DUKE POWER COMPANY

MCGUIRE NUCLEAR STATION

UNIT 2

ADDENDUM TO THE
REACTOR CONTAINMENT BUILDING
INTEGRATED LEAK RATE TEST

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INVESTIGATION OF CONTAINMENT DEVIATIONS FROM "AS FOUND" CONDITIONS

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Unit 2 Integrated Leak Rate Test
Addendum

SYNOPSIS

An investigation was performed to assess the condition of the McGuire Unit 2 containment prior to maintenance during the EOC-2 outage. The results of this investigation, along with the total containment leak rate measured by the Integrated Leak Rate Test performed in May 1986, were used to calculated the "as found" containment leakage.

Containment integrity requirements at McGuire define the maximum leak rate (L_A) as 0.30% of the containment air mass per day. This converts to 135,920 SCCM.

A total leak rate savings of 96,112 SCCM was determined by the investigation. The total containment leak rate measured by the ILRT, (L_{AM}) was 0.08371% mass per day, or 37,930 SCCM. The total improvements to containment integrity made during the outage (e.g., savings) plus L_{AM} equals 134,042 SCCM, which represents the "as found" leak rate.

Comparing the conservatively calculated "as found" containment leak rate to L_A yields the following conclusions:

- A challenge of the "as found" containment by a design basis accident would not have resulted in leakage exceeding L_A.

- The present containment integrity program is adequate for maintaining acceptable leak rates.

EVALUATION

The first surveillance Integrated Leak Rate Test (ILRT) was performed for McGuire Unit 2 during the EOC-2 outage. Prior to the outage, the need to pretest containment isolation valves before maintenance to assess ILRT impact had not been identified. Thus, a review of penetration maintenance histories was performed to quantify the leak rate improvements (or "savings") made prior to the ILRT. The leak rate measured during the ILRT plus savings gives the "as found" total containment leak rate.

The first step in determining the "as-found" containment leak rate was to identify all outage maintenance on penetration components performed prior to the ILRT. No work was identified for any electrical penetration. The results of this survey for mechanical penetrations are given in Table 1.

All the work identified was then evaluated for possible impact on component leak rate. Thirty-nine penetrations were subject to at least one work request (WR). Of these, fifteen penetrations had WRs which involved only electrical circuitry and could not have improved the valves' leakage. On twenty-four penetrations work was done which could produce leakage savings.

In order to calculate the impact of work on a particular penetration, the minimum thru-path leakage before and after the work were compared. For penetrations with work performed on only one side and no pretest data, the leak rate of the undisturbed side was conservatively assumed to be the "before" thru-path leak rate. If the post-maintenance thru-path leak rate was less than this value, the difference was reported as savings. If this approach was applied to a penetration whose originally tighter side had been worked on, the calculated savings would be greater than actual, a conservative error.

Twenty-one penetrations either had only one containment isolation valve worked on or adequate pretest data existed so that an "as-found" minimum pathway leakage could be determined. Table 2 shows the leakage savings determined for each of these twenty-one penetrations as well as the airlock and equipment hatch data. Three penetrations had work done on both sides of containment. Each of these penetrations is analyzed in the Appendix.

The savings calculated for all penetrations is 96,112 SCCM, with one penetration contributing approximately 98% of the total. Leakage measured during the ILRT is equivalent to 37,930 SCCM. Summing the calculated savings and the ILRT leak rate gives a conservative "as found" total containment leak rate of 134,042 SCCM.

Following all outage maintenance, the total containment leak rate for Type B and C penetrations was calculated to be 4192 SCCM. A breakdown of these "as left" values is given by Table 3.

Comparing the above values to the "as found" acceptance criteria of 135,290 SCCM (L_A) and the Type B and C penetration surveillance limit of 81,552 SCCM (0.6 L_A) demonstrates the following:

- degradation of the containment leak rate during the surveillance interval did not cause limits to be exceeded.

- the "as left" leak rate is well below surveillance limits, allowing ample margin for degradation during the following surveillance interval.

