



SOME PROBLEMS OF MAINTENANCE REGULATION AT UKRAINIAN NUCLEAR POWER PLANTS

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Abstract

Among all the possible problems arising in a connection with provision of NPP power units safe operation, the maintenance and repair at the Ukrainian NPPs possess an important place.

System of maintenance and repair at the Ukrainian NPPs is presently still traditional one, based on the former USSR' document "Rules of the NPPs Equipment Maintenance and Repair Arrangement" (РД.53.025.002-088).

For to provide technical systems reliability and safety in an accordance with "General Provisions on NPP Safety" (ОПБ-82) (presently ОПБ-95 is in underway in Ukraine) nuclear operators are implementing their maintenance and repair. These procedures are obligatory conditions for NPP operation during all the life term.

To implement an equipment maintenance and repair there are appropriate divisions in NPP structure envisaged such as departments, laboratories, sections, shops, etc. composing an NPP maintenance and repair service. There are also another specific enterprises engaged in such activities.

1. Maintenance at the Ukrainian NPPs

A maintenance is in conduct of some operations implementing which do not require equipment to be moved in a routine repair while being carried out during a periodic review of technical state, cleaning, adjustment, grease replacement, etc. as envisaged by manufacturer specifications and rules of technical operation.

Presently there are 14 power units in operation in Ukraine. A brief information is presented in Table 1.

A maintenance and repair arrangement and management are not the same at all the Ukrainian NPPs.

A typical, traditional structure is adopted at the Rivne and Khmel'nitsky NPPs, where the responsible person is a deputy Chief Engineer for maintenance (Drawing 1).

