Research on test method for performance evaluation of RGL system

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Abstract. The performance level of instrumentation control system of nuclear power plant has great influence on the safety and reliability of nuclear power units. Rod control system (RGL) is one of the main control systems of PWR nuclear power plants. In the upstream phase of nuclear power plant overhaul, the RGL rod position channel performance re-evaluation test is the key test of the rod control system. The purpose is to collect the command rod position of the control rod during the rod lifting and inserting period to measure the rod position change. Then calculate the deviation, and then judge whether it is qualified according to certain rules. In this paper, a test system for RGL rod channel performance re-evaluation test is designed, which can automatically calculate the measurement information of all rod positions and automatically determine whether the rod position is out of tolerance. Ensure that the control rods are available during operation.

1. Introduction

During the overhaul and refueling period of nuclear power plant, the RGL rod position channel performance re-evaluation test is needed to check the dynamic response performance and static measurement linearity of the rod position probe, and further adjust the MCP22 threshold voltage if necessary [1]. The control rod assembly is used to start the reactor, regulate the reactor power, compensate for reactivity loss and provide normal shutdown under normal operating conditions [2]. Under the accident condition, the reactor can be quickly inserted into the reactor core by its own gravity, so that the reactor can be shut down in a short time to prevent harmful operation conditions. Therefore, it is necessary and important to measure the rod position information and calculate whether the rod position is out of tolerance in the process of inserting and lifting the control rod assembly (RCCA) at low speed [3].

2. Traditional testing methods

D Rod position measurement channel re-identification, in the process of inserting the control rod, the operator observes the rod position displayed by the MCP30 module, observes the change of the measurement rod position [4], then looks at the rod position counter, reads the current command rod position, in order to read the accurate command rod position, the control rod must be low-speed insertion, the change of the measurement rod position. After recording the measuring rod position and the command rod position, the relationship between them is calculated manually by computer. It needs four people to cooperate with each other to complete a test. The experimenter's experience, level and energy

are very demanding. The experimenter must be familiar with all the details of the test and spend a lot of time preparing for the test, plus the test time has passed. The test personnel need to measure, record and analyze a large amount of data. It is time-consuming, laborious and error-prone to uplift and insert the control rod step by step. Mistakes are also time-consuming. Therefore, this paper develops a bar channel performance appraisal test method based on Labview, which can carry out automatic testing, and calculate the deviation according to certain rules in real time, and give an alarm when it exceeds the set range. The test results can be derived and printed, which greatly simplifies manual work and reduces human error.

3. Functional description

The purpose of the RGL rod channel reevaluation test is to collect the achievement position of the control rod during the measurement position transformation, calculate the deviation, and then judge whether it is qualified according to certain rules. During the reevaluation test of rod position channel, the signals collected by RGL test device include: 16-channel rod group scanning signal Scan, 20-channel measuring rod position signal MP, 12-channel command rod position signal DP., Schematic diagram of repositioning test signal for rod position channel is shown in Fig. 1.

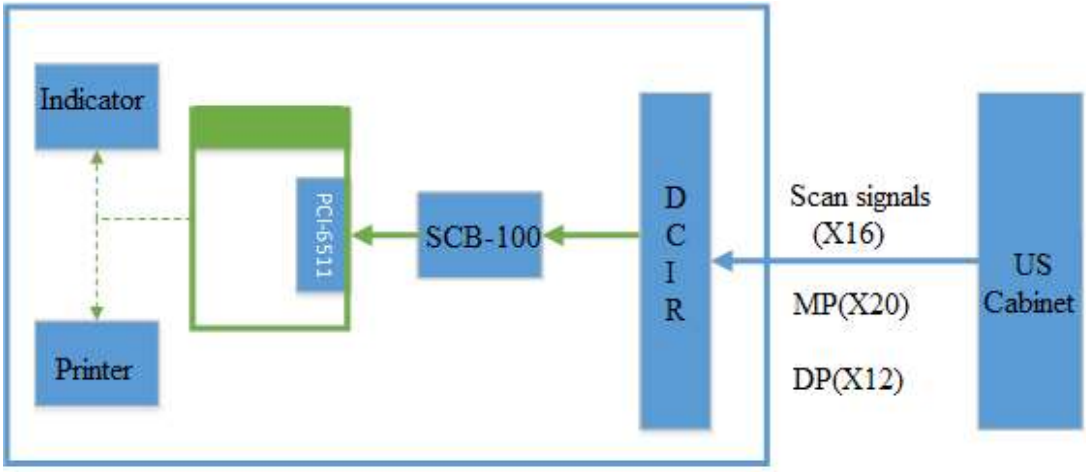

Figure 1. Schematic diagram of signals of rod position channel.

The control rod position feedback is provided in this test system. The position of the control rod and the command position of the control rod should be within a certain error range to make the position of the control rod controllable. The rod control instruction is transmitted to four rod bundles in a bar group each time.

The rod position re qualification test is used to check the linearity of the measuring rod position and the instruction bar position. The test bench needs to measure the following parameters:

- The scanning signal of rod group.
- Measurement position
- Achievement position

The rod position re qualification test is carried out in turn according to the rod group, and the data of 8 control rods can be recorded at the same time:

- The 16 bar group scanning signals are used to identify the corresponding rod group of the current measuring rod position signal.
- 20 measuring rod position signal
- 12 path command bar signal

Each collection thread can only carry out a stick rod test or stick rod test. The rod speed of rod lifting and rod inserting will affect the test results. Generally, 24 steps / minute stick speed test is used.

