Conference Paper

Modernization of Test Benches of UDMW

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Abstract

The article analyzes the reasons for the downtime of test stands, reveals the shortcomings of the automated control system, and suggests ways to solve the problems.

Keywords: automation of control systems of technological processes, modernization.

1. Introduction

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The Ural Diesel Engine Plant is testing the new DM-185 engine family on test benches № 2, 3, 4. The new engine family is planned to be used in shipbuilding, locomotive construction, quarry equipment and small power generation facilities [1-2].

To test diesel units, a software and hardware complex based on Test Cell Manager (TCM) and Test Object Manager (TOM) software is used, which provides [3-4]:

- Diesel unit control (automatic start, stop, including emergency);
- Control of the loading device;
- Management of the electronic fuel supply system;
- Operating media management (temperature, pressure);
- Measurement and calculation of diesel unit parameters and operating media (air, oil, water, fuel, exhaust gases);
- Control of diesel unit equipment and stand components in manual and automatic modes.

1.1. Goals and objectives of modernization

In order to understand the necessity of the modernization project, the downtime of the equipment was found out due to the malfunction of the automated control system of technological processes (hereinafter – ACS TP), the analysis will be carried out on the basis of the journal of works of the testing stand № 2. Based on the results of the analysis

of the work log, the schedule of the test bench No. 2 for the period from November 1, 2017 to January 31, 2018 was drawn up. (See Fig. 1). During the period under review, 100-hour tests of the diesel generator were carried out. Downtime for other reasons includes downtime due to malfunctions not related to the automated process control system equipment, as well as other types of work performed by operators.

The main reasons for equipment downtime due to the failure of the automated process control system were: an undeveloped system of technological protections, blockages and alarms, the lack of redundancy of important for safety testing modules of the software and hardware complex, the lack of filtering analog signals, the lack of information on the automated workplace of the operator on the actual state of operation of equipment subsystems, interface congestion. To prevent and reduce the impact of these causes on the performance of stand equipment, we will disassemble them in more detail in this article.

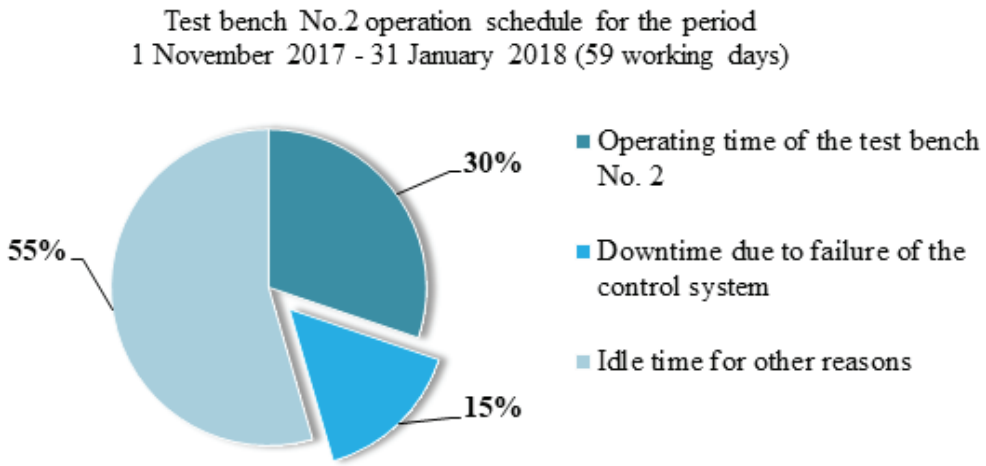

Figure 1: Operation schedule of stand No. 2.

The concerns of modernization of test benches:

- Increase the availability factor of the stand equipment of the automated process control system from 66% to 97%;
- To increase labor productivity by means of automation of equipment operation in 1,5 times.

Tasks of modernization of stands:

- Reduce the terms of diagnostics of software and hardware complex malfunction from 60 minutes (average value) to 20 minutes;
- Increase equipment fault tolerance by 2 times;

- Reduce the impact of the human factor on the operation of the software and hardware complex through the introduction of automatic control programs;
- Create an accessible and flexible operator interface.

1.2. Shortcomings of the software and hardware complex

In this part of the article I will analyze in more detail the drawbacks of the upper and lower levels of the automated process control system.

Identified drawbacks:

- On the video frames of the operator's workstation there is a set of diagnostic elements necessary only for the control system engineer;
- There is no a single information window about the triggering of alarm and warning alarms. All necessary for the operator system parameters are located on different video frames, which complicates the monitoring of alarm and warning alarms;
- There are no shutdowns of operation time of technological protections, blockages and alarms. This shortcoming reduces the operator's ability to take any action before the protection is triggered or the protection, blocking or alarm may be false;
- There are no correct technological schemes on the video frames of the operator's workstation;
- Presence of virtual (not really installed) sensors that display incorrect environment parameters;
- There is no filtering of analog signals. High speed of data processing and the use of actual values of parameters, rather than average ones, lead to unreliable display of sensor readings on the screen of the operator's workstation;
- There is no information on the actual state of operation of the subsystem equipment. The operator cannot influence an individual valve or actuator remotely, only in manual mode.

1.3. Ways of solving identified problems

Analysis of video frames and TCM and TOM software database has led to the conclusion that there are a large number of virtual (non-existent) sensors and signals that duplicate the channels of actually installed sensors. For example, from 418 channels of TCM test

bench № 2: 188 signals should be used, 106 virtual signals, 124 redundant signals. Based on a large number of virtual signals and sensors, design signals, protection and blocking were implemented. False signals are displayed on video frames and mislead the operator.

