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August 26, 1988

Mr. T. E. Murley
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC. 20555

Attn: Document Control Desk

Subject: Braidwood Unit 1
Limitorque Operator Lubrication
NRC Docket No. 50-456

Reference: (a) April 22, 1988 S.C. Hunsader letter to T.E. Murley
(b) NUREG-1002, Safety Evaluation Report, Supplement #6, dated May, 1988
(c) June 23, 1988 S.C. Hunsader letter to T.E. Murley

Dear Mr. Murley:

Reference (a) identified four (4) valves that potentially could be exposed to radiation values greater than 2 x 10^7 rad. These valves are 1QG057A and 1RY8000A (inside containment), and 1CV112B and 1CV112C (outside containment). In order to show that the operators for these valves will function as intended, reference (a) indicated that a qualification test of a representative grease sample would be performed and completed within 60 days from the date Braidwood Unit 1 enters Mode 2 which occurred on April 24, 1988. Reference (b) provided the NRC staff's review and evaluation of this submittal.

Reference (c) informed the NRC staff that this testing had been completed with the results being provided in Attachment A to that letter. The samples of Exxon EPO/EPI mixed with Sun EP50 had maintained a consistency whereby the lubricating capability had not been reduced. Under a radiation exposure condition, it was verified that the grease will perform its intended function.

During the reviews performed of mixed grease samples eight (8) valves were found with mixtures of 12% to 33% of Sun EP50 mixed with Exxon Nebula EPO/EP1. Additional grease mixture testing was performed that envelopes these cases. The results are presented in Attachment A. In these cases the mixed grease maintained its lubricating capability and as such was verified that it will perform its intended function.

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This is being provided for NRC review. Please address any questions concerning this matter to this office.

Very truly yours,

S. C. Hunsader

S. C. Hunsader
Nuclear Licensing Administrator

/klj
cc: S. Sands (NRR)
W. Forney (RIII)
Braidwood Resident Inspector

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Attachment A

Background

During the 1988 E.Q. audit of Braidwood Station by the NRC, several Limitorque operators on safety-related and non safety-related valves were found to have mixtures of grease with different soap bases. Under cover of a June 23, 1988 S.C. Hunsader letter to T.E. Murley, Commonwealth Edison provided to the NRC the results of the light mixtures (2% to 5% by weight) of unqualified grease in the base grease.

Eight valves were found to have a heavy mixture (12% to 33% by weight) of unqualified grease in the base grease. Seven of these valves had the grease changed out prior to unit startup. The grease in one valve, a loop isolation valve, was not changed out and is discussed further in the operability assessment section of this report.

Since eight (8) valves were found to have a heavy mixture (12% to 33% by weight) of unqualifed grease in the base grease, additional grease mixtures were tested to address the significance of operation of these eight valves while they contained the grease mixture.

This report first discusses the additional grease testing and the results of that testing and then addresses the operability of the valves while they contained the heavy mixtures of grease.

Sample Description

Forty samples of Exxon EPO and EP1 greases (qualified) were penetration tested in accordance with ASTM D-1403, after mixing with 25%, 50%, and 75% (by weight) of SUN 50 EP grease (unqualified). Further, Exxon EPO was mixed with 25%, 50%, and 75% (by weight) of Exxon EP1. Dropping point for many of the mixtures was determined in accordance with ASTM D-566. These tests were performed to define the characteristics of heavy mixtures of greases with different soap bases before and after irradiation as well as the effects of radiation on mixtures of Nebula EPO and EP1 (same soap base).

Table A shows the mix ratio of SUN 50 EP grease with Exxon Nebula EPO. The effect on the dropping point (if tested) and penetration value for each sample is also shown.

Table B provides the same information as in Table A for mixtures of SUN 50 EP grease with Exxon Nebula EP1.

Table C identifies the effects of radiation exposure on the penetration value and dropping point for heavy mixtures of Exxon Nebula EPO grease with Exxon Nebula EP1 grease.

Each of these tables also includes the effects of irradiation on the pure greases used in the mixtures.

Table 2 from the June 23, 1988 submittal showing radiation effects on the light mixture grease characteristics is also included for ease of reference and comparison.

Appearance

One sample, the 25% SUN/75% EP1 mixture that had been irriadiated to 2×10^5R, appeared quite dry prior to working. Upon working, its appearance and consistency were no different from the unirriadiated sample.

The appearance and consistency of all other mixtures remained unchanged from that of the unirradiated samples after exposure to both 2×10^5R and 2×10^8R gamma.

Data Interpretation - Heavy Mixtures

A. SUN/EPO Mixtures (Table 3)

Unirradiated mixtures, including the 50/50 mixture, show virtually no change in penetration from the pure SUN grease. The unirradiated mixture of 25% SUN/75% EPO is approximately midway between pure unirradiated samples of SUN and EPO.

The penetration values for the heavy mixtures of SUN and EPO show minor changes between 0 and $2x10^5$ R when compared to the unirradiated mixture.