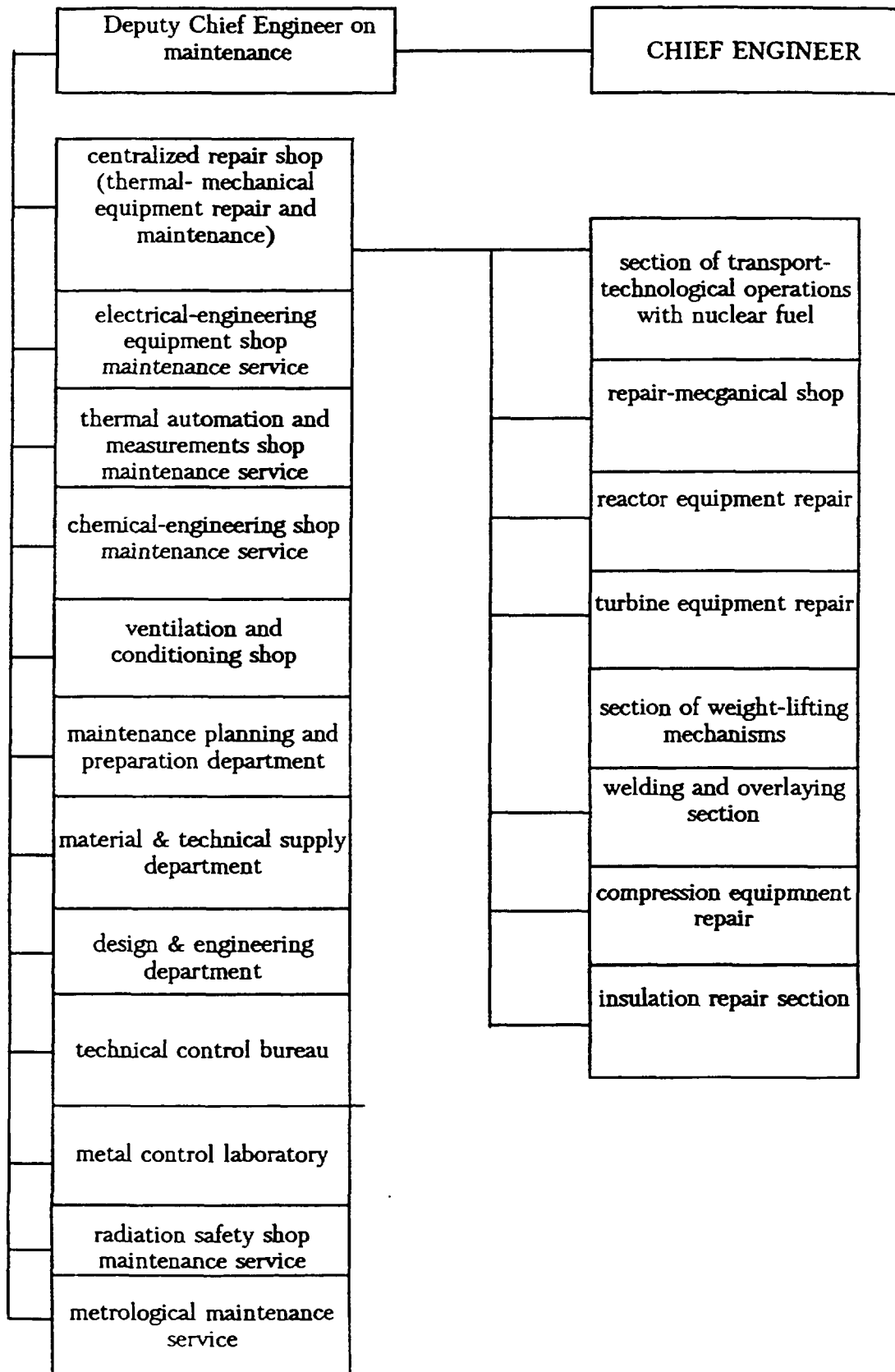
Nuclear Power Plant in Ukraine

Table 1.

NPP UNIT	REACTOR TYPE	POWER (Mwe)	DATE COMMISSIONED	OPERATIONAL LIFE*	PRODUCED IN 1994 (million kWh)	IAEA MISSIONS Type-R
RIV 1	VVER-440/V-213	402	12/31/80	14,5 years	2848	1993 November
RIV 2	VVER-440/V-213	416	12/30/81	13,5 years	2952	
RIV 3	VVER-1000/V-320	1000	12/24/86	8,5 years	5983	
RIV 4	VVER-1000/V-320	1000	under construction			
****ZAP 1	VVER-1000/V-320	1000	10/10/84	10,5 years	4035	1994 June
ZAP 2	VVER-1000/V-320	1000	7/2/85	10 years	4396	
ZAP 3	VVER-1000/V-320	1000	12/10/86	8,5 years	4601	
ZAP 4	VVER-1000/V-320	1000	12/24/87	7,5 years	6248	
ZAP 5	VVER-1000/V-320	1000	8/31/89	6 years	5180	
ZAP 6	VVER-1000/V-320	1000	under commission			
****KHM 1	VVER-1000/V-320	1000	12/31/87	7,5 years	6689	1993 March
KHM 2	VVER-1000/V-320	1000	under construction			
KHM 3	VVER-1000/V-320	1000	under construction			
KHM 4	VVER-1000/V-320	1000	under construction			
****SUK 1	VVER-1000/V-302	1000	12/22/82	12,5 years	5377,8	1995 January
SUK 2	VVER-1000/V-338	1000	1/6/85	10 years	4224,8	
SUK 3	VVER-1000/V-320	1000	9/20/89	5,5 years	5898,5	
SUK 4	VVER-1000/V-320	1000	under construction			
CHO 1	RBMK-1000	1000	9/26/77	17,5 years	4763	1994 May
CHO 2	RBMK-1000	1000	12/21/78	**		
****CHO 3	RBMK-1000	1000	11/10/81	13,5 years	5693	
CHO 4	RBMK-1000	1000	12/1/83	***		

- * - Operational life as of 6/1/95
- ** - Unit 2 was shut down after the fire on October 11th, 1991
- *** - Unit 4 was destroyed during the accident on April 26th, 1986
- **** - Routine maintenance repair as of 6/1/95

KHMELNITSKY NPP MAINTENANCE SERVICE STRUCTURE



At the South-Ukraine NPP the 1st deputy Chief Engineer is responsible for maintenance and repair arrangement, while deputy Chief Engineer - for documentation.

At the Zaporozhye NPP the responsibility for repair and maintenance is distributed between four persons as follows:

- deputy General Director on electrical and C&I systems operation and repair;
- deputy General Director on whole-station systems (water, oxygen, nitrogen supply, water treatment, compression station, etc.);
- deputy General Director on power units repair and maintenance (technical systems of reactor and turbine shops);
- deputy Chief Engineer on repair is responsible for preparation of documents

After NPPs obtained an "operational organization" status the maintenance and repair system and its structures underwent small changes as follows.