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M118	2MNSPT5070	86695	N
	2MNSPT5390	66024	N
		86695	N
	2MNSPT5520	66024	N
		86695	N
	2MNSPT5530	93813	Y
M118A	2MMIMV6980	951122	Y
	2MMIMV7010	None	N/A
M118B	2MMIMV6990	None	N/A
	2MMIMV7020	None	N/A
M118C	2MMIMV7000	None	N/A
	2MMIMV7030	None	N/A
M119	2MVPMV0015	None	N/A
	2MVPMV0016	None	N/A
	2MVPPX5240	None	N/A
M138	2MVPMV0019	None	N/A
	2MVPMV0020	None	N/A
	2MVPPX5600	None	N/A
C152	2IACV5350	None	N/A
	2IASV5160	None	N/A
M212	2MNCEV0540	93879	Y
	2MNCEV0530	None	N/A
M213	2MVPMV0017	None	N/A
	2MVPMV0018	None	N/A
	2MVPPX5250	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M215	2MVBMV0049	93632	N
	2MVBMV0050	None	N/A
	2MVBMV0051	None	N/A
M216	2MNCMV0057	None	N/A
	2MNCMV0056	None	N/A
	2MNCMV0120	None	N/A
M219	2MVSMV0012	93632	N
	2MVSMV0013	None	N/A
	2MVSMV0025	None	N/A
M220	2MVIMV0129	93632	N
	2MVIMV0040	None	N/A
	2MVIMV0284	None	N/A
M221	2MWLMV0321	None	N/A
	2MWLMV0322	None	N/A
	2MWLMV0385	None	N/A
M235	2MNMMV0003	None	N/A
	2MNMMV0006	None	N/A
	2MNMMV0007	93632	N
	2MNMMV0420	None	N/A
M239	2MNSPT5060	86695	N
	2MNSPT5510	86695	N
	2MNSPT5380	66024	N
		86695	N
M239A	2MMISV6870	65525	N
	2MMISV6890	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M239B	2MMISV6880	65525	N
	2MMISV6900	None	N/A
M239C	2MMISV6910	65528	N
		86710	Y
	2MMISV6930	None	N/A
M239D	2MMISV6920	65528	N
		86709	Y
	2MMISV6940	None	N/A
M240	2MRVMV0032	86708	Y
	2MRVMV0316	None	N/A
	2MRVMV0033	None	N/A
	2MRVMV0130	None	N/A
M243	2MVQMV0001	None	N/A
	2MVQMV0002	None	N/A
M259	2MNBMV0260	None	N/A
	2MNBMV0261	None	N/A
	2MNBMV0262	86707	Y
M279	2MRVMV0076	None	N/A
	2MRVMV0077	None	N/A
	2MRVMV0126	None	N/A
	2MRVMV0317	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M280	2MNMRV0069	None	N/A
	2MNMMV0072	None	N/A
	2MNMMV0075	None	N/A
	2MNMMV0078	None	N/A
	2MNMMV0081	None	N/A
	2MNMMV0082	None	N/A
M307	2MRNMV0252	None	N/A
	2MRNMV0253	None	N/A
	2MRNMV0451	None	N/A
	2MRNMV0886	None	N/A
M309	2MNMMV0022	93865	N
	2MNMMV0025	93865	N
	2MNMMV0026	93632	N
		93866	N
	2MNMMV0421	None	N/A
M313	2MNSPT5050	86695	N
	2MNSPT5500	66024	N
		86695	N
	2MNSLP5370	66024	N
		86695	N
M315	2MRNMV0276	None	N/A
	2MRNMV0277	None	N/A
	2MRNMV0452	None	N/A
	2MRNMV0881	None	N/A
M317	2MVIMV0124	None	N/A
	2MVIMV0150	93632	N
	2MVIMV0378	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M320	2MKCMV0279	None	N/A
	2MKCMV0424	048715	Y
		93833	N
	2MCKMV0425	048697	Y
		93833	N
M321	2MNIMV0095	65732	N
		93632	N
		93836	N
	2MNIMV0096	65732	N
		93632	N
		93836	N
	2MNIMV0120	65732	N
		93632	N