Exposure to $2x10^8$ R shows penetration values between 392 and 407 for both the pure SUN and the mixtures. This is virtually identical to the results of the light mixtures shown in Table 2.

Some changes in dropping points were observed but this is only significant for 2 mixtures, the 75% SUN/25% EPO and 50% SUN/50 EPO after $2x10^8$ R exposure. The dropping point decreased to 285^0F and 275^0F, respectively.

B. SUN/EP1 Mixtures (Table 4)

The unirradiated penetration values for pure SUN and pure EP1 are very close (309 SUN, 328 EP1). None of the unirradiated heavy mixture penetration values show significant change from pure SUN grease.

Modest softening of all mixtures was observed upon exposure to $2x10^5$ R with the exception of the 25% SUN/75% EP1 mixture. This mixture showed significant stiffening, exhibiting penetration values of a Grade 3 grease.

Exposure to $2x10^8$ R caused softening in all mixtures (the 75% SUN/25% EP1 was softest at a penetration value of 395, which is comparable to the light mixtures shown in Table 2.

The 25%/75% mixture softened to a value that is virtually identical to unirradiated pure SUN grease.

Significant dropping point change is apparent for only one mixture, the 75%/25% after $2x10^8$ R exposure. The dropping point temperature decreases to 295F for this mixture.

C. EPO/EP1 Mixtures (Table 5)

Only minor changes in penetration values occurred from 0 to $2x10^5$R for all mixtures.

All mixture penetration values were in the 302 to 319 range after exposure to $2x10^8$R. This is consistent with the light [illegible] results shown in Table 2.

No changes in dropping point for any of the [illegible] observed.

Operability Assessment

Six of the eight valves identified with heavy grease mixtures are identified in Table D below with the mixture ratio, E.Q. Zone, expected radiation field and temperature. All of these six valves are located outside the containment in the auxiliary building.

Table D

Valve	Ratio Nebula/SUN	E.Q. Zone	Radiation	Temp
1AF017A		A8 (mild)	1×10^4R	140^0F
1CV8355C	7:1	A13C	1×10^7R	130^0F (max)
2CC9412A	3:1	A13C	1×10^7R	130^0F (max)
2CV8355B	2:1	A13C	1×10^7R	130^0F (max)
2CV8355D	3:1	A13C	1×10^7R	130^0F (max)
2SI8920	4:1	A13C	1×10^7R	130^0F (max)

The grease mixtures tested (3:1 or 75% Nebula/25% SUN and 1:1 or 50% Nebula/50% SUN) bound the worst mixture found (2:1 or 66% Nebula/33% SUN). Since, after exposure to 2×10^5R and 2×10^8R, all grease mixtures tested had the apperance, consistency, and penetration values characteristic of grease and dropping points of 275^0F or greater, all six of these valves were operational while containing the heavy mixture of grease.

Valve 1RC 8001 A is a main loop isolation valve that is power locked out during all operational modes. Power is restored only during shutdown to expedite NSSS maintenance. This valve serves no safety function beyond maintaining the pressure boundary, thus operability and E.Q. qualification are not issues. The grease in this valve has not yet been changed out.

Valve 1CC9438 is the inboard containment isolation valve for the component cooling return line from the number 1 seal on the reactor coolant pumps. This valve closes within 10 seconds of receipt of a Phase B containment isolation signal (FSAR Table 6.2.-58). Assuming a loss-of-off-site power coincident with the LOCA/MSLB, the valve will receive the isolation signal 22 seconds after the initiation of the event (Tech. Spec. Tables 3.3-5 and 3.6-1). Therefore, operability of the valve for 32 seconds after initiation of the event is necessary.

From FSAR Figure 6.2-14, the containment temperature reaches 275^0F approximately 30 seconds after the initiation of the MSLB. At this time (accident only) radiation exposure has reached approximately $1x10^4$ Rads. Also from FSAR Figure 6.2-14, the containment temperature reaches approximately 300^0F, 40 seconds after the initiation of the MSLB while radiation exposure level remains at approximately $1x10^4$ Rads. The worst case radiation exposure level for 300^0F containment temperature 40 seconds after MSLB initiation is approximately $6x10^5$ Rads. This radiation exposure level considers a normal 3 year dose plus accident.

By visual observation, a grease mixture was identified in the valve Limitorque grease box. Using Atomic Absorption Sepctroscopy (AAS), the ratio of the grease mixture was determined to be 33% SUN with 66% Nebula. Physical data from the heavy mixture test program shown the worst overall mixtures (25% SUN/75% EP1 and 50% SUN/50% EPO) to bound the mixture actually contained in the actuator.

The 25% SUN/75% EP1 mixture stiffens to the consistency of a grade 3 grease after exposure to $2x10^5$R gamma, then softens as exposure increases to $2x10^8$R gamma. A dropping point of 446^0F is maintained as radiation exposure increases. This high dropping point ensures lubrication will be maintained around the worm gear during and after an accident. The heavier grease grade is judged to be insignificant in that the worm gears will perform equally well regardless of whether a heavy or a lighter grease is used.