NPP is developing and upgrading by its own, with its structure taking into account, documentation on maintenance and quality assurance.

While issuing of licenses on NPP operation, reviewing or amending of operational documentation, making of technical decisions and undertaking of appropriate measures intended in safety improvement, analysing of reports on NPP operation malfunctions and annual reports on NPP safety current level the Regulatory Body of Ukraine is facing with problems of NPP equipment and staff reliability determination.

There exists a computerized data base in a STC where presently an information is maintained on more than 500 operational events occurred at the Ukrainian NPPs since 1992 up to now.

This information is transferred to the Regulatory Body by NPPs in an accordance with "Provision on NPP operation malfunctions investigation and account procedure" (ПНАЭ-Г-005-12-91).

Some of the reports on malfunctions are analysed by ASSET methodology with composing of events tree, determination of direct and root causes and implementing of corrective measures.

STC is already for 4 years dealing with an investigation of incidents occurring at the Ukrainian NPPs. The results were annual reports on incidents analysis.

While 14 units were in operation, the total number of malfunctions reportable to the Regulatory Body in 1994 was 135 cases (in 1993 they were 167, i.e. by 19 % more than in 1994).

In 9 cases of the total number the limits and conditions of the safe operation were violated (compare with 6 ones in 1993). There were deviations from the allowed mode of operation in all the 9 cases (level 1 by INES).

At the Diagram 1 the distribution of events at all the NPPs during 1994 year is presented.

At the Diagram 2 the distribution of events at all the NPPs during 3 years is presented.

Into an integral flow of malfunctions are included both those accounted as reportable to the Regulatory Body and recorded at the shop level. It revealed while collecting of statistical data that safety-significant systems malfunctions after maintenance, repairing and testing were recorded as shop level ones.

Presently the problem of clear distinguishing between malfunctions types is of considerable topicality, and here is a room for the Regulatory Body to assist nuclear operators.

The necessity appeared to create more expanded data base including complete information on malfunctions after maintenance and repair which would help to obtain representative data for to calculate reliability indices. These results can be used while PSA development.

At Diagram 3 some results on malfunctions connected with errors during equipment repair and maintenance are shown.

At Diagram 4 some results on malfunctions connected with errors during inspections, testing and maintenance are shown.

2. Maintenance quality indexes

NPP submit an information on its activity as to maintenance and repair as well as malfunctions of safety-significant systems after maintenance in "Annual report on power units operational safety current state assessment".

Deficiencies in power unit safety-significant systems equipment operation while maintenance and repair are estimated by maintenance and repair quality index. This is a parameter of equipment malfunctions stipulated by unqualified maintenance and repair flow averaged by the period under review.