		93836	N
		122423	Y
	2MNIMV0436	None	N/A
	2MNIMV0046	None	N/A
M322	2MKCMV0047	86725	Y
	2MKCMV0429	93833	N
	2MKCMV0430	93833	N
M323A	2MMISV5580	None	N/A
	2MMISV5581	65525	N
M323B	2MMISV5582	None	N/A
	2MMISV5583	65525	N
M325	2MVXVM0030	None	N/A
	2MVXMV0020	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M326	2MNCMV0141	None	N/A
	2MNCMV0142	None	N/A
	2MNCMV0261	None	N/A
	2MNCMV0154	None	N/A
M327	2MKCMV0338	048698	Y
		93833	N
	2MKCMV0339	None	N/A
	2MKCMV0340	None	N/A
M330	2MNIMV0048	None	N/A
	2MNIMV0047	65732	N
		93836	N
	2MNIMV0107	None	N/A
M331	2MVEMV0010	None	N/A
	2MVEMV0011	None	N/A
	2MVEMV0012	None	N/A
M337	2MYMMV0115	None	N/A
	2MYMMV0116	None	N/A
	2MYMMV0124	None	N/A
M342	2MNVMV0849	None	N/A
	2MNVMV1001	None	N/A
	2MNVMV1002	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M348	2MNIMV0264	65732	N
		93836	N
	2MNIMV0265	None	N/A
	2MNIMV0266	65732	N
	2MNIMV0267	65732	N
		122319	Y
	2MNIMV0466	None	N/A
M353	1MRFMV0832	None	N/A
	1MRFMV0833	None	N/A
	1MRFMV0834	None	N/A
M355	2MKCMV0332	048733	Y
	2MKCMV0333	None	N/A
	2MCKMV0280	None	N/A
M356	2MWEMV0013	None	N/A
	2MWEMV0014	None	N/A
	2MWEMV0023	None	N/A
M357	2MVPMV0006	None	N/A
	2MVPMV0007	None	N/A
	2MVPPX5200	None	N/A
M358	2MFWMV0011	None	N/A
	2MFWMV0012	None	N/A
	2MFWMV0013	None	N/A
	2MFWMV0063	None	N/A
M359	2MVIMV0160	93632	N
	2MVIMV0161	None	N/A
	2MVIMV0282	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M360	2MWLMV0039	None	N/A
	2MWLMV0041	86703	Y
	2MWLMV0389	None	N/A
M361	2MNCMV0195	048704	Y
	2MNCMV0196	054316	Y
	2MNCMV0259	None	N/A
M367	2MVPMV0001	None	N/A
	2MVPMV0002	None	N/A
	2MVPPX5180	None	N/A
M368	2MVPMV0010	86837	Y
	2MVPMV0011	86898	Y
	2MVPPX5220	None	N/A
M372	2MNFMV0233	None	N/A
	2MNFMV0234	None	N/A
	2MNFMV1051	121985	Y
M373	2MNFMV0228	None	N/A
	2MNFMV0229	None	N/A
	2MNFMV0231	048735	Y
	2MNFMV0959	None	N/A
M374	2MWLMV0064	None	N/A
	2MWLMV0065	None	N/A
	2MWLRV0264	None	N/A
	2MWLMV0390	None	N/A
	2MWLMV0802	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M375	2MWLMV0001	121987	Y
	2MWLMV0002	121988	Y
	2MWLMV0024	None	N/A
	2MWLMV0816	None	N/A
M376	2MKCMV0322	None	N/A
	2MKCMV0320	048734	Y
	2MKCMV0321	None	N/A
M377	2MFWMV0004	None	N/A
	2MFWMV0005	None	N/A
	2MFWMV0030	None	N/A
M378	2MVXMV0031	None	N/A
	2MVXMV0033	None	N/A
	2MVXMV0034	None	N/A
M384	2MVQMV0005	None	N/A
	2MVQMV0006	None	N/A
	2MVQMV0011	None	N/A
M385	2MRVMV0079	None	N/A
	2MRVMV0080	None	N/A
	2MRVMV0139	None	N/A
	2MRVMV0365	None	N/A
M386	2MVIMV0148	93632	N
	2MVIMV0149	None	N/A
	2MVIMV0362	054317	Y
	2MVIMV0376	None	N/A

