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"Operational Aspects, Results and Problems Associated with R/B Testing at Gentilly 2."

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HYDRO-QUÉBEC
CANADA

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1 INTRODUCTION

There are many methods, some more complex or difficult to deal with than others, to verify the containment building integrity. At G-2, we chose the temperature compensation method.

Our selection criterias were:

1) the greater precision of this method
2) the possibility of executing the test with the plant running at full power
3) short period required for the test
4) After the technique is understood, its simplicity of execution
5) Can be easily inserted in the normal operating test program with a minimum of personnel
6) this technique can be used at both low and high pressure

In this presentation we will succintly discuss the different phases of the technique such as: the background, the prerequisite, the problems, the results and, finally, we will give some recommendations to facilitate the use of this method.

2 BACKGROUND

In 1987, during a leakage rate test at 125 KPa(g) we observed (detected) an abnormal degradation of the leaktightness of the containment. After discussions with the regulatory authorities (A.E.C.B.) we worked on developing an integrity test. The purpose of the test was and still is to give assurance that, anywhere around the building, no valves are left open accidentally. To stay within reasonable limits, we fix the size of those potential valves at 2.5 cm of diameter.

Also, we developed that particular technique of investigation so that we could do the test while the reactor is running at full power, without affecting the safety and the operation of the plant.

In order to do so, we made sure to fix the test pressure at 3 KPa(g), which is slightly below the set point of the safety shutdown system. It was not necessary to modify those specific set points to do the test and this element is of importance because we especially did not want to put ourselves in a non-analyzed state. We cannot predict what would happen if, during the test, a LOCA occurred, and what would be the difference of pressure between the calculated value after an accident if we start to pressurize to 0 KPa(g) or at 3 KPa(g).

3 PREREQUISITE

As we were saying earlier, the integrity test must be executed while the plant is running at 100 % full power. But, in order to avoid incidents or even accidents, we must be very careful during the preparation of the test with the following:

1) Start up of the data collection system.

2) Verification of all the instruments related to the test.

3) Adjustement of the humidity network.
   This specific parameter has the greatest effect on the error calculation. Because all the instrumentation is located in accessible areas with heavy traffic, we must absolutely verify the adjustment before each test.

4) Verification of the leaktightness of the temperature compensation network.
   Because of the precision of the T.C.M., the length of the network and the fragility of the network welds, we must verify, before every test, the leaktightness of the network. This verification consists of achieving absolute vacuum of the tubing (0 to 1 militorr or 0 to 0.1Pa (absolute)). After that, we must verify the pressure increase. It must not exceed 20 militorrs per hour (2.6 Pa/hour).

5) The last point to (verify) is the running of the instrument air temporary compressors.

Still, because of the T.C.M. precision, we must prevent any unexpected feed of gas inside the containment building. The compressed gas system (Helium, Carbonic gas, Hydrogen and Nitrogen) have such a small consumption that it is easy to measure those leaks with good precision.

But the instrument air distribution system can be a problem because the normal leak of the instrument purge is 10 times higher than the maximum allowed leak, at 124 KPa(g). I leave to your imagination what is the effect at 3 KPa(g)...

Yet, we didn't find any method permitting the measurement with a good accuracy and a practical way to comptabilise that leak.

To solve the problem, we modified the intake of the instrument air network in such a way that the suction of the compressor would take the inside air of the reactor building. In doing so, we prevent the infiltration of any outside and unknown air.

We also needed to regulate the compressing cycle of the compressor to prevent the peak of the pressure measurements during the integrity test. This minimizes the peaks in the instrument air system as well as in the integrity test pressure.

4 INSTRUMENTATION AND TEST DESCRIPTIONS

4.1 INSTRUMENTATION

The basis of the temperature compensation method is to use a reference volume inside the reactor building which consists of a tubing network going all around the building with a constant weighting factor related to the size of the room in which the tubing is located. The total volume of the network is about 25 liters that is a scale factor of approximatively 0.5 millionth of the total free volume of the containment.

The calculation is based upon the perfect gas law. The parameters which are to be measured during the test and must satisfy the basic equations are: the atmospheric pressure, the reactor building pressure, the differential pressure between the containment and the tubing network, the temperature compensation network pressure and its vacuum gauge. All those variables are connected to a data collection system.

4.1.1 ATMOSPHERIC PRESSURE

The barometric pressure is an additional information on the effect of the atmospheric pressure variation on the test pressure. The barometer takes its reading outside the roof of the Service building by a 0-200 KPa MENSOR, model 11900, barometer.

4.1.2 R/B PRESSURE

We must continuously measure the differential pressure of the reactor building (reference is with the outside of the building) due to the fluctuation of the atmospheric pressure, the leaks from the reactor building to the outside and to the increase of the dew point. A 0-200 KPa MENSOR (model 11900) is connected to the reactor building through a 9 mm spare tubing and the reference is connected outside the Service Building roof.