The 50% SUN/50% EPO grease mixture displays a decrease in dropping point to 315^0F after exposure to $2x10^5$R while maintaining a penetration valve consistent with the unirradiated grease. As described above, containment temperature is 300^0F after 40 seconds. Since the worst case radiation level at this time is $6x10^5$R, the dropping point for the 50% SUN/50% EPO mixture would remain at approximately 315^0F. This ensures that lubrication in the form of grease would be maintained around the worm gears for the 40 second time required to operate this valve assuming a loss-of-offsite power coincident with a LOCA/MSLB.

It is concluded that no detrimental effect on the operability of any of these eight valves is caused by having heavy mixtures of SUN 50 EP grease with either Nebula EPO or Nebula EP1 grease in the Limitorque operator gear box.

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Table A

Mix Ratio	Rad. Level	Penetration Worked	Penetration Unworked	Dropping Point °C/°F (D-566)
100% SUN	0	309	294	183/362
	$2x10^5$	320	298	177/351
	$2x10^8$	407	328	176/349
75% SUN/25% EPO	0	292	270	165/328
	$2x10^5$	343	324	150/302
	$2x10^8$	392	358	140/285
50% SUN/50% EPO	0	314	309	173/343
	$2x10^5$	301	245	157/315
	$2x10^8$	407	328	135/275
25% SUN/75% EPO	0	354	347	230/446
	$2x10^5$	324	257	230/446
	$2x10^8$	403	287	230/446
100% EPO	0	384		230/446
	$2x10^5$			230/446
	$2x10^8$			230/446

Mixed Ratio	Rad Level	Penetration Worked	Penetration Unworked	Dropping Point °C/°F
100% SUN	0	309	294	183/362
	$2x10^5$	320	298	177/351
	$2x10^8$	407	328	176/349
75% SUN/25% EPI	0	292	279	168/334
	$2x10^5$	339	283	151/304
	$2x10^8$	395	373	146/295
50% SUN/50% EPI	0	310	294	230/446
	$2x10^5$	343	324	230/446
	$2x10^8$	369	223	158/316
25% SUN/75% EPI	0	296	283	230/446
	$2x10^5$	241	159	230/446
	$2x10^8$	305	208	230/446
100% EPI	0	328		230/446
	$2x10^5$	309	309	230/446
	$2x10^8$	395	377	230/446

Table C

Mix Ratio	Rad. Level	Penetration Worked	Penetration Unworked	Dropping Point °C/°F (D-566)
100% Nebula EPO	0	384		230/446
	$2x10^5$	362	362	230/446
	$2x10^8$	407	399	230/446
98% EPO/2% EPI	0	354		230/446
	$2x10^5$	384	373	230/446
	$2x10^8$	410	410	230/446
95% EPO/5% EPI	0	380		230/446
	$2x10^5$	377	373	230/446
	$2x10^8$	410	410	230/446
75% EPO/25% EPI	0	373		230/446
	$2x10^5$	373	369	230/446
	$2x10^8$	410	407	230/446
50% EPO/50% EPI	0	358		230/446
	$2x10^5$	369	354	230/446
	$2x10^8$	392	392	230/446
25% EPO/75% EPI	0	347		230/446
	$2x10^5$	339	358	230/446
	$2x10^8$	403	399	230/446

Table C (Cont'd)

Mix Ratio	Rad. Level	Penetration		Dropping Point °C/°F (D-566)
		Worked	Unworked	
5% EPO/95% EPI	0	324		230/446
	2×10^5	328	328	230/446
	2×10^8	392	392	230/446
2% EPO/95% EPI	0	324		230/446
	2×10^5	309	335	230/446
	2×10^8	410	399	230/446
100% EPI	0	328		230/446
	2×10^5	309	309	230/446
	2×10^8	395	377	230/446

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Table 2

Sample	Mix. Ratio	Rad. Level	Penetration (D-1403*) Worked	Penetration (D-1403*) Unworked	Dropping Point °C(D-556)
B1A	2% Sun/98% EPO	0	392	395	230
B2A		$2x10^5R$	384	388	230
B3A		$2x10^8R$	410	410	230
B1B	2% Sun/98% EPI	0	339	339	230
B2B		$2x10^5R$	320	328	230
B3B		$2x10^8R$	407	407	230
B1C	5% Sun/95% EPO	0	388	392	230
B2C		$2x10^5R$	384	388	230
B3C		$2x10^8R$	407	407	230
B1D	5% Sun/95% EPI	0	328	332	230
B2D		$2x10^5R$	328	324	230
B3D		$2x10^8R$	403	407	230
Reference					
1	100% EPO	0	384 (Actual Value)		230
2	100% EPI	0	328 (Actual Value)		230
3	100% EPO	0	370 (Manf. Spec.)		230
4	100% EPI	0	326 (Manf. Spec.)		230

*Converted to full scale (ASTM D-217) penetration values.