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Risk-Based Inspection of Some Components of Power Plant Prunéřov-II

Jan Janošťák[1,a*], Jakub Stoniš[1,b] and Zdeněk Ramík[1,c]

[1]VÍTKOVICE ÚAM a.s., Purkyňova 648/125, 612 00 Brno, Czech Republic

[a]jan.janostak@vitkovice.cz, [b]jakub.stonis@vitkovice.cz, [c]zdenek.ramik@vitkovice.cz

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Abstract. The paper deals with rendering of Risk-Based Inspection method (RBI) for use in maintenance system on „retrofit“ power plant Prunéřov-II (EPR-II). Data collected during inspections are stored in database of RIMaSys system. Assessment of inspection data may be used for planning next inspections and to keep the risk of failure of power plant inspected components under control. RIMaSys computer code developed in VÍTKOVICE ÚAM a.s. company was used.

1. Introduction

Risk level analysis is very important not only in business and financial transactions, but in industry too. In heavy industry, chemical industry, aircraft industry and others is risk level analysis used for fitness for service management and inspection planning.

Use of RBI method [1] for assessment of risk of several components of power plant Prunéřov-II (EPR-II) is presented in this paper. For inspection data collection and assessment system RIMaSys developed in VÍTKOVICE ÚAM a.s. company is used.

2. Risk-Based Inspection method (RBI)

Risk-Based Inspection is modern and powerful process based on planning of inspections, visual examinations and nondestructive inspection techniques of equipment. Risk is defined by combination of probability and consequence of equipment failure. Probability and risk can be estimated in one of three ways.

Qualitative RBI is based on experience and expertise of visual testing and nondestructive inspection techniques. Most of components are assessed by qualitative approach, the aim is to obtain wide overview of state of technical preservation of equipment.

Quantitative RBI considers structural degradation and damage in probabilistic manner, so measurement data (wall thickness, size of defect and so on) are necessary for assessment. Only the most important components are assessed by quantitative approach.

Semi-quantitative RBI is between above approaches.

In progress from qualitative to quantitative RBI the results are more accurate, but the cost and the time to achieve them grow up.

2.1. Qualitative RBI

RBI leads towards predictive maintenance based on previous inspections and experiences. Qualitative RBI approach implemented in RIMaSys system is based on risk matrix. Risk is represented as a matrix divided into areas of high, medium and low risk. Equipments at high risk matrix area will be most often inspected. Equipments at low risk level will be least often inspected. If risk level of failure and safety of these equipments are know, it is possible to extend inspection period or eliminate unnecessary inspections.

Selection of inspection points and schedule power plant inspections is difficult task in which team of experienced experts should assist.

Probability factor can be derived from data of equipment inspection score list. Value of probability factor determines class of probability. Class of consequences depends on correction factors due to effect of risk of failure on workers health and safety, on environment, on recovery costs, on production loss and others. Risk matrix shown in Table 1 depends on class of consequences and class of probability.

Table 1: Risk assessment matrix

		Risk matrix			
Class of probability ↑	high	**low**	**high**	**very high**	**very high**
	medium	**low**	**medium**	**high**	**very high**
	low	**very low**	**low**	**medium**	**high**
	very low	**very low**	**very low**	**low**	**medium**
Class of consequences		very low	low	medium	high

→

Risk level values are from 1 (excellent) to 5 (insufficient) as is shown in Table 2.

Table 2: Scale of risk level values

Qualitative ranking of risk of equipment		
Risk level	Value	Description of equipment condition
very high	**5**	Equipment is in insufficient condition
high	**4**	Equipment is in poor condition
medium	**3**	Equipment is in good condition
low	**2**	Equipment is in very good condition
very low	**1**	Equipment is in excellent condition

Risk level values based on inspector's point of view scored in time of inspection may be altered by evaluation functions in RIMaSys. Fuzzy approach is used.

3. Software system RIMaSys

The RIMaSys system [2] developed in VÍTKOVICE ÚAM a.s. company is based on RBI method. System consists of two program parts, RIMaSys for PC runs on Windows based computer and RIMaSys for mobile devices, such as smartphones and tablets, runs on operating system Android – almost all types of mobile devices with different screen size are suitable.

During inspection of the power plant components tablet with RIMaSys is used for data collection. RIMaSys running on PC is used for power plant equipment inspection planning, export inspection data sheet to tablet and import collected inspection data from tablet.

Assessment of inspection data, which are stored in MSSQL database type file on hard disk with RIMaSys on PC, may be used for planning next inspection and other analyses.