Diagram №1. Event distribution over Ukrainian NPPs in 1994

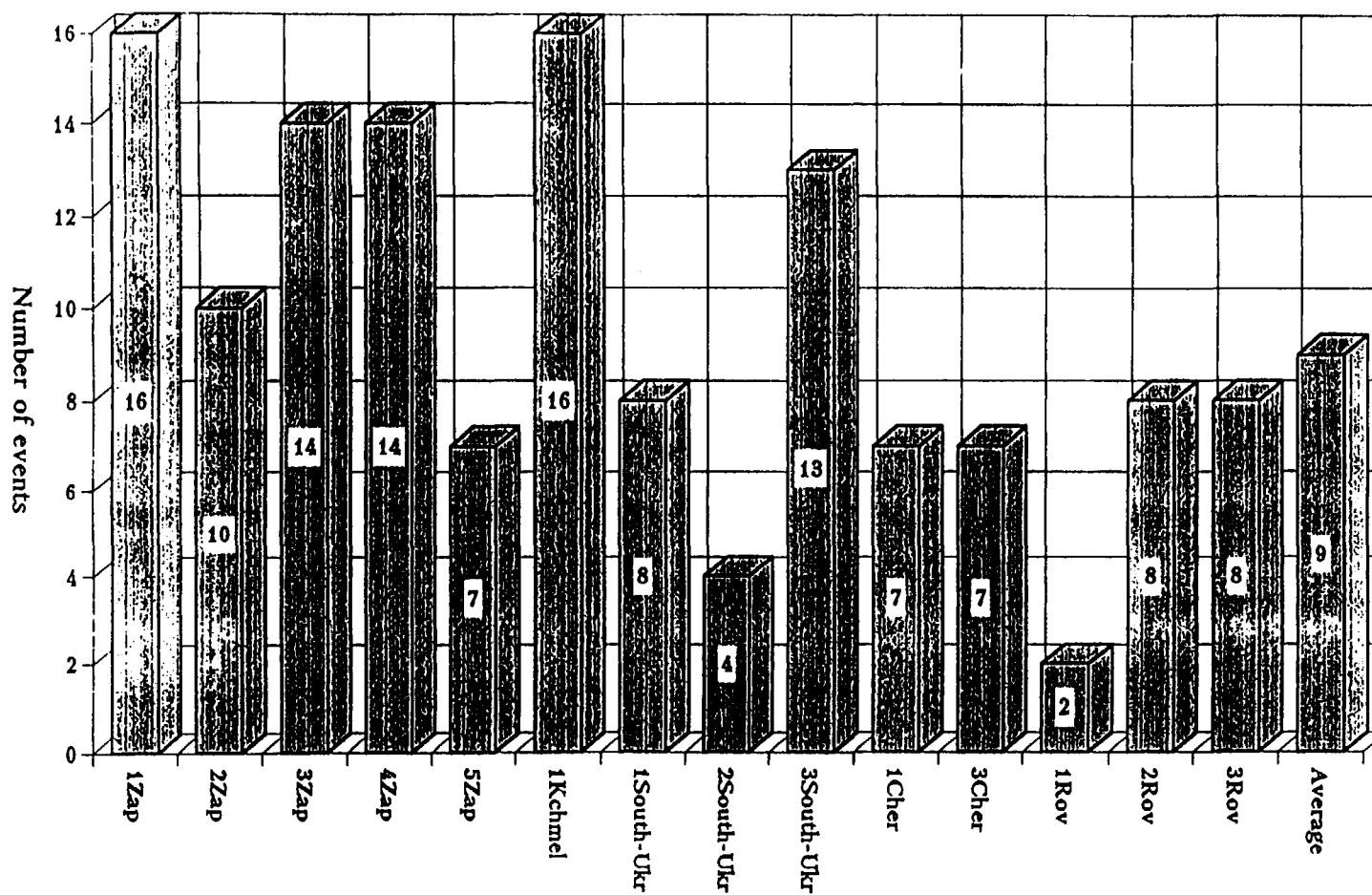


Diagram №2. Event distribution over Ukrainian