The video frame also lacks images of various pneumatic units, fuel supply schemes, oil supply and water treatment. Video frame is a simplified version of the actual scheme of the bench system and is not intended for the operator to perform tasks on testing the diesel unit.

One of the variants of solving the problem can be the change of simplified technological video frames to video frames of detailed technological schemes of systems and subsystems operation. Subsystems should be placed on separate video frames for the convenience of equipment management. Create a single simplified video frame from which to control the stand equipment, all the main signals from the sensors, the window of light and sound alarms are displayed.

Advantages of using the proposed interface:

- Availability of all necessary functions for diesel unit testing;
- Simplicity in mastering, friendly interface;
- Presence of the event log;
- The developed system of light and sound signalling;
- Change of parameters in a mode of real time;
- Presents a real picture of the parameters of the processes occurring on the test bench;
- It serves for quick identification of deviations in the operating modes of the stand equipment;
- Precise sketches of video frames, setpoint map should be developed on the basis of analysis of TOM and TCM software database.

Changing the video frames in TCM and TOM software, eliminating the remarks during the work of measuring and control devices, it is impossible to guarantee the reliability of the sensor readings at the operator's workstation due to the lack of filtration of analog signals. High signal processing speed (10-100 ms) and absence of filtration by averaging the parameters by time leads to fluctuations in the readings (pressure up to +/- 0.5 bar for the sensor scale 0-16 bar, temperature up to +/- 5 °C for the sensor scale -40 - 250 °C). To exclude these fluctuations, we will average the readings of the sensors by time: 5 seconds - for temperature sensors, as the temperature changes less inertia, 1 second

- for pressure, flow and level sensors, 100 ms - for sensors that measure the current and voltage.

In order to avoid an emergency situation due to incorrect sensor readings, it is necessary to switch off the sensor virulently or withdraw the protection to which it is connected. In the current top-level configuration, system parameters can only be changed in the project planning mode. In design mode, it is not possible to influence the process, to control the equipment, to monitor the readings of systems and subsystems, but only to make changes to the design. When switching to the design mode in the TOM software, the stand systems are switched off. Some system parameters, such as setpoints, can only be changed when all TCM and TOM programs are finished.

	Active	Name	Condition Type	Operator	Channel To Be Checked	Limit Value	Limit Unit	Pre Trigger Delay	Transition State
1	☑	L_Set_DP_Sin_User_HF	ERROR	more	DP_Sin	User_Limit_HF		0.000	Not Affected
2	☑	L_Set_DP_Sin_User_HW	WARNING	more	DP_Sin	User_Limit_HW		0.000	Not Affected
3	☑	L_Set_DP_Sin_User_LW	WARNING	less	DP_Sin	User_Limit_LW		0.000	Not Affected
4	☑	L_Set_DP_Sin_User_LF	ERROR	less	DP_Sin	User_Limit_LF		0.000	Not Affected
5	☑	L_Set_DP_Sin_Const_HF	ERROR	more	DP_Sin	7.000		0.000	Not Affected
6	☑	L_Set_DP_Sin_Const_HW	WARNING	more	DP_Sin	3.000		0.000	Not Affected
7	☑	L_Set_DP_Sin_Const_LW	WARNING	less	DP_Sin	-3.000		0.000	Not Affected
8	☑	L_Set_DP_Sin_Const_LF	ERROR	less	DP_Sin	-7.000		0.000	Not Affected
9	☑	SINGLE_HF	INFO	more	DP_Sin	7.000		0.000	Not Affected
10	☑	SINGLE_HW	INFO	more	DP_Sin	3.000		0.000	Not Affected
11	☑	SINGLE_LW	INFO	less	DP_Sin	-3.000		0.000	Not Affected
12	☑	SINGLE_LF	INFO	less	DP_Sin	-7.000		0.000	Not Affected

Figure 2: Table of protections, interlocks and alarms

Figure 2 shows the current interface of the protection, blocking and alarm editing table. This interface is saturated with information and is intended only for the control system engineer.

To exclude emergency shutdown due to unreliability of sensor readings or false triggering of protections and blockages it is necessary to implement the following set of measures:

- to use average values of signals from sensors;
- set the time delay for the triggering of protection and blocking. Time delay of 1 second is often enough to exclude false triggering of protection and blockages, as a consequence of the operator's taking the necessary set of measures to prevent a possible emergency situation;
- implement virtual input/output buttons for protection. Allow to switch off protection during operation of the diesel-unit in case of failure of the sensor associated with this protection;
- create an editable setting card on a separate TCM video frame. This feature allows the operator to change the setting values without turning off the bench system;

- implement color signaling on the setting map when the alarm and warning values of the parameters are reached, using the dark curtain principle. Colour scheme: alarm signaling - red, warning - yellow, no signaling - white;
- to create a separate pop-up window for the convenience of the operator with the elements of paragraphs 3, 4, 5.

Acknowledgement

Performance of measures specified in this article will lead to increase of readiness of the stand equipment of the automatic process control system from 66 % to 97 %, and as will increase labour productivity of engineers of testers and automatic process control system, thanks to automation of work of the equipment, reduction of terms of diagnostics of malfunctions and influence of the human factor on work of a hardware and software complex.

References

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[3] TestCellManager. Test Systems, 2010.

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