RIMaSys main windows for PC and tablet are shown in figures Fig. 1 and Fig. 2.

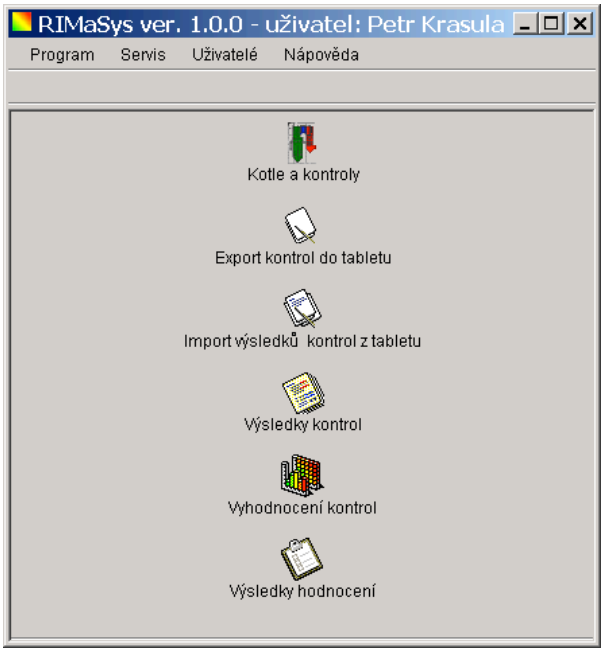

Fig. 1: RIMaSys main window for PC

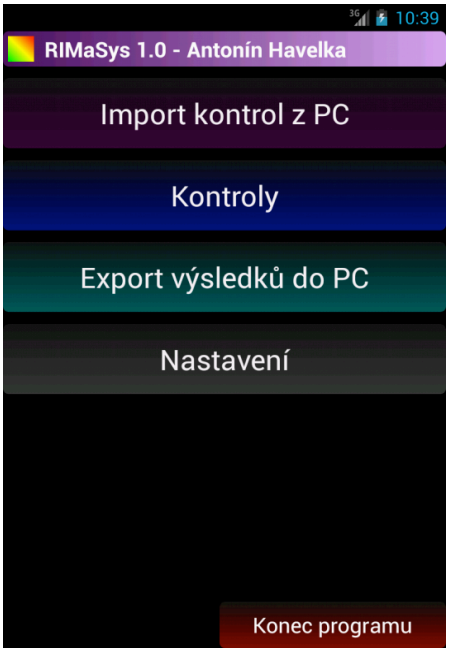

Fig. 2: RIMaSys main window for tablet

3.1. RIMaSys system for PC

Power plant components are hierarchically organized into tree structure in accordance with EPR-II information system. RIMaSys tree window allows user to select components for inspection control. Menu options and selections are accessed by mouse clicking as in usual Window systems.

Example of typical RIMaSys windows layout in time of selection of power plant components for inspection is shown in Fig. 3.

