

# Theoretical Study on Operability Test of Solenoid Operated Valve actuator in compliance with IEEE Standards

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## 1. Introduction

Equipment Qualification (EQ) technologies and facilities for all the equipment used in nuclear power plant (NPP) are continuously being developed to be possible to perform independently the EQ test. But some of the equipment such as solenoid operated valve (SOV) actuator has yet experience to perform the EQ test in domestic country.

The SOV, which is an electromechanical valve controlled by an electric current through a solenoid coil, belongs to a power operated valve (POV) like as a motor operated valve and an air operated valve [1]. Normally, EQ test of the POV actuator should be in compliance with IEEE Std 382 together with IEEE Std 323 [2-3]. But the IEEE standards are not clearly presented about EQ test of the SOV. Especially, technical specifications such as a test method, lists and facilities to perform the operability test are the most valuable information for EQ test organizations.

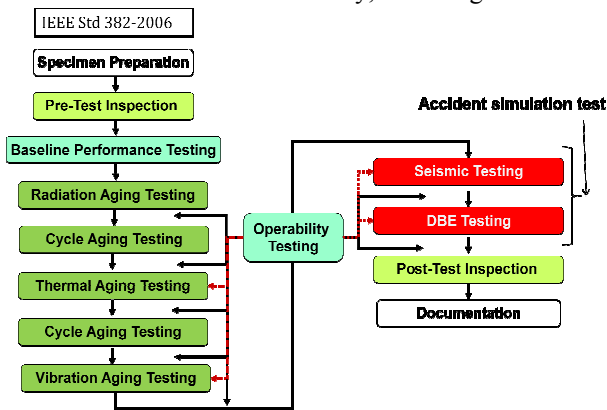
In this study, EQ test procedure of the SOV, the lists and methods of operability test are analyzed to perform EQ test of SOV actuator in compliance with IEEE standards.

## 2. EQ test procedure of SOV actuator

### 2.1 Test Procedure

Equipment Qualification test of the SOV actuator is classified into three categories; Operability test, Normal aging test and Accident simulation test. Normal aging tests include radiation, cycle, thermal and vibration aging test, and Accident simulation test include seismic test and design basis event (DBE) test as shown in Figure 1.

The operability test is normally performed before and after of each tests. Additionally, test stages such as



uator

Thermal aging test, Vibration aging test, Seismic test and DBE test are performed during the test. The baseline operability test performing at the first time of repetitive operability tests establishes reference actuator performance data for comparison with performance at other stages of the qualification test program.

### 2.2 Lists of Operability Test

According to IEEE Std 382-2006, operability test of SOV actuator is presented as below.

- a) **Pull-in voltage** at maximum specified operating pressure drop
- b) **Drop-out voltage** at maximum specified differential pressure and at zero pressure
- c) **Minimum specified operating pressure** at nominal voltage

And the operability tests below are to be recorded once only during EQ test and not repeated for subsequent tests unless required by the actuator specification.

- d) Internal leakage at rated pressure
- e) External leakage at 1.5 times the rated pressure
- f) Test fluid and its quality characteristics
- g) Special application requirements such as response time, duty cycle and flow rate

## 3. Method of operability tests

### 3.1 DC operation voltage test

The pull-in voltage is the minimum voltage at which the solenoid valve can be energized at maximum specified operating pressure drop. The drop-out voltage is the voltage below which the solenoid valve is no longer energized at maximum specified differential pressure and at zero pressure. An increasing or decreasing voltage step by step is subject to the solenoid as shown in Figure 2.

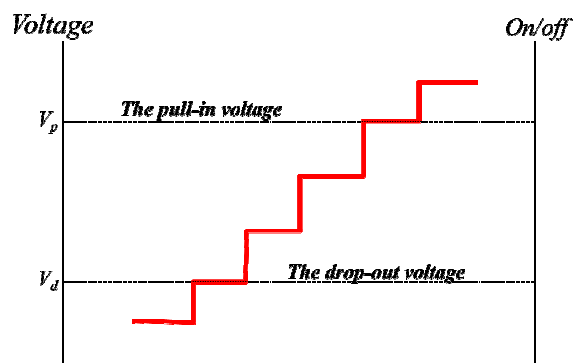


Fig 1. Conception of DC operation voltage test

### 3.2 Specified Operating Pressure test

The specified operating pressure test is performed to measure the minimum pressure at which the solenoid valve can be energized at nominal voltage specified by manufacturer. In testing, the decreasing pressure step by step is subject to valve port at specified voltage.