Mechanical Penetration Work Request Survey
Table 1

Penetration	Isolation Valve or Instrument	WR No. 3/15→5/23/86	Seat Possibly Affected?
M390	2MRVMV0101	None	N/A
	2MRVMV0102	None	N/A
	2MRVMV0366	None	N/A
	2MRVMV0140	None	N/A
C392	2IAECV5340	None	N/A
	2IAESV5080	None	N/A
M394	Flanged	None	N/A
M402A	2MNSSV5550	65824	N
	2MNSSV5551	65824	N
M402	2MNSPT5040	86695	N
	2MNSPT5360	None	N/A
	2MNSPT5490	66024	N
		86695	N
	MNSPT5540	93813	Y
M454	2MVPMV0012	86842	Y
	2MVPMV0013	86842	Y
	2MVPPX5230	None	N/A
M456	2MVPMV0008	86842	Y
	2MVPMV0009	86842	Y
	2MVPPX5120	None	N/A

Leakage Savings Determination
Table 2

Penetration	Minimum Path Leakage Flow "As Found"	"As Left"	Savings SCCM
M118	20	20	0
M118A	20	20	0
M212	2	2	0
M239C	48	20	28
M239D	20	20	0
M240	22	22	0
M259	20	20	0
M321	22	14	8
M322	20	20	0
M327	85	20	65
M348	50	50	0
M355	20	20	0
M360	7	7	0
M368	66	1	65
M372	2	2	0
M373	4	2	2
M376	65	20	45
M386	2	2	0
M402	20	20	0
M454	31	17	14
M456	44	235	0
		SUBTOTAL	227
Upper Airlock	1450	972	478
Lower Airlock	1085	232	853
Equipment Hatch	4	89	0
		AIRLOCK SUBTOTAL	1331
M320			0
M361			0
M375			94524
		TOTAL SAVINGS	96112

Table 3
Type B and C Penetration "As Left" Leak Rates

Test	Rate (SCCM)
Electrical Penetrations (PT/2/A/4200/01B	45
Non-Bypass Leakage (PT/2/A/4200/01P)	132
Bypass Leakage (from Enclosure 13.2)	2811
Upper Personnel Airlock (PT/2/A/4200/01E)	972
Lower Personnel Airlock (PT/2/A/4200/01F)	232
Total (Type B and C Leakage)	4192

Appendix

Analysis of Three Penetrations with Work Done on Both Sides of Containment

Three penetrations M320, M361 and M375 had work done on both sides of containment. Below, each one's work and history are discussed to assess its impact to this outage's ILRT.

M320 is a penetration for the 8-inch KC (component cooling) return line. The Aux Building side isolation valve is KC325A, an 8-inch butterfly valve with a Limitorque operator. The containment side isolation valve is KC424B, also a butterfly valve with a Limitorque operator; parallel to KC424B is a 1-inch bypass line with check valve KC279.

Preventive maintenance (PM) was performed on the Limitorque operators of KC424B and KC425A. The PM entails inspection and lubrication as needed for the Equipment Qualification Program. These valves close to a travel limit switch with a torque limit backup. As long as the travel limit switches were not adjusted any improvement in valve torque loading will not improve the valve seat. The limit switch was adjusted on KC424B but not on KC425A. Neither valve had to be lubricated. Thus the seat of KC425A was not improved. Leakage for both valves has been below measurable limits for the past two surveillances. LLRT performed after this maintenance yielded leak rates of 20 sccm for KC425A and 220 sccm for KC424B. Based on a consistent history for KC425A, it is reasonable to assume an "as found" minimum path leakage of 20 sccm with zero savings.

M361 is a penetration for the 2-inch NC lubrication oil supply line. The Aux Building side isolation valve is NC195B, a 2-inch globe valve with a Limitorque operator. The containment side isolation valve is NC196A, a similar valve and operator. A 3/4-inch bypass line with check valve NC259 is in parallel with NC196A.

