NRC FORM 658
(9-1999)

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DATE OF MEETING
11/28/2001

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Docket Number(s)	**50-346**
Plant/Facility Name	**DAVIS-BESSE**
TAC Number(s) (if available)	**MB 2626**
Reference Meeting Notice	**ADAMS NO. ML013310537**
Purpose of Meeting (copy from meeting notice)	**To discuss information related to supplemental information regardind inspection plans and commitments for Davis-Besse in response to Bulletin 2001-01**

NAME OF PERSON WHO ISSUED MEETING NOTICE	TITLE
STEPHEN P. SANDS	**PROJECT MANAGER**

OFFICE
NRR

DIVISION
DLPM

BRANCH
PD III-2

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Agenda

☆ Introduction/Background	Steve Moffitt
☆ Deterministic Model	Dave Geisen
☆ Probabilistic Risk Assessment	Ken Byrd
☆ Inspection Plans	Mark McLaughlin
☆ Closing Summary	Steve Moffitt

Today's Objective

Provide Reasonable Assurance that Davis-Besse is safe to operate until February 16, 2002.

Background:

- ☆ NRC Bulletin 2001-01 response provided
- ☆ Telephone call received on September 28
- ☆ Teleconference on October 3
- ☆ Brief drop by visit on October 11
- ☆ Meeting with NRR Staff on October 24
- ☆ NRR Staff and ACRS meetings on November 8 & 9
- ☆ Meeting with NRR Staff on November 13
- ☆ Teleconference on November 26

Deterministic Aspects

DBNPS's evaluation is based on visual inspections performed in 10, 11, and 12 RFO (May 1996, April 1998, and April 2000).

The inspection results afford us assurance that all but 4 nozzle penetrations were inspected in 1996, all but 19 inspected in 1998, and all but 24 penetrations inspected in 2000.

The limiting nozzle population is those nozzles that could not be inspected in 1998 or 2000.

It is conservatively assumed that for these penetrations, an axial through-weld flaw occurs immediately upon startup from 10 RFO (May 1996).

Initial Flaw Size

Initial flaw depth of 0.5 mm, 172° around the nozzle, is assumed to exist immediately upon achieving a full penetration axial flaw.

BASIS:

☆ This is a conservative flaw initiation site size.

☆ It is further conservatively assumed that multiple starting flaws could exist and that these would eventually link together.

☆ It is conservative in that by assuming this starting point, we also are assuming that we have already had several years of flaw propagation axially through the Alloy 182 weld material.

Use of Modified Scott Model

The Modified Scott Model is still deemed credible as a mean curve for crack growth rates.

☆ Data received to date does not negate the curve.

☆ Numerous curves have been developed and to a certain degree, they all rest on engineering judgement.

☆ The data from OTSGs for Alloy 600 is relevant for developing the CGR curves and in fact is conservative in that the Alloy properties are still relevant and because any cold-working of the tubes at the tube support sheet would increase the failure rate over non-worked Alloy 600, will make this conservative.

Risk-Informed Evaluation

☆ Davis-Besse risk assessment provides a bounding estimation of risk. Bounding or conservative assumptions were used to resolve uncertainties.

☆ Studies of sensitivity was performed for all significant parameters.

☆ Results indicate incremental CDF would be bounded in the "small" category and expected to be "very small" per RG 1.174.

☆ Incremental LERF and Public health risk is expected to be negligible.

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Risk-Informed Evaluation
Nozzle Leak Frequency

The Davis-Besse plant specific PSA has used the method from the generic Framatome analysis which applies a constant leak initiation frequency.

- ☆ The constant rate over predicts the number of leaks in early cycles.

- ☆ Impact of inspection on conditional probability of a leak at a future date is not quantified.

Risk-Informed Evaluation

Nozzle Leak Frequency

Other approaches have assumed that the onset of leakage can be approximated by a two parameter Weibull cumulate probability distribution.

☆The Davis-Besse risk assessment was modified to apply a Weibull distribution.

☆Studies were performed to investigate the sensitivity to the Weibull scale and shape parameters.

☆The conditional probability of a leak by a future date given no leak now can be calculated if a nozzle has been inspected and no leakage detected.

Risk-Informed Evaluation

Nozzle Leak Frequency

Predicted Leaks for various Weibull Leak Initiation Models

Davis-Besse Refueling Outage	Davis-Besse EFPY	Davis-Besse EFPY Corrected to 600F	Expected Number of Leaking CRDM Nozzles			
			Upper (95%) Projection 1.5 Shape Parameter	Median Projection 1.5 Shape Parameter	EPRI MRP Weibull Model Projection	EPRI MRP Shape Parameter Modified Scale Parameter
10	10.56	12.91	5.0	1.0	$9.5x10^{-5}$	0.02
11	12.33	15.07	6.3	1.3	$1.7x10^{-3}$	0.36
12	14.06	17.18	7.6	1.6	$1.9x10^{-2}$	4.00
13	15.81	19.32	8.9	1.9	0.17	28.3
-	16.37	20.00	9.3	2.0	0.32	43.7

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Past Inspections

- ☆ Inspections were assumed to have a failure probability of 1.00 if boron inhibited detection of nozzle leakage.

- ☆ Inspections were assumed to have a failure probability of 0.05 if no boron was present.

- ☆ Sensitivities were performed to investigate the effect of various leakage detection probabilities.

Risk-Informed Evaluation

Probability of Circumferential Cracking

☆ Evidence from recent B&W plant inspections has indicated that not all axial cracks have resulted in initiation of circumferential cracking.