NPPs in 1992-1994

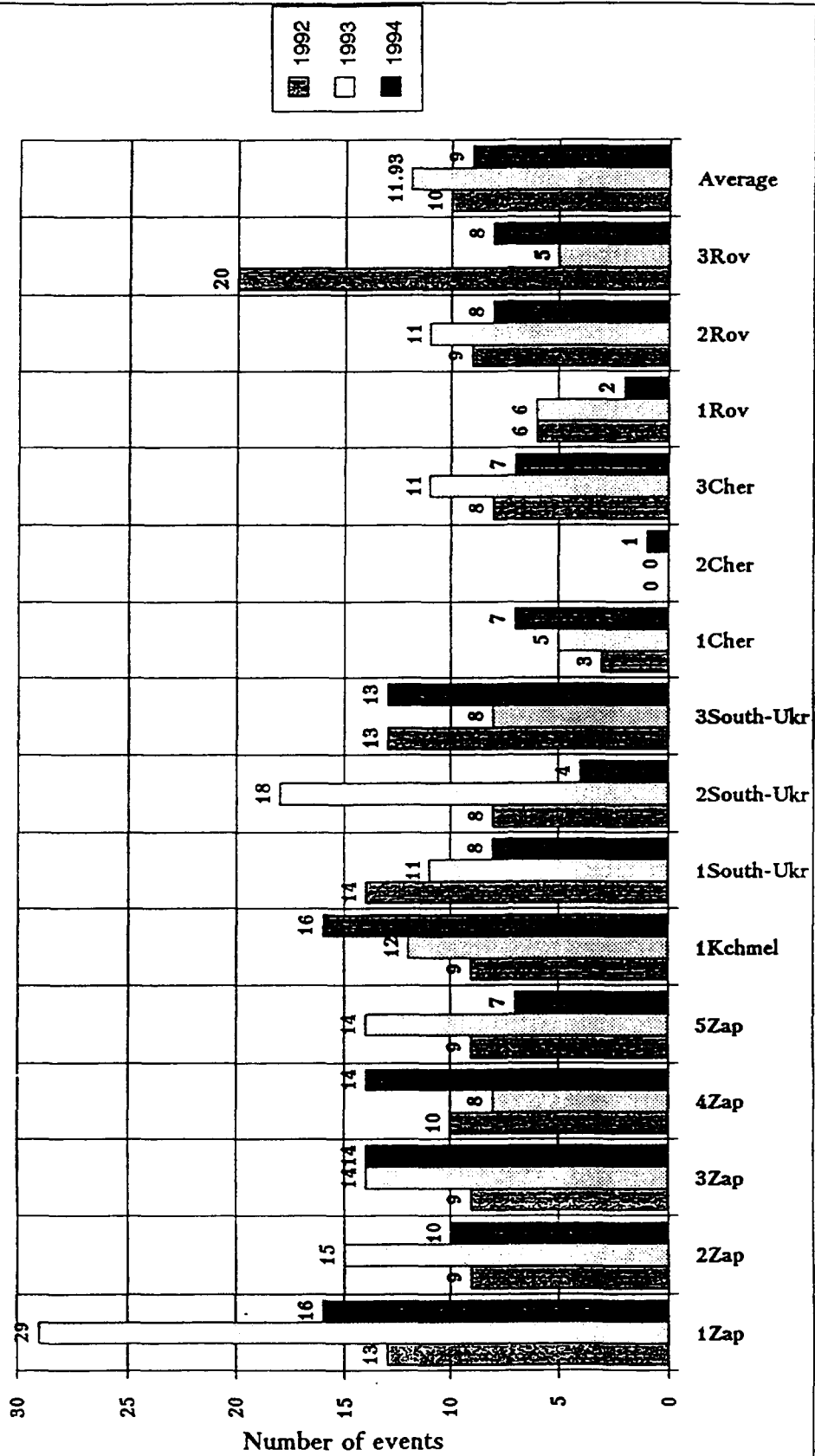


Diagram №3. Event distribution connected with maintenance and repair faults.

