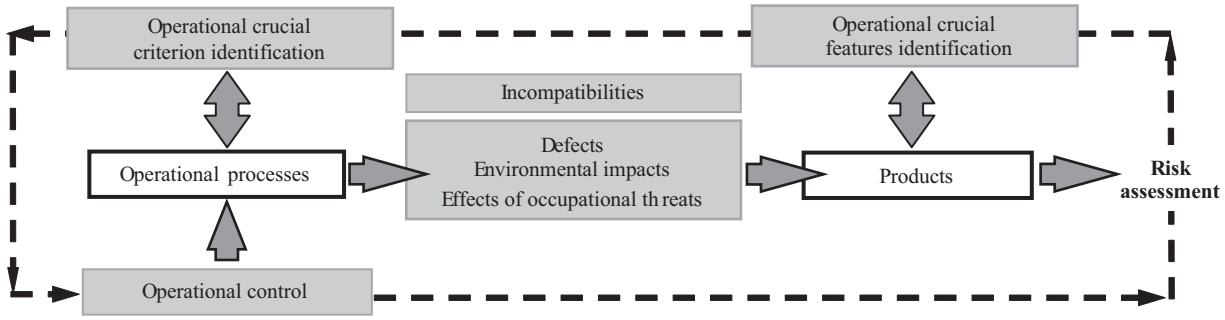

Figure 2 Scheme of the feedback of the character of operational control based on the quality, environmental and occupational safety criterion

Integrated operational control forms a method of integrated risk management, which applies on the operational, and particularly technological, level. Flexibility of the risk assessment methods, tools and methods of evaluation and design of quality, methods of environmental influence, occupational risk assessment methods as well as dependences between causes of operational incompatibilities and potential operational incompatibilities allows for the usage of the algorithm connected with their occurrence. It includes:

- description of the character of incompatibilities and their causes,
- definition of the significance of incompatibilities,
- determination of the probability of incompatibility occurrence,
- integrated risk assessment, and
- identification of the significant incompatibilities described by the highest values of Integrated Risk Ratio (IRR).

Risk which is connected with occurrence of the integrated incompatibilities based on the quality, environmental and occupational criterion has been defined by the function of probability of incompatibility occurrence (described by priority ratio of incompatibility occurrence, PRO) and significance of incompatibility (described by priority ratio of incompatibility significance, PRS). As the effect - the risk has been described as the Integrated Risk Ratio being the product of priority ratio of incompatibility occurrence and priority ratio of incompatibility significance and expressed in the scale of 1-100.

Operational control based on the quality, environmental and occupational criterion, realised according to the procedure shown on the Figure 3, includes:

- integrated operational risk assessment as regards legal requirements, technical specification as well as the requirements of the others interested sides, especially of technological and construction character,
- determination of the Integrated Risk Ratio as well as the ratio of the difficulty of operational criterion assurance in the context of the realised processes, operational criterions and features with those processes connected and potential incompatibilities, their causes and effects,
- definition of the crucial operational criterions and features on the basis of the determined value of Integrated Risk Ratio and the ratio of the difficulty of operational criterion assurance,
- assessment of the process stability defined on the basis of variability character,
- determination of the process capability in the range of crucial operational criterions and features,
- integrated assessment of the process and its possible regulation in the case of the lack of the conformity with the required values of operational criterions and features.

Heat treatment processes

Technological process of toughening, being the subject of the analyses, includes: martensitic hardening and medium-temperature tempering.

The assessment of the integrated risk of the process has been realised according to the prepared risk proceedings.

Specification of the values of the Integrated Risk Ratio (IRR) as well as the values of risk the fulfilling quality requirements (Quality Risk Ratio, QRR), environmental requirements (Environmental Risk Ratio, ERR) and occupational safety requirements (Occupational Risk Ratio, ORR) for processes of martensitic hardening and medium-temperature tempering has been shown in Table 1.

Table 1 **Specification of Integrated Risk Ratio (IRR) as well as Quality (QRR), Environmental (ERR), Occupational (ORR) Risk Ratio values for the analysed processes of heat treatment**

Kind of process	QRR	ERR	QRR	IRR
Martensitic hardening	93	180	195	468
Medium-temperature tempering	88	160	182	430

The effects of the integrated risk assessment have been used in the range of operational control in the identification of the crucial operational criterions and features. One has assessed the character of variation and - on their basis - defined the capability of the realised processes and controlled their risk by monitoring of the test values and making the necessary regulations.

Risk of the realised heat treatment processes, both hardening and tempering, has been characterised as high. The factor deciding about the high value of Integrated Risk Ratio in martensitic hardening ($IRR_H = 468$) and medium-temperature tempering ($IRR_T = 430$) has proved to be heat treatment technology based on the heating, soaking and cooling treatment with usage of the heating and cooling medium of temperature even about 1 200 °C.

There is no possibility to assure the designed mechanical properties by application of the equally effective technology of high temperatures. In spite of existing environmental aspects and impacts being the effect

