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RELIABILITY ANALYSIS OF BUTTERFLY VALVE (BV) USING THE FAILURE AND EVENTS TREES

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Abstract: In this paper, the predictive reliability study it has been made analyzing the failure modes of elements, starting from undesirable events. The events tree of BV it has been represented in view of the undesirable hypothesis (events), like: the failure of a function (f_i); the failure of a BV subsystem.

1. Introduction

In this second paper it has been continued the studies of BV predictive reliability using the failure and events trees.

During the reliability analysis, the butterfly valve (BV) from HPP Remeți, it has been regarded like a system compound of following subsystems:

- The closing subsystem (CSS);
- The sealing subsystem (SSS);
- The control subsystem (NSS);
- The operate subsystem (OSS);
- The protection subsystem (PSS).

2. The reliability analysis of BV using the failure and events trees

For a profound understanding of the BV elements failure modes, in succession it is presented a case study for BV 360-170 from HPP Remeti (table 1).

Table 1 *Failures modes of BV elements*

Subsystem	Elements	Failures modes	Symbol
0	1	2	3
CSS	the carcass	• flaws or holes (pore appearance)	F_1
		• solid bodies accumulations	F_2
		• fixed joining surface of two semi carcass wear (upstream and downstream)	F_3
		• wear of assembling elements (screws)	F_4
	the shutter disk	• wear	F_5
		• deviation (changing the functioning parameters)	F_6
		• cavitation	F_7
		• shutting of	F_8
	the spindles	• greased absence	F_9
		• wear	F_{10}
		• screws deterioration	F_{11}
		• wear of sealing elements (rubber seals, quad rings)	F_{12}
		• searing sleeve	F_{13}
		• change of dimension, flare and ovality	F_{14}

	the arms	• shutting of pin tearing	F_{15}
		• shutting of	F_{16}
SSS	the sealing seat	• wear	F_{17}
		• the pshycal-chemical properties changing	F_{18}
	the sealing elements	• the pshycal-chemical properties changing	F_{19}
		• wear	F_{20}
		• wear of control elements	F_{21}
	the rubber seal	• seal breakage	F_{22}
		• stressing up to specified limits	F_{23}
NSS	manual	• functioning parameters changing	F_{24}
		• interruption	F_{26}
	automatic	• functioning parameters changing	F_{27}
		• interruption	F_{28}
	the protections	• interruption	F_{29}
		• unidentified	F_{30}
OSS	the needle valve	• needle blocking	F_{31}
		• sticking the sealing surfaces	F_{32}
		• wear of assembling and fastening elements (screws, pins)	F_{33}
		• the rod thread deterioration	F_{34}
		• servomotor functioning parameters modification	F_{35}
	the servomotor	• wear of piston • the rod thread deterioration • wear of sealing elements (seals, rings) • wear of assembling and fastening elements (screws, pins) • wear of rod head bushing	F_{36} F_{37} F_{38} F_{39} F_{40}
		• wear of servomotor pin	F_{41}
	the control valve with electromagnet	• wear of slide -valve	F_{42}
		• the tilting screw deterioration	F_{43}
		• the rod thread deterioration	F_{44}
		• wear of sealing elements (seals)	F_{45}
		• wear of assembling and fastening elements (screws, pins)	F_{46}
		• the electromagnet spring distortion	F_{47}
		• the electromagnet coil tension absence	F_{48}
		• the insulation parameters modification	F_{49}
	the constriction valve with double direction	• unadjustement motion	F_{50}
		• wear of sealing elements (seals)	F_{51}
		• wear of valve seating	F_{52}
		• strain of valve springs	F_{53}
		• the valve balls deterioration	F_{54}
		• wear of fastening and anchoring elements	F_{55}
		• noises in pipes	F_{56}
		• flaws or holes pipes	F_{57}