Preventive maintenance was performed on the Limitorque operators of NC195B and NC196A. The PM entails inspection and lubrication as needed for the Equipment Qualification Program. These valves close to a torque limit. Lubrication could allow the actuator to have more torque for making the seat. However, neither valve needed to be lubricated; therefore, the seats were not improved. Leakage for both valves has been below measurable limits for the past two surveillances. The LLRT history shows that each valve has leaked below detectable amount every test. It is reasonable to assume for this penetration an "as found" minimum path leakage of 20 sccm with zero savings.

M375 is a penetration for the 3-inch WL line which discharges from the reactor coolant train tank. The Aux Building side isolation valve is WL1B, a 3-inch diaphragm valve with a Rotork operator, as is the containment side isolation valve WL2A. A 1/2-inch bypass line with check valve WL24 bypasses WL2A. A 1-inch high point vent with WL816, a Kerotest valve, protrudes from the Aux Building side of the penetration.

WL1B and WL2A were determined to be leaking while troubleshooting for excess reactor coolant leakage. LER 360-86-03 describes how this was done. Work requests were written to repair the valves. No prework leakage was measured.

The reactor coolant leakage calculation yielded 1.5-2 gpm in unidentified leakage. Assume 2 gpm was leaking through M375.

The maintenance on WL1B uncovered a broken shaft on the Rotork limit switches which would either seat the valve or stop it at an intermediate position. Assume the valve was stopped in the open position.

The discharge pressure of the reactor coolant drain tank (NCDT) pumps was 125 psig. These pumps were on at the time, recircing the NCDT. To account for piping losses, assume the pressure upstream of WL2A was 110 psig. This line dumps into the reator water holdup tank which is near atmospheric pressure. To account for piping losses assume pressure downstream of WL2A was 10 psig.

Assume the leaking WL2A simulates an orifice in the line. Based on these assumptions an equivalent type A leakage can be determined for air. Volumetric flow of water through an orifice is:

$$q_{H2O}(\text{vol/t}) = C_1 \frac{d^2}{\sqrt{1-(d/D)^4}} \sqrt{\frac{\Delta P_1}{\rho_1}}$$

where:

C_1 = constant to make units balance

d = orifice diameter

D = pipe diameter

ΔP_1 = pressure drop across the orifice = 100 psi

ρ_1 = density of the water 1 gm/cc

For air or any other gas the equation is:

$$q_{gas}(\text{vol/t}) = C_1 \frac{Y\, d^2}{\sqrt{1-(d/D)^4}} \sqrt{\frac{\Delta P_g}{\rho_g}}$$

where:

Y = a compressibility factor

ρ_g = density of the gas 0.00106 gm/cc (at 100F, saturated, and 14.7 psi which is the downstream pressure)

ΔP_g = 15 psi for Type A test conditions

Dividing these two equations:

$$\frac{q_{gas}}{q_{H2O}} = \frac{Y\sqrt{\Delta P_g \rho_1}}{\sqrt{\Delta P_1 \rho_g}}$$

Compressibility factors range from .85 to 1.0.
For conservatism assume Y = 1.0.

Thus:

$$\frac{q(air)_{ILRT}}{q(water)_{leak}} = 11.90$$

Therefore:

$$\begin{aligned} q(air)_{ILRT} &= 11.90 \times 2 \text{ gpm} \\ &= 11.90 \times 7570. \text{ sccm} \\ &= 90051. \text{ sccm} \end{aligned}$$

For uncertainty 5% will be added to this number. Thus, the equivalent leakage of air through penetration M375 was 94554 sccm. The retest LLRT yielded a leakage of 30 sccm. There was a savings of 94524. sccm on M375.

REFERENCES

1. LER 370-86-03
2. R.W. Miller, "Flow Measurement Engineering Handbook", McGraw-Hill Book Company, 1983.
3. C.O. Bennett and J.E. Myer, "Momentum, Heat, and Mass Transfer", 2nd Ed., McGraw-Hill Book Company, 1974.