Data analysis needs to calculate the deviation between the measuring rod position and the instruction bar position, and the deviation calculation methods are as follows:

- GAPmin=DPmin-MP(x);
- GAPmax=DPmax-MP(x);

Taking the R-bar of unit 1 of Daya Bay Nuclear Power Station as an example, all the R-bar speeds of the R-bar after the pull-in test are analyzed as shown in Figure 2.

	H02					B08					H14					P08				
	DP	GAP	DP	GAP	HEP	DP	GAP	DP	GAP	HEP	DP	GAP	DP	GAP	HEP	DP	GAP	DP	GAP	HEP
0	5	5	6	6	-1	5	5	6	6	-1	5	5	6	6	-1	5	5	6	6	-1
0	6	6	6	6	/	7	7	6	6	/	6	6	6	6	/	6	6	6	6	/
8	7	-1	7	-1	0	8	0	7	-1	1	7	-1	7	-1	0	7	-1	7	-1	0
8	13	5	13	5	/	13	5	13	5	/	13	5	13	5	/	13	5	13	5	/
16	14	-2	14	-2	0	14	-2	14	-2	0	14	-2	14	-2	0	14	-2	14	-2	0
16	22	6	21	5	/	22	6	22	6	/	22	6	22	6	/	22	6	21	5	/
24	23	-1	22	-2	1	23	-1	23	-1	0	23	-1	23	-1	0	23	-1	22	-2	1
24	31	7	31	7	/	31	7	31	7	/	31	7	31	7	/	31	7	31	7	/
32	32	0	32	0	0	32	0	32	0	0	32	0	32	0	0	32	0	32	0	0
32	38	6	38	6	/	37	5	37	5	/	37	5	37	5	/	38	6	37	5	/
40	39	-1	39	-1	0	38	-2	38	-2	0	38	-2	38	-2	0	39	-1	38	-2	1
40	45	5	45	5	/	45	5	45	5	/	45	5	45	5	/	45	5	45	5	/
48	46	-2	46	-2	0	46	-2	46	-2	0	46	-2	46	-2	0	46	-2	46	-2	0
48	53	5	53	5	/	54	6	53	5	/	53	5	53	5	/	53	5	53	5	/
56	54	-2	54	-2	0	55	-1	54	-2	1	54	-2	54	-2	0	54	-2	54	-2	0
56	63	7	63	7	/	63	7	63	7	/	63	7	63	7	/	63	7	63	7	/
64	64	0	64	0	0	64	0	64	0	0	64	0	64	0	0	64	0	64	0	0
64	70	6	70	6	/	70	6	70	6	/	70	6	70	6	/	70	6	70	6	/
72	71	-1	71	-1	0	71	-1	71	-1	0	71	-1	71	-1	0	71	-1	71	-1	0
72	77	5	77	5	/	77	5	77	5	/	77	5	77	5	/	77	5	77	5	/
80	78	-2	78	-2	0	78	-2	78	-2	0	78	-2	78	-2	0	78	-2	78	-2	0
80	85	5	85	5	/	85	5	85	5	/	85	5	84	4	/	85	5	85	5	/

Figure 2. Test results of R rods

Look at the history of R rod stick measurement channel as shown in Figure 3.

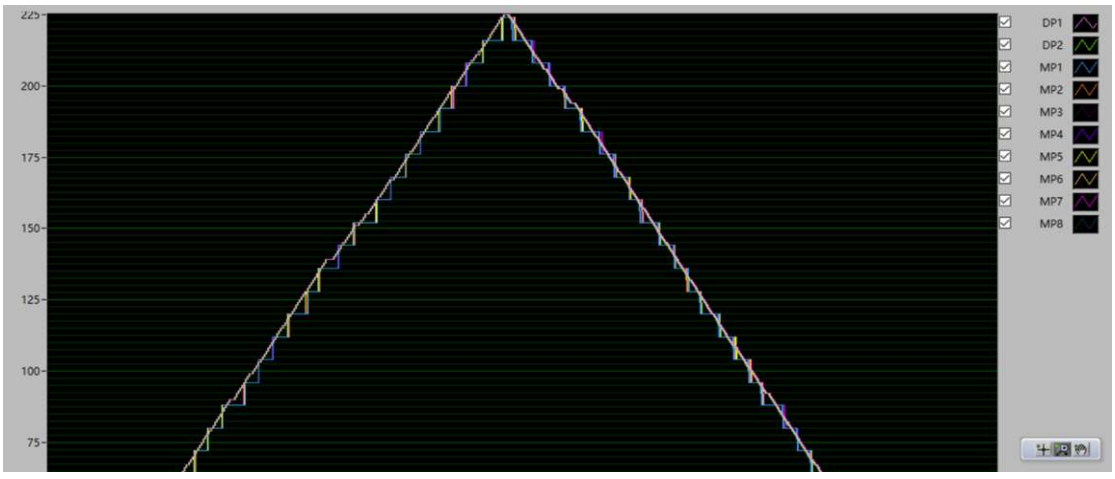

Figure 3. Rod position measurement channel for R rods

The system automatically calculates the measurement information of all rod positions, and can export the test information to Excel table, and automatically judge whether the rod position is out of tolerance.

4. Conclusion

RGL rod channel performance reappraisal test system has been formally used in overhaul work site, which solves the limitation of traditional test methods on personnel experience, level and energy. At present, only familiar with the operation of test equipment can complete the test, but also reduces the number of test, saves time, and reduces the human error induced test. The probability of repetition checking ensures the consistency of test data, the timeliness and reliability of result analysis, and shortens the critical path of overhaul.

References

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