	the operate circuit	• wear or unadjustement of fittings	F_{58}
		• MCA unadjustment	F_{59}
		• water losses	F_{60}
		• the oil pressure absence	F_{61}
	the manual pump	• wear of assembling and fastening elements (screws, pins	F_{62}
		• wear of sealing elements (seals)	F_{63}
		• the inlet and outlet valve unadjustement	F_{64}
		• noises and vibrations during functioning	F_{65}
PSS	the lubricate circuit	• manual pump functioning parameters modification	F_{66}
		• flaws or holes pipes	F_{67}
		• oil losses	F_{68}
		• valves unadjustement	F_{69}
	the signaling devise	• wearing	F_{70}
		• unadjustment	F_{71}
	the pin tearing	• wearing	F_{72}
		• torn	F_{73}
	the differential manometer with electric contacts	• wearing	F_{74}
		• functioning parameters modification	F_{75}
	the level relay	• wearing	F_{76}
		• functioning parameters modification	F_{77}
	the end running limits	• wearing	F_{78}
		• unadjustment r	F_{79}

In figure 1, it has been represented the events tree related to the undesirable event “catastrophic failure of BV operate subsystem”. In figure 2 it has been represented the events tree related to undesirable event “the failure of BV closing-sealing function, f_2”.

The probability appearance of undesirable event “catastrophic failure of BV closing subsystem” is:

$$F_{OSS} = F_{NV} + F_S + F_{CVE} + F_{CV} + F_{OC} + F_{MP} \tag{1}$$

$$\begin{aligned} F_{NV} &= \sum_{i=1}^{5} F_{3i}; F_S = \sum_{i=6}^{9} F_{3i} + \sum_{i=0}^{1} F_{4i}; F_{CVE} = \sum_{i=2}^{9} F_{4i}; F_{CV} = \sum_{i=5}^{9} F_{6i}; \\ F_{OC} &= \sum_{i=5}^{9} F_{5i} + \sum_{i=0}^{1} F_{6i}; F_{MP} = \sum_{i=2}^{5} F_{6i} \end{aligned} \tag{2}$$

F_i – the probability appearance of F_i fault; F_{ij} - the probability appearance of F_{ij} fault. Knowing the failure probability value (F_{OSS}) it has been evaluated the others reliability indicators:

$$R_{OSS} = 1 - F_{OSS}; \beta_{OSS}(T_A) = F_{OSS} x T_A \tag{3}$$

Base on the graph represented in figure 2 it has been wrote the relation of the probability of undesirable event appearance, “failure of BV closing-sealing function”:

$$P\left(\overline{f_2}\right) = \Pr ob\left(\overline{CSS} \cup \overline{SSS}\right) = F_{CSS} + F_{SSS} = \sum_{i=1}^{9} F_i + \sum_{i=0}^{9} F_{1i} + \sum_{i=0}^{3} F_{2i} \quad (4)$$

4. Conclusions

As a result of analysis and studies achieved it obtained that the butterfly valve reliability it is important for the HPP reliability. The predictive reliability analysis it has been continued using the failure and events trees. Base on them it can evaluate, also the reliability indicators.

BIBLIOGRAPHY

[1]. Felea, I. - *Ingineria fiabilității în electroenergetică*, Editura Didactică şi Pedagogică, Bucureşti, 1996

[2]. Felea, I., Coroiu, N. – *Fiabilitatea şi mentenanța echipamentelor electrice,* Editura Tehnică, Bucureşti, 2003

[3]. Ivas, D. ş.a. – *Fiabilitate, mentenanță, disponibilitate, performabilitate în hidroenergetică,* Editura Prisma, Rm. Vâlcea, 2000

[4]. Nitu, V.I., Ionescu, C. - *Fiabilitate în energetică*, Editura Didactică şi Pedagogică, Bucureşti, 1980