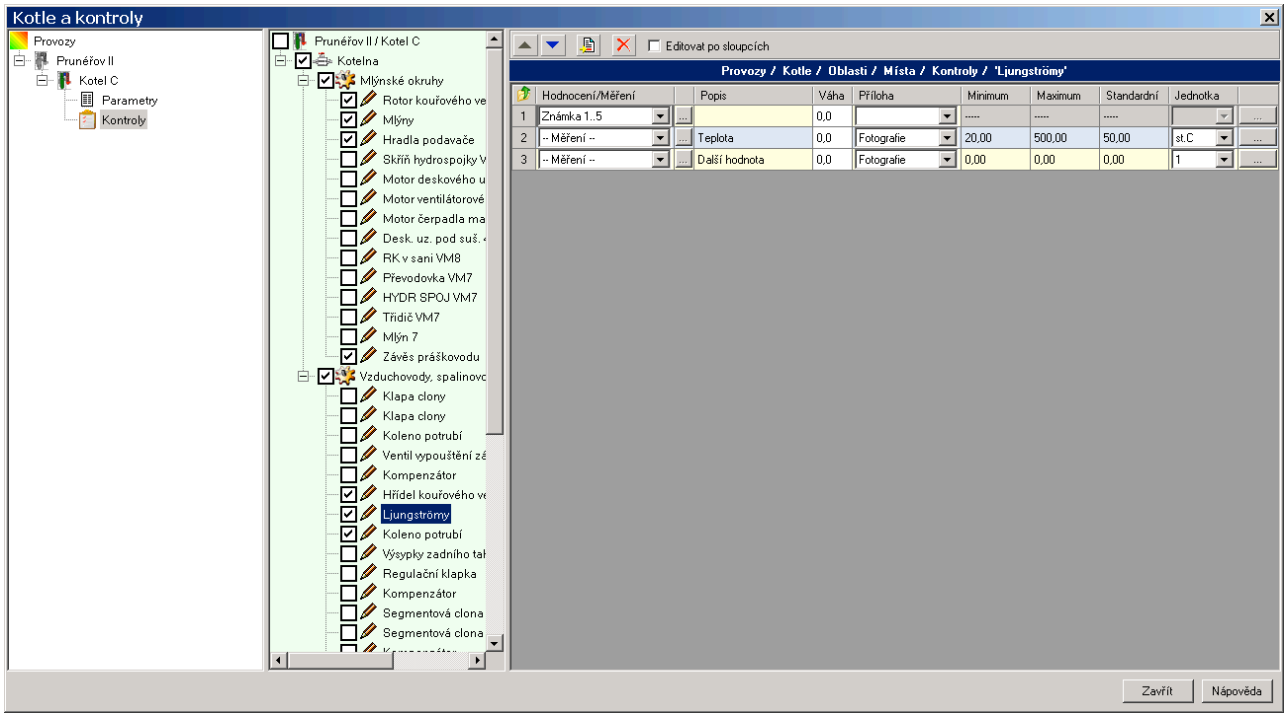

Fig. 3: Selection of power-plant components for inspection

Data of selected components for inspection stored in database file on PC are exported to tablet. In Fig. 4 is shown setting of connection parameters for export to tablet. Connection parameters should be set before transfer of data from PC to tablet begins. Setting connection import parameters (see Fig. 5) is similar. Transfer of data from PC to tablet may be performed by wire-less way via WiFi or by USB cable.

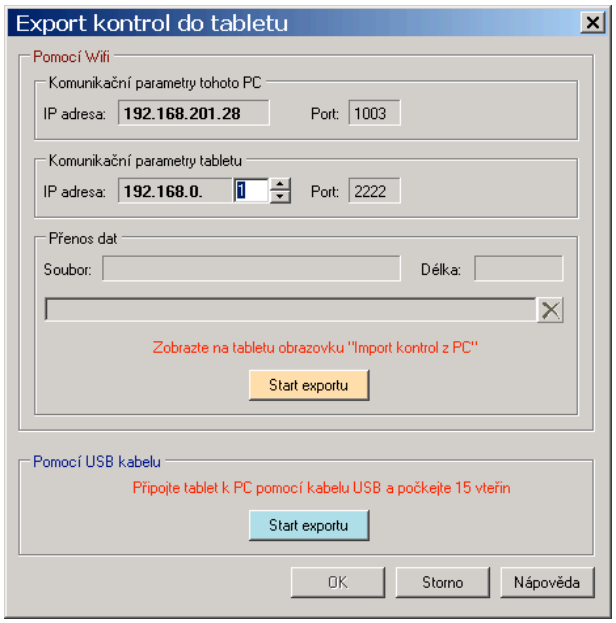

Fig. 4: Setting parameters for export to tablet

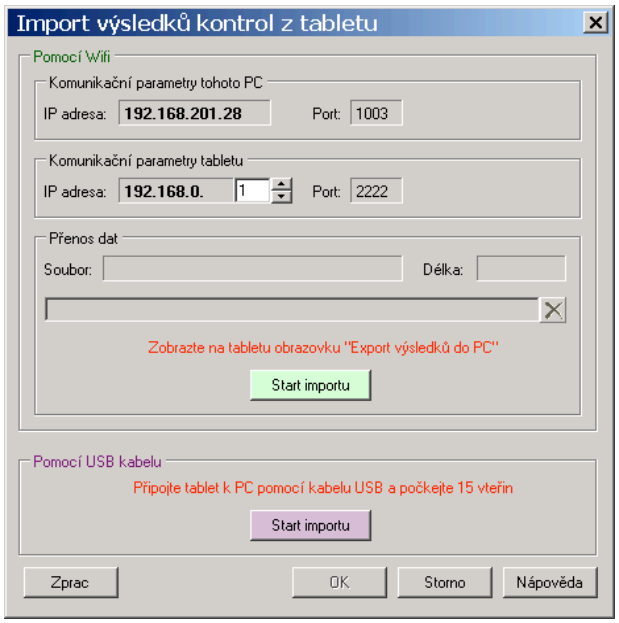

Fig. 5: Setting parameters for import from tablet

RIMaSys windows layout on PC after inspection data for Ljungström were imported from tablet is shown in Fig. 6.