To increase the accuracy of the test pressure reading it would be preferable to use a manometer with a lower range.

4.1.3 DIFFERENTIAL PRESSURE BETWEEN R/B AND TCM NETWORK

A low range manometer (0-7 KPa) installed inside the R/B is used to measure the inside pressure change due to the leaks, and the variation of the dew point of the air inside the containment. The instrument used to measure that differential pressure in a MENSOR manometer (model 11900) connected on the pressure side to the T.C.M. tubing when the reference of the instrument is opened to the atmosphere of the R/B.

4.1.4 DEW POINT

Beside the leaks (in or out of the R/B) the vapor pressure coming from all liquid sources in the containment affects the total pressure of the air inside the R/B. This parameter is measured through a network which draws air from different rooms of the building to a chilled mirror installed inside the building.

The hygrometer measures the dew point of the air sample and the treatment program gives the equivalent vapor pressure. This hygrometer is a "GENERAL EASTERN" (model hygro M-1) with a range from -20° to +25° C.

4.1.5 TEMPERATURE COMPENSATION TUBING PRESSURE

This information helps us to check the reactor building temperature. The temperature of the T.C.M. tubing is directly affected by the temperature inside the R/B. However, the treatement program converts pressure variation into temperature variation. There are still three (3) R.T.D. used to give the initial temperature reading, a MENSOR 0-250 KPa barometer is used for that.

4.1.6 HUMIDITY NETWORK PRESSURE

A "Rosemount" pressure transmitter is used to read and transfer the pressure of that humidity network to the data collection system. This measurement is necessary because the pump suction created an error on the dew point reading. The program is built to use that pressure to correct the vapor pressure table at the test pressure.

4.1.7 DATA COLLECTION SYSTEM

Each instrument is connected to a microprocessor which, every 15 seconds, records the instrument reading and, every two (2) minutes, determines the average reading. That is done in the front mode of the program. In background mode, all the calculation, graphics production and results are done. Therefore, the results are always available during the test.

4.2 TEST

Now I will shortly describe what happens during the four (4) different steps of the test. First we pressurize for about forty-five (45) minutes to increase the inside pressure of the R/B to the test pressures (2.75 KPa). Next, during a six (6) hour period, we monitor the pressure variation of the T.C.M. tubing network and we transfer that to what we call an "unknown leak". Third, during a five (5) hour period, we create a known leak through a predetermined hole and we monitor the pressure change of the T.C.M. That verification confirms there are no gross errors in the test. Fourth and last, we depressurize the containment for at least 15 minutes.

As you can see, this test is very simple and only requires that you stay awake for <u>one night</u> during a week-end.

5 PROBLEMS

During the 1990 full pressure test we had to dry the R/B air (24 hour period) to prevent any condensation on the equipment inside the building during the depressurization. After that drying period, the dew point was as low as -18° C to reach -15° C at the end of the pressurization period to 2.75 KPa. The dew point meter range is -20° to +25° C. As we were near the low part of it, we experienced lot of problems with the precision of the measure. To prevent that we start with the dew point between -5° to +5° C.

A greater than normal atmospheric pressure variation gave us nightmares; we started at 101.5 KPa and finished at 102.0 KPa, creating a drop of 0.5 KPa in the tubing pressure (2.30 KPa to 1.80 KPa).

That pressure variation had a direct effect on the error and to prevent it the test should be done in a relatively stable atmospheric period as given by the meteorologist.

6 TEST RESULTS

At the 1989 test at 2.75 KPa we had measured a 39.36 slm after an eight (8) hour period. That leak was the equivalent of a leak through a 3.5 mm orifice. This result had been verified by creating a 16.23 scfm leak (2.3 mm orifice) during a five (5) hour period with an error less than 5 % of the known leak.

The 1990 test results were not what we expected because of all the problems that we had been having, as discussed previously. At 124 KPa the results were so that after only two(2) hours of reading, we knew the leak rate, but we had to run the test for a longer period due to the other method used in parallel to the T.C.M.

After eleven (11) hours, the leak rate was 0.77 % of total free volume/day with a .31% error of that value that corresponds to a six (6) mm hole.

7 RECOMMENDATIONS

To have a very good precision in the vapor pressure reading we must arrange the R/B dew point to be in the range of -5° to +5° C so the dew point meter will operate at maximum precision.

To prevent large atmospheric pressure change from directly affecting pressure measurement, we must plan the test using meteorologist information.

To increase the precision of the inside pressure reading VS the outside pressure reading, it would be preferable to use a low range manometer, a 0-7 KPa instead of a 0-200 KPa.

8 CONCLUSION

At the end, the T.C.M. is very precise and it helps us to verify easily the integrity of the containment building. We also can use that method at high pressure and it allows us to reduce significantly the leak rate period.