### 3.3 Leakage test facilities

Internal leakage test is to check tightness of valve seat under rated pressure. External leakage test is to check tightness of gasket and O-ring at 1.5 times than rated pressure. To judge leakage, the number of air bubble or gas detector is used. Test facilities are presented in Figure 3 and Figure 4.

### 3.4 Response time test

The response time test carries out the test at the initiation and completion of the full EQ testing. Response time is a time interval between solenoid power-off time and the time that valve pressure start to decrease as shown in Figure 5.

## 4. Additional Operability Test

Though testing electric characteristic conditions of SOV is not included in operability lists of IEEE Std 382-2006, the change of electric conditions such as electric resistance or dielectric strength effects directly operability of SOV plunger. Dielectric strength test measure the leak current for not less than 1 minute between each power supply cables and SOV shell under the high voltage (e.g. 2500 Vac). Insulation resistance test measure the resistance the same position.

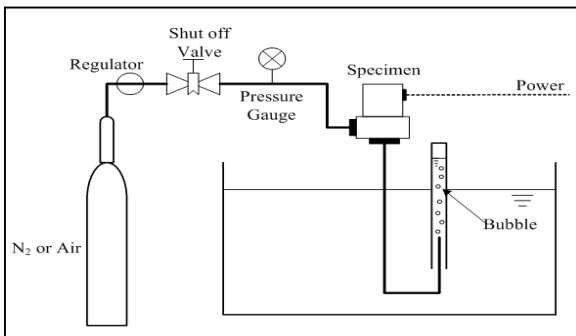


Fig 3. Internal leakage test schematics

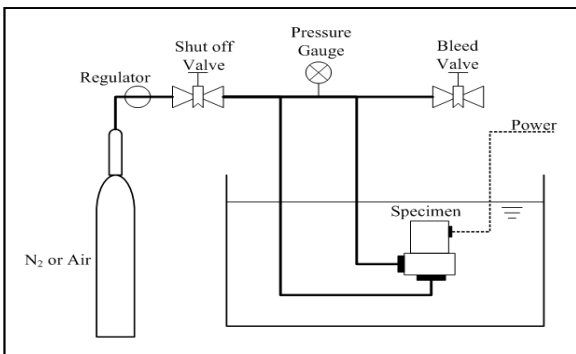


Fig 2. External leakage test schematics

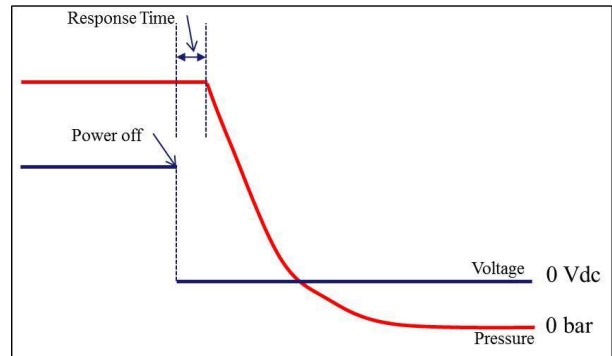


Fig 2. Conception of response time test

## 5. Conclusions

This paper studied the followings about the EQ test of SOV actuator used in NPP.

- 1) EQ test procedure of SOV in compliance with IEEE Std 382-2006
- 2) Lists and method of the operability tests
- 3) Additional operability test

This research might be considered to be very valuable technical information for new developer or EQ test organization of SOV.

## 6. Acknowledgment

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## REFERENCES

- [1] B.J Lim, C.D Park, C.S Song, Study on Equipment Qualification Technology of MOV actuator for Continued Operation (2007).
- [2] IEEE Standard for Qualification of Safety-Related Actuators for Nuclear Power Generating Stations (2006)
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