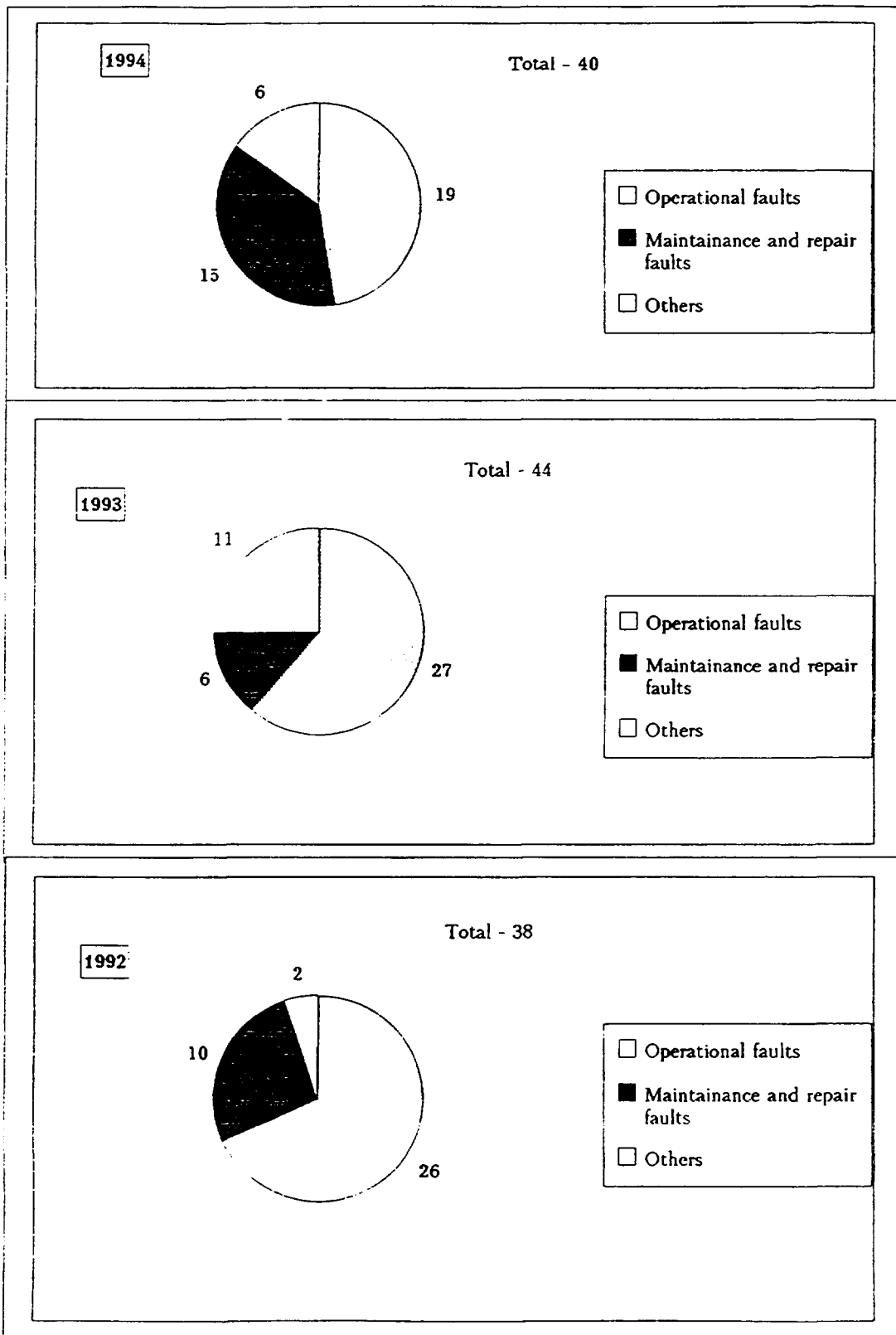
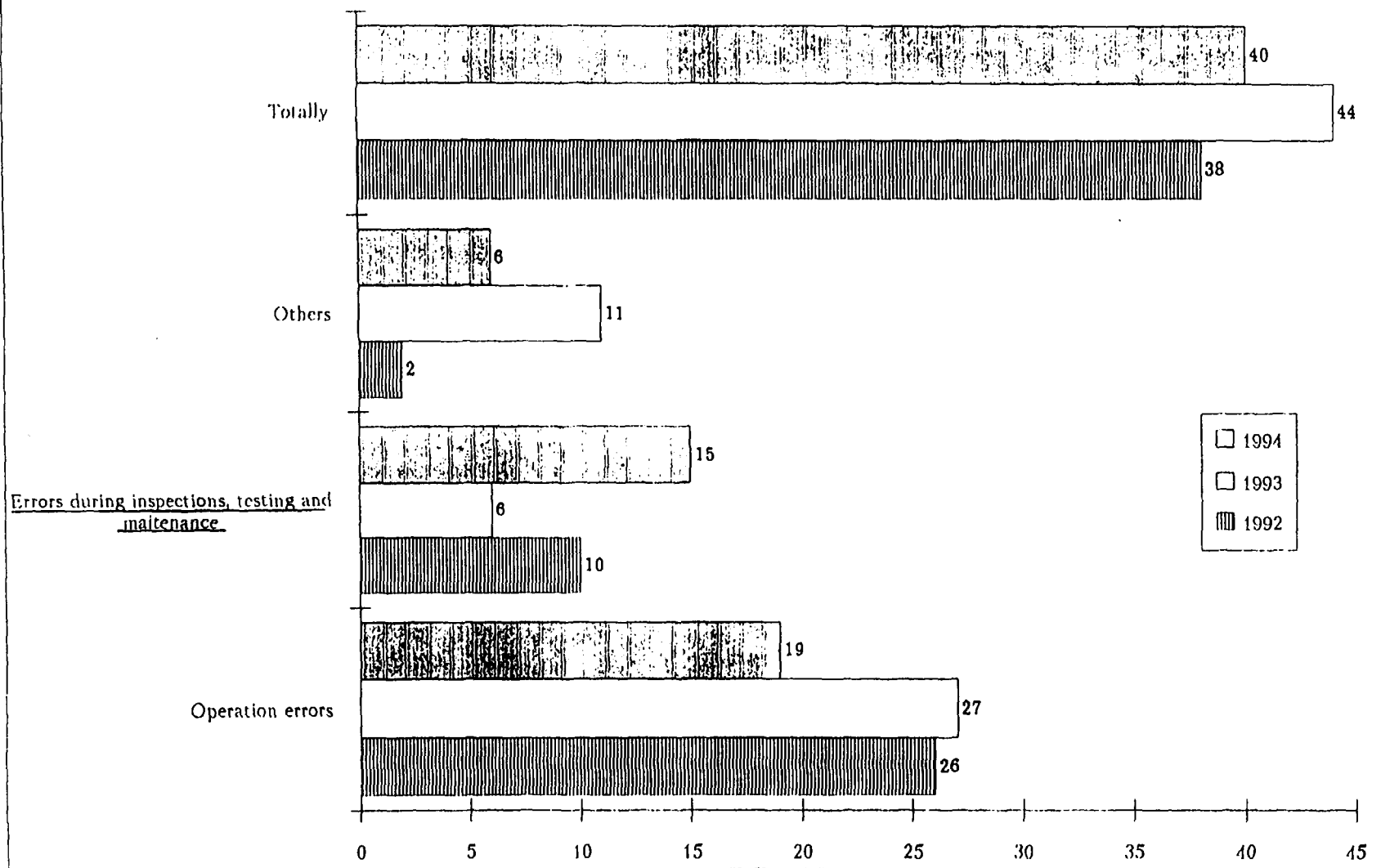