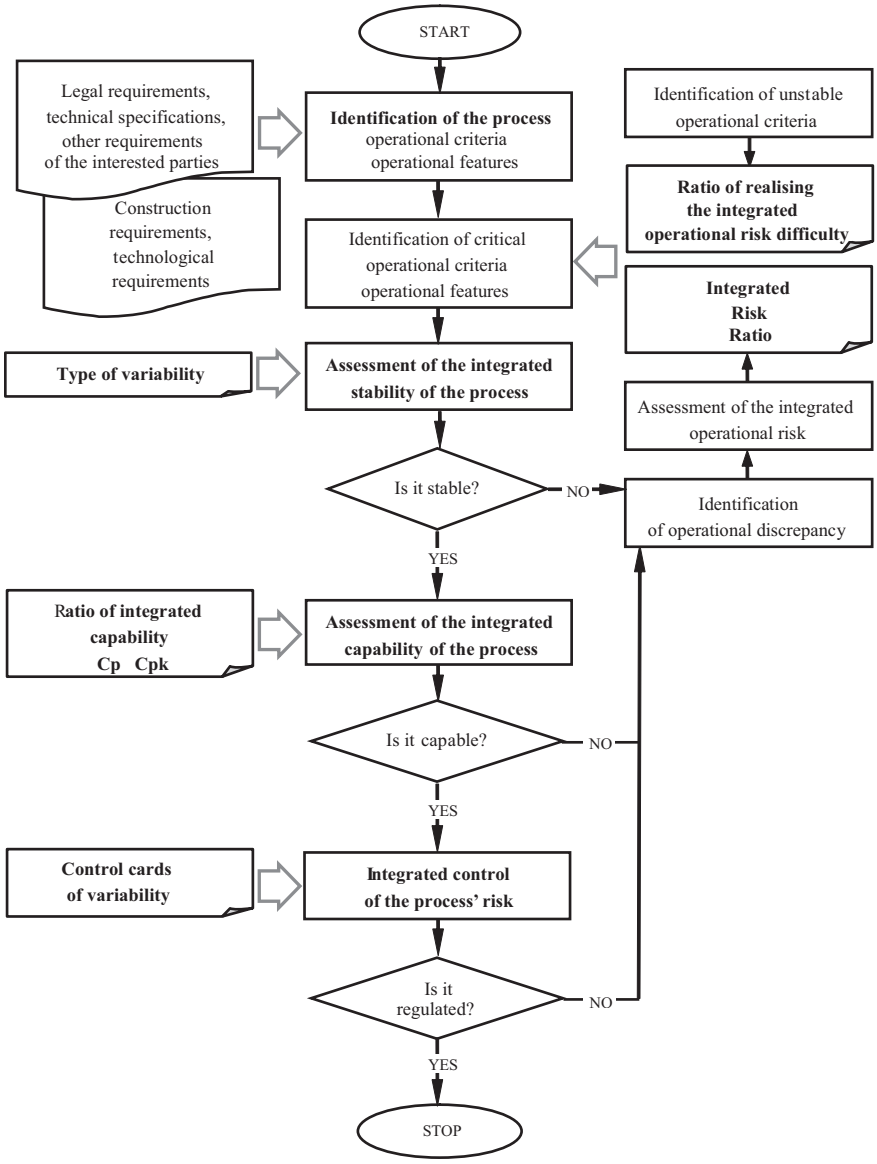

Figure 3 Supervision procedure of the integrated operational risk based on quality, environmental and occupational criterion

of assurance of high temperatures in the carried out heat treatment and creating very high value of the Environmental Risk Ratio - not resulting from non-observance of the law - risk of the processes has been defined as acceptable.

CONCLUSIONS

In the time of the assessment of the integrated risk based on the quality, environmental and occupational safety criterion organisation performs the identification of threats connected with processes and products as well as evaluates the risk concerning the effects of those threats.

The effects of threats identification are supplied to the appropriate stakeholders and constitute the basis of integrated risk management by planning and implementation of the organisational and technological solutions minimising the risk. Those activities should be adequate to the size and character of the integrated risk, based on the solutions, which are the best in respect of organisational, technological and technical meaning as well as fulfil legal provisions and the other requirements, both external and consistent with good practice. Organisation has no obligation to apply the solutions, which are the most expensive but only financial optimal and minimising the risk the level, which is acceptable by every interested side.

The result of the assessment of heat treatment processes, grounded on the Integrated Risk Ratio values, has been the undertaken activity in order to avoid the integrated risk. Avoidance of the risk seems to be the best way for its minimization or even elimination in the organisation. However, in case of the analysed processes of martensitic hardening and medium-temperature tempering there is no possibility to fulfil the requirements by application of the other technical or technological solutions. It is necessary to take advantage of organisational solutions in the form of operational control allowing for the maintenance of the threats of heat treatment processes in the supervised conditions.

REFERENCES

[1] A. Szymanek, Safety and risk in technic, Technical University Publishing House, Radom, 2006.
[2] T. T. Kaczmarek, Risk and risk management. Interdisciplinary interpretation, "Difin" Publishing House, Warsaw, 2010.
[3] G. Banse, G. Bechmann, Interdisciplinary risk research, Western Germany Publishing House, Opladen-Wiesbaden, 1998.
[4] T. Karkoszka, M. Soković, Integrated risk estimation of metal insert gas (MIG) and metal active gas (MAG) welding processes, Metalurgija 51 (2012) 2, 179-182.
[5] T. Karkoszka, Risk management as an element of process continuity assurance, Procedia Engineering, 63 (2013), 873-877.
[6] B. Agarski, I. Budak, B. Kosec, J. Hodolič, An approach to multi-criteria environmental evaluation with multiple weight assignment, Environmental Modeling and Assessment, 17 (2012), 255-266.
[7] D. Pavletić, M. Soković, T. Buksa, Application of risk assessment tool in shipyard quality management, International Maritime Association of Mediterranean Publishing House, Istanbul, 2009, 1099-1106.
[8] G. Burke, B. Singh, L. Theodore, Handbook of Environmental Management and Technology, John Wiley & Sons, New Jersey, 2005.
[9] G. Kosec, A. Nagode, I. Budak, A. Antić, B. Kosec, Failure of the pinion from the drive of a cement mill, Engineering Failure Analysis, 18 (2011) 1, 450-454.
[10] M. Kutz, Environmentally Conscious Manufacturing, John Wiley & Sons, New Jersey, 2007.

Note: The responsible translator for English language is Dominika Wnukowska, Silesian University of Technology, Gliwice, Poland