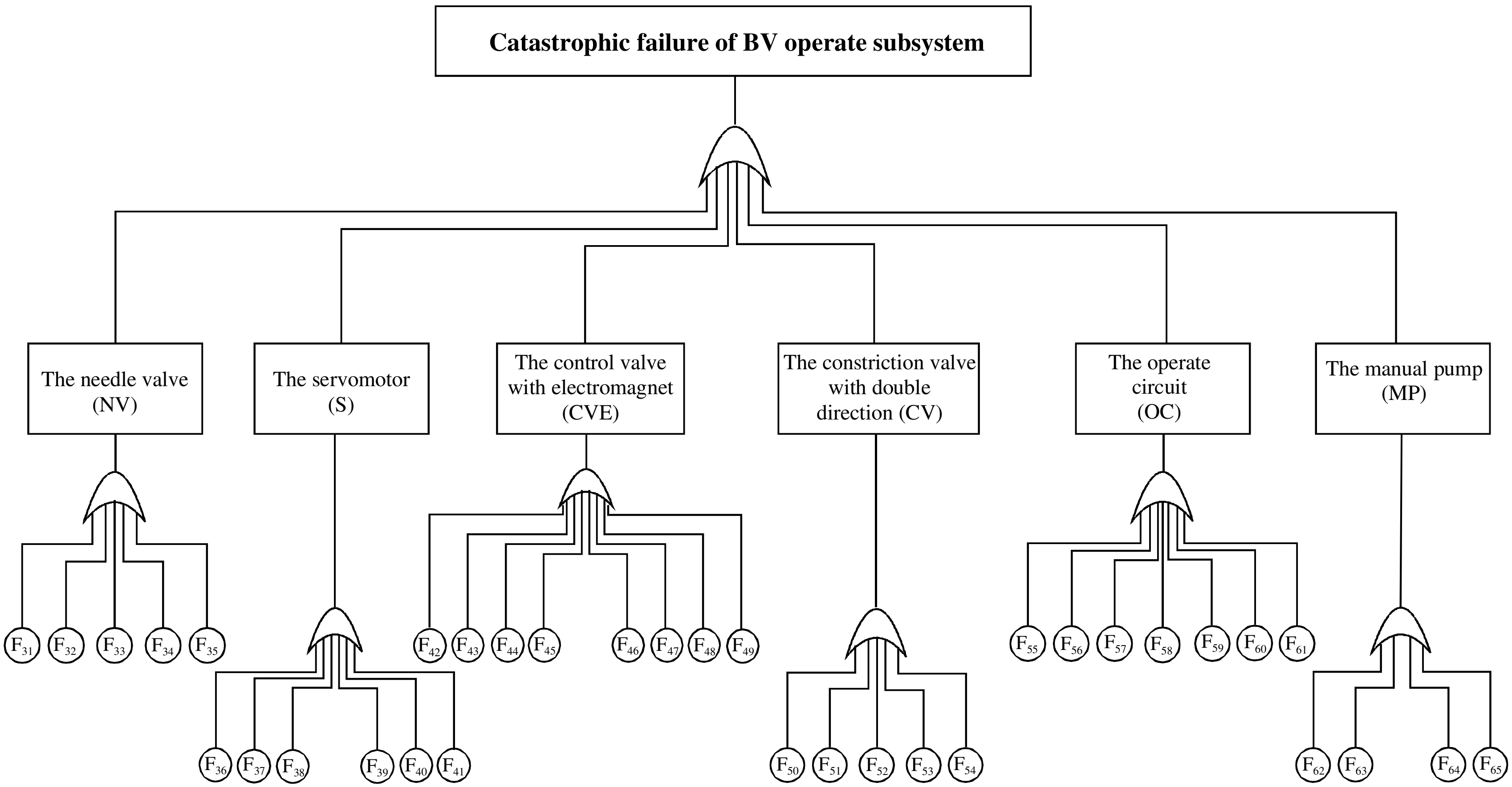

Fig. 1 The events tree related to the undesirable event „catastrophic failure of BV operate subsystem"