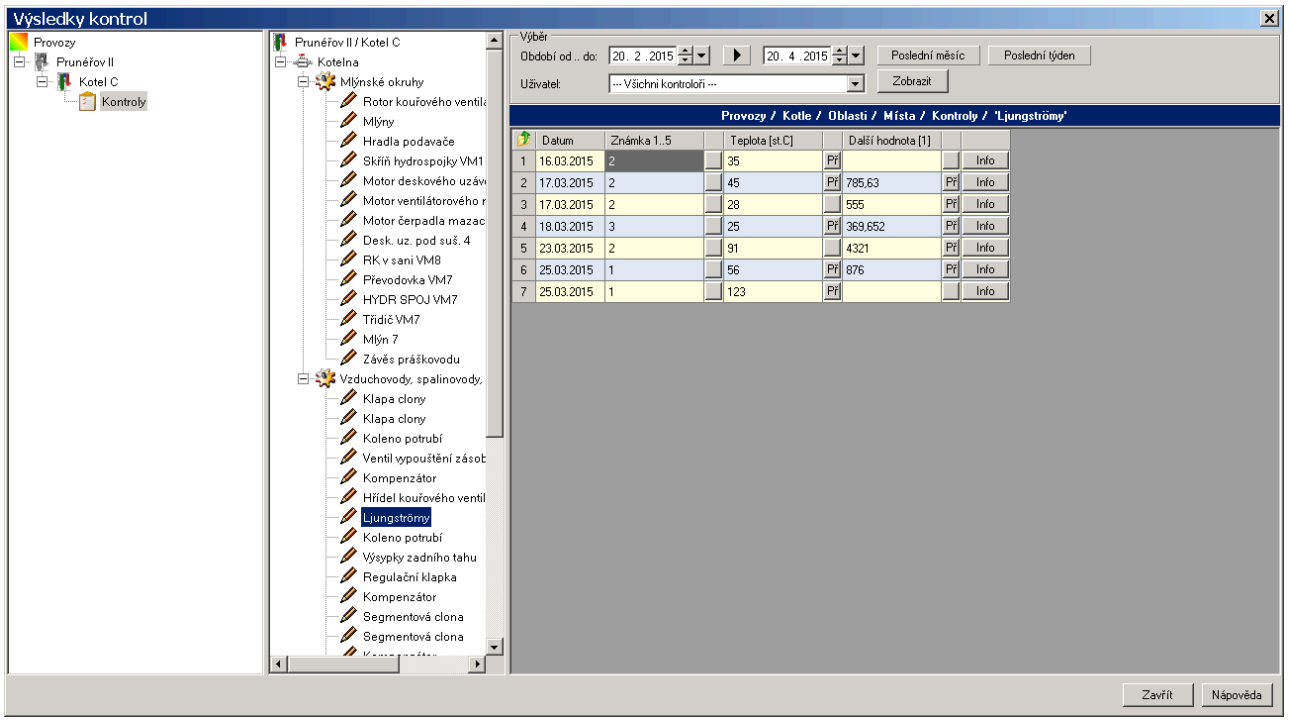

Fig. 6: Example of inspection results for Ljungström

Functions for inspection result evaluation are prepared for implementation in RIMaSys, see icons at bottom in Fig. 1.

3.2. RIMaSys system for tablet

Tablet with RIMaSys system is used for collecting inspection data. Set of planned inspections is imported from PC (see Fig. 7).