Diagram №4. HE led to initiating or propagating of operation events.



It is calculated by the formula as follows:

$$K = \frac{F}{T_o} \cdot 1000, \text{ where}$$

F - safety-significant systems equipment malfunctions number

T_o - duration of unit operation on-power

They usually include into reports a graph of maintenance quality index quarterly distribution and assessment of its value acceptability. In Table 2 Ukrainian NPPs maintenance quality index distribution is shown.

Maintenance quality indices for 1992-94. Table 2

Unit, Plant	Year		
	1992	1993	1994
1KHM	0.162	0.692	0.443
3RIV	0.685	0.230	0.49
1SUK	0.163	1.239	0.176
2SUK	0.455	1.675	0.155
3SUK	0.301	0.453	0.321
SUK(average)	0.3	1.12	0.22
1ZAP	0.30		0.39
2ZAP	0.14		0.34
3ZAP	0.19		0.49
4ZAP	0.29		0.45
5ZAP	0		0.15
ZAP(average)	0.18		0.36
Average Ukr. NPP	0.33	0.86	0.38

3. Conclusions

It is necessary to solve the following tasks of the most topicality:

- (1) To create the national normative-technical base in a field of maintenance and repair with the use of an international experience;
- (2) To develop the QA programmes in a field of maintenance and repair;
- (3) To create the unified data base on equipment malfunctions while operation;
- (4) To adjust a feedback by operational experience.

It is possible to make conclusions as follows:

- during the last three years a flow of malfunctions connected with safety-significant systems inoperability trends to increase;

- despite of positive trends in safety-significant systems malfunctions account improvement, in-depth analysis is evident of real number of malfunctions sufficiently exceeds their number accountable by existing provisions.

Such a situation is stipulated the causes as follows:

- insufficient controlling by the Regulatory Body;
- lack of clearly formulated criteria of safety-significant system channel malfunction and its boundaries in operational documentation;
- requirements to reports on safety-significant systems malfunctions and those connected with transient processes at NPP are the same;
- insufficiency of malfunctions at NPP accounting system.

Generalization of experience and feedback arrangement require in-depth analysis of those malfunctions, mostly influencing upon safety. In this connection the methods utilizing probabilistic models of operational events and accident sequences are of great interest.

Taking into account the gained experience and considerable PWR integral work duration in Ukraine (more than 100 reactor-years for VVER) VVER operational experience generalization is also of great interest.

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