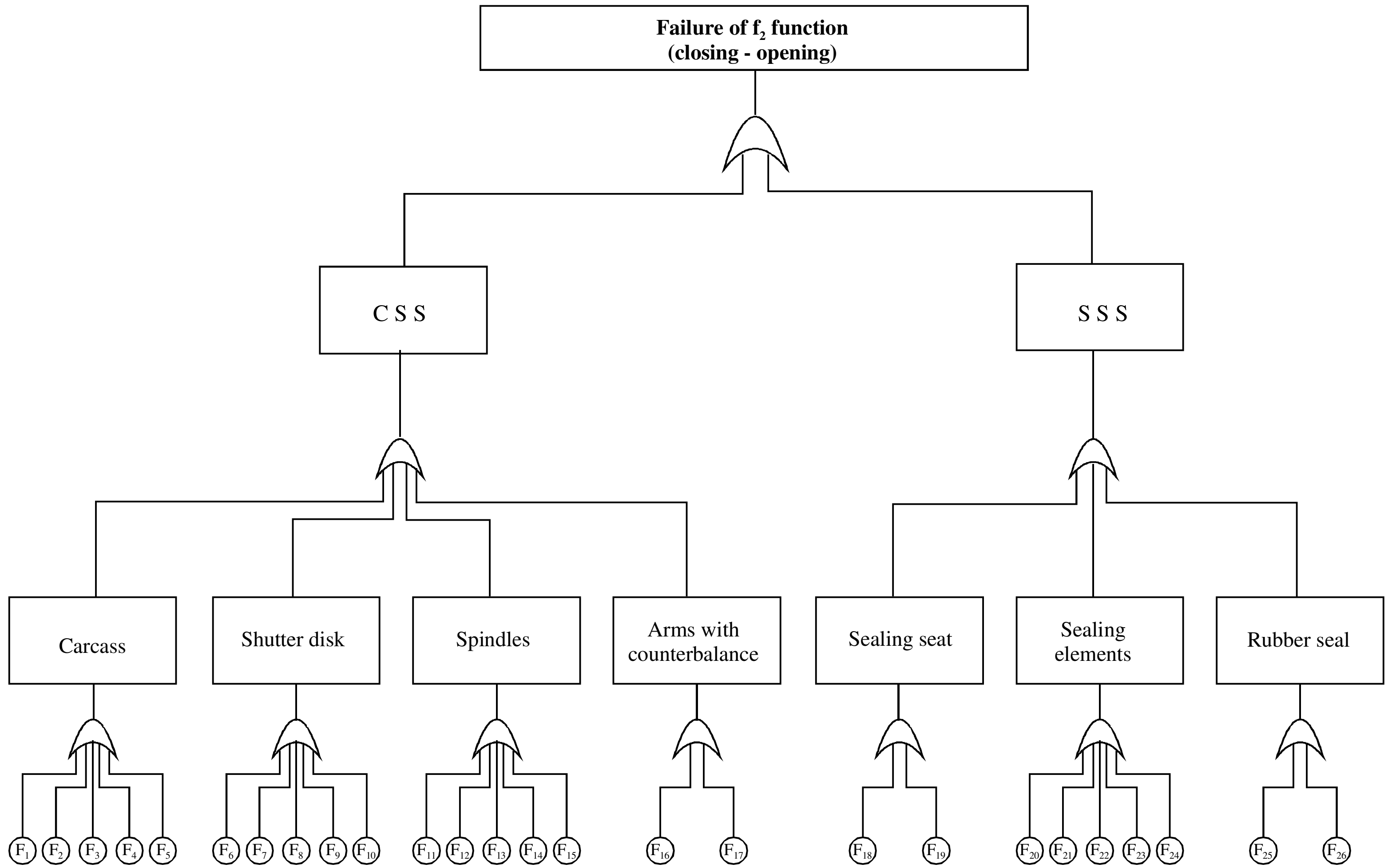

Fig.2 The events tree related to the undesirable event failure of BV f_2 function