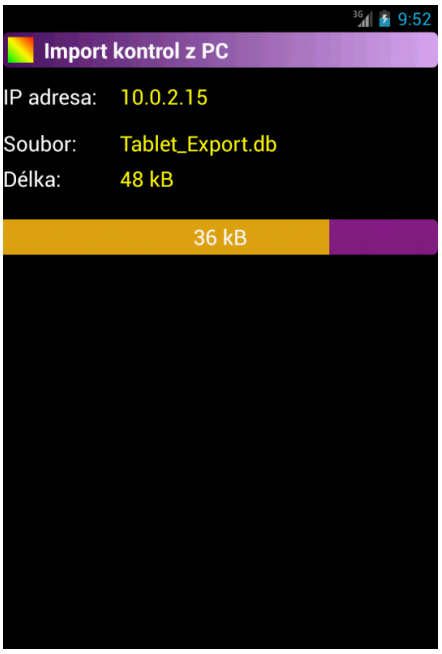

Fig. 7: Import of planned control set to tablet

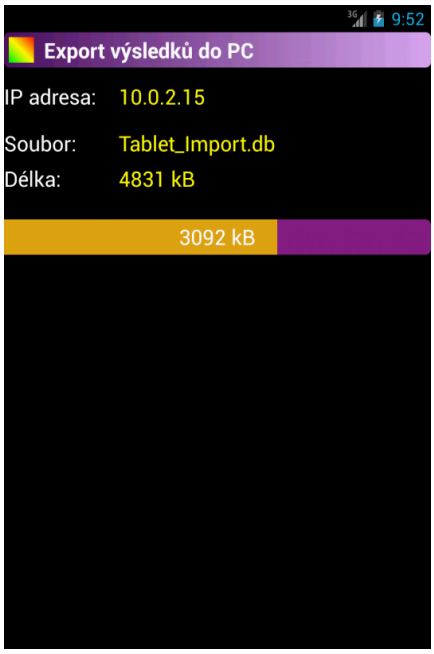

Fig. 8: Export of inspection data from tablet to PC

Example of list of planned controls for EPR-II selected equipments is shown in Fig. 9. Inspection data in tablet database file are grouped into form of inspection check list. Example of check list on tablet form is shown in Fig. 10. Check list consists of several photos, written short note describing state of controlled equipment and risk level assessment from inspector's point of view.

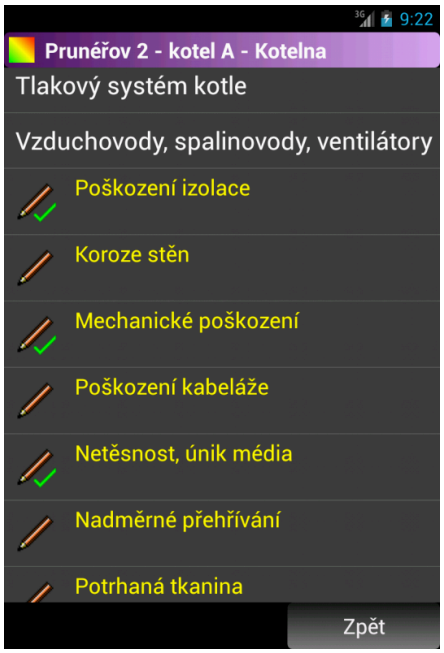

Fig. 9: Example of list of planned controls

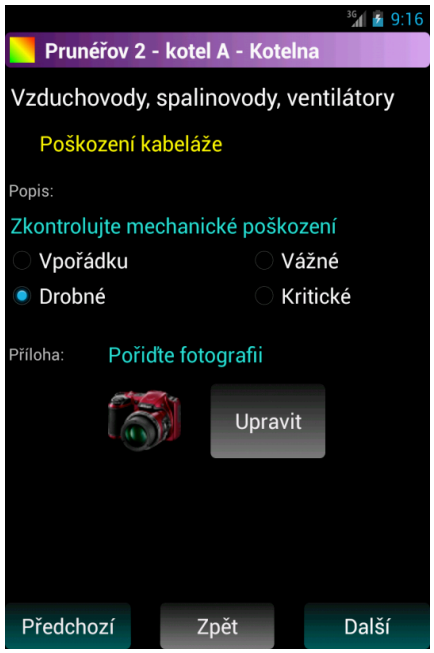

Fig. 10: Example of inspection check list including short note, photo and risk-level assessment buttons

After planned inspection and data gathering has finished, inspection data from tablet are exported to RIMaSys on PC, see Fig. 8. Data from tablet to PC are transfered by WiFi or USB cable.

Desired quality and resolution of photos taken by tablet are possible to set in RIMaSys main window (see Fig. 2).

4. Conclusion

Assessment of risk of failure of selected inspected components of power plant Prunéřov-II (EPR-II) is based on RBI method.

The RIMaSys system developed in VÍTKOVICE ÚAM a.s. company is used for inspection, planning, collection data in MSSQL database type file and assessment.

Summary

The paper describes aims stated in paper introduction. Use of RBI method for assessment of selected power plant Prunéřov-II components is presented. RIMaSys computer code developed in VÍTKOVICE ÚAM a.s. company is introduced.

Acknowledgement

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