# Status of Functional Qualification System for Nuclear Valve Assembly in KIMM

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## 1. Introduction

Generally, the valve used in nuclear power plant is required for the functional test as ASME QME-1 [1,2,3]. This test confirms that the safety related function of the valve is proper in design basis condition such as high pressure, high temperature, high radiation and design extended condition. The measured performance parameter, such as pressure [4], temperature, flow rate, thrust, stroke, and time, is used for the maintenance method and the evaluation of the aging and fatigue in the operating valve [1,2,3]. In these days, the survival of the safety related valve in severe accident is important issue.

In Korea Institute of Machinery & Materials (KIMM), the functional facility and related Quality Assure (QA) system are made. In addition, the qualification research was made for the functional test of the valve as ASME QME-1. The methodology is based on the ASME QME-1 1997. But the future work for the ASME QME-1 2007 was performed. In real situation, the engineering work is needed for the functional test of the nuclear valve in QA system. So the research work for the qualification is needed.

In this paper, the status of the test facility, the basic concept of the ASME QME-1 test, and the future work are presented.

## 2. Characteristic of test facility

**Steam supply :**

A facility for creating flow conditions such as the valve installed in the nuclear power plant. Equipment consists of a boiler and a pressure tank, it is possible to use up to 200 bar, 360 ℃. Technically, to raise and maintain the pressure in the inlet of the test valve, two method can be used. First method is to supply enough fluid to the valve and second method is to lower the supply pressure of the high pressure steam through the pressure reducing valve. And the pressure are adjusted using the 14, 2, 1 inch valves. In this case it requires a precise pressure control. Each of the valves adjusts the pressure by the Delta PLC, and the control based on the set value sent from the master controller (LG PLC).

**High temperature and high pressure piping:**

The test valve is installed into the pipe and flowmeter, pressure gauge, and a thermometer are additionally installed.

Fig 1. Steam supply

Fig 2. The High pressure pipe

**Valve diagnostic equipment**:

This is an instrument for checking the operability of the examination of the test valve. The measurements are the pressure, temperature, flow rate, thrust / torque and displacement.


Fig 3. Valve diagnostic equipment

**The master controller:**

The controller manages and organizes the test facility. The main function is to set the target pressure in the pressure reducing valve of the steam generator, and to

gives an operation signal, which is applied to the specimen. In addition, the master controller is used to manage the signals related to the operation of the test valve and the control valve, and to check the flow rate information. This master controller is connected by communication with the slave controller independent to each device. However, the master controller does not include the measurement related to the performance of the valve.

## 3. Characteristic of test

In this chapter for the subject is the engineering characteristics and significance of the test [1,2,3].

**Leakage test:**
The purpose of this experiment, a test for comparison of the amount of leakage from the actual measured values with the specification of the power plant designers. There are the two types of test, the Main seat leak test performed by the maximum differential pressure and, stem-shaft to perform a cold working pressure(CWP) that is determined depending on the material [1,2,3,4]. The leakage is generally directly related such as of non-metallic packing material and a spring constant. So, the valve manufacturer has to select a suitable material.

**Fundamental frequency determination test:**
This test is to measure the natural frequency of the valve assembly and to compare with the requirements of the specification. In the South Korea it is required that the first natural frequency is more than 33 Hz. The test method is using the FFT method, or using a vibration table. If the detected natural frequency is less than 33 Hz, ASME QME-1 has required to the another test according to IEEE 382. However, the domestic require to re-design the valve with new model.

**Environmental and aging simulation test:**
All non-metallic material used for the valve assembly is should be tested of aging and environmental accidents to heat, radiation, abrasion according to ASME QME-1 QR-B. And the accessories are to be pre-verified in accordance with the environmental conditions to be used.

**Cycle test:**
This test is to determine the reliability and operability while a static pressure to the fluid valve assembly is applied. At this time, the measuring of time, displacement and temperature is performed and the operability is evaluated. At this time, the resulting force due to the fluid force, the friction force and its own weight is all considered.

**End-loading tests:**
The test is to confirm the operability of the reaction forces occurring in the piping connected to the valve assembly. In this test the applied pressure is CWP and the loading moment, which is applied to the valve assembly, depends on the material and size of the pipe. The test valve assembly is to deformed by moment force. Therefore, a leakage test is performed after this test.

**Seismic (static) test:**
The test is to perform if the primary natural frequency is greater than 33 Hz. It applies that static force is determined by the mass of the seismic acceleration and the weight of the valve assembly. At this time, the fluid pressure applied is a selection pressure for verification.

**Flow interruption and functional capability demonstration test:**
This test intends to verify the ability of the valve assembly to open or close against substantial flow which can cause large dynamic fluid forces on the valve disk, which the actuator must overcome. Actuator should give maximum thrust required for the valve operation. In this test, the thrust, the pressure, displacement, temperature, and flow rate are measured and the flow interruption capability is evaluated.

## 4. Future Work

Now, the functional test of power operated valve (POV), check valve (CV), and pressure relief valve (PRV), which come from the domestic area, was in the process in KIMM. And the plan and related work for the operation test of main steam safety valve (MSSV) and pressure safety valve (PSV) in the operated nuclear power plant are progress. The facility for MSSV and PRD in KIMM is enough to the test. The capable size of valve is 16 inch, 8 inch, 6 inch, 4 inch, 1 inch. The pretest for MSSV and PRV are already performed in KIMM.

Currently, the functional test of the active valve was performed as ASME QME-1 1997. The test valve is selected by grouping the target valves using the design similarity. The valve, which is called parent valve in ASEME QME-1, except the test valve can be evaluated by the similarity analysis.

But the similarity analysis for the production active valve is not enough and in short of validity. So in the ASME QME-1 2007 revision, all the production active valve are required of the static diagnosis test and dynamic diagnosis test. The standard of ASME QME-1 2007 is equivalent to the KEPIC MF-2010, which is referred in NRC Regulatory Guide 1.100 Rev. So the new built nuclear power plant requires of the strong application of the functional qualification by ASME QME-1-2007 to the active equipment after the accident of fukushima daiichi nuclear power plant and of requirement of the safety confirmation of air operated valve (AOV) and GL-89-10. This experience changes

the ASME QME-1 1997 and the main agent of the functional qualification is free and extended. And the efficient method is needed. In addition, the publication of the qualification specification is obligatory and the periodic check is the requirement of the law.

Based on the strong application of the technical standard for the functional qualification of the active vale, the development and verification of the methodology, such as test and test based analysis, are in serious condition. The detail of the development and verification are as follows,

- The development of the test manual and procedure according to new functional qualification requirement based on the strong technical standard ( ASME QME-1 2007)
- The selection of the performance parameter related to the valve operation based on the new technical standard such as KEPIC MF-2010 (ASME QME-1-2007).
- The methodology of measurement and analysis of the performance parameter such as thrust, stem position, stroke, and stroke time.
- The calculation and evaluation of the required thrust and survival thrust, and margin
- The development of the flow analysis method according to the function of the valve opening and the related verification method
- The development of the functional qualification method for the large size valve, which cannot be tested in the current facility, which is the application of the flow analysis method.

## 5. Conclusion

The functional qualification of the valve in the nuclear power plant is performed in KIMM

The development of the research and facility required in the functional qualification is in progress.

Now the functional qualification is possible domestically, that was impossible in previous time due to the lack of qualification technology and facility.

## REFERENCES

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