☆ B&W plants have experienced 27 axial cracks and 6 circumferential cracks.

☆ Probability of the initiation of a circumferential crack is estimated to be 0.22 based on B&W evidence.

Risk-Informed Evaluation

Nozzle Failure Probability

☆ Probability of CRDM nozzle failure is determined by performing a Monte Carlo simulation on the Scott deterministic crack growth model.

☆ Conservative or bounding assumptions were used when data was not available.

☆ Studies were performed to investigate the sensitivity to all significant inputs.

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Risk-Informed Evaluation

Nozzle Failure Probability - Conservative Assumptions

☆ Initial crack size - Applied a uniform distribution from 0-180 degrees.

☆ Stress Profile - Uses the worst case stresses.

☆ Crack Growth Rate Coefficient - Applies crack growth rate coefficient from heat 69.

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Risk-Informed Evaluation

Nozzle Failure Probability - Sensitivity Studies

- Initial crack size
- Initial crack depth
- Temperature
- Stress Profile
- Crack Growth Rate Coefficient

Risk-Informed Evaluation

Conditional Core Damage / Release Probability

- ☆ Davis-Besse conditional core damage probability for a 0.1 ft^2 medium LOCA is 2.7×10^{-3}.

- ☆ Conditional large early release probability for a medium LOCA is about 4.0×10^{-6}.

- ☆ The conditional core damage probability for this analysis is less than applied in the PSA because the medium LOCA range in the PSA is 0.02 ft^2 - 0.5 ft^2.

Risk-Informed Evaluation

Results

	Constant Initiation Frequency		Upper (95%) Projection 1.5 Shape Parameter		EPRI MRP Shape Parameter Modified Scale Parameter	
	Bounding	Best Estimate	Bounding	Best Estimate	Bounding	Best Estimate
CDF	1.8 E-6	9.9 E-8	1.1 E-6	6.3 E-8	3.3 E-7	1.9 E-8
LERF	2.6 E-9	1.5 E-10	1.7 E-9	9.4 E-11	4.9 E-10	2.8 E-11
Person REM	0.16	9.2 E-3	.11	5.9 E-3	3.1 E-2	1.7 E-3

Risk-Informed Evaluation

Unique Aspects of Davis-Besse Risk Assessment

☆ Inspection Information - Davis-Besse inspections do not indicate evidence a nozzle leaks.

☆ Material Heat Information - 64 of 69 Davis-Besse nozzle material heats have no history of axial or circumferential leaks at other plants.

Risk-Informed Evaluation

Conclusions

☆ CDF - The plant specific risk assessment conservatively estimates a bounding incremental core damage frequency to be in the range which is categorized as "small" per RG 1.174. The actual incremental core damage frequency would be categorized as "very small" per RG 1.174.

☆ LERF - The plant specific risk assessment conservatively estimates a bounding incremental large early release frequency which is categorized as "very small" per RG 1.174. The actual incremental release frequency is negligible.

☆ Public Health Risk - The plant specific risk person rem per year is negligible.

Inspection Plans

- ☆ 13RFO:
  - ☆ 100% qualified visual
  - ☆ 100% NDE
  - ☆ Flaw characterization if found.
  - ☆ Data will be made available for industry use.
- ☆ Vessel Head Replacement at first available opportunity

Davis-Besse Specific Features and Actions

☆Record of inspection from last three outages.

☆Only B&W plant with a continuous head vent which provides high confidence in temperature measurements.

☆Reduce reactor vessel head temperature from 605°F to 598°F.

☆Additional training for Operators on issues raised in Bulletin 2001-01.

☆Maximize availability of redundant critical safety systems.

Comparison of Inspection Dates

December 31st

- Two Shutdowns Required (One Inspection, One Refuel)
- Approximately 30 REM additional exposure to employees.
- Limited NDE

February 16th

- Single Shutdown for inspection and refueling.
- Normal refueling outage dose.
- Full NDE and flaw characterization.

No significant difference in risk (incremental CDF).

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Summary

Based on Conservative Analysis:

Davis-Besse is Safe to Operate until February 16, 2002.

Heat 69 Crack Growth - Constant Leak Initiation Frequency

Leak Initiates	Initiation Frequency (yr)	CRDM in Group	Initiation Frequency (yr)	Nozzle Failure Probability	CCDP	Probability Circ Crack	10 RFO Insp. Fails	11 RFO Insp. Fails	12 RFO Insp. Fails	CDF (yr)	LERF (yr)	REM (yr)
13	1.1	4	6.38E-02	1.25E-05	2.70E-03	2.22E-01	NA	NA	NA	4.78E-10	7.08E-13	4.44E-05
12	1.1	4	6.38E-02	1.25E-05	2.70E-03	2.22E-01	NA	NA	1	4.78E-10	7.08E-13	4.44E-05
11	1.1	4	6.38E-02	9.65E-03	2.70E-03	2.22E-01	NA	1	1	3.69E-07	5.46E-10	3.43E-02
10	1.1	4	6.38E-02	4.43E-02	2.70E-03	2.22E-01	1	1	1	1.69E-06	2.51E-09	1.57E-01
										2.06E-06	3.05E-09	1.92E-01
13	1.1	15	2.39E-01	1.25E-05	2.70E-03	2.22E-01	NA	NA	NA	1.79E-09	2.65E-12	1.67E-04
12	1.1	15	2.39E-01	1.25E-05	2.70E-03	2.22E-01	NA	NA	1	1.79E-09	2.65E-12	1.67E-04
11	1.1	15	2.39E-01	9.65E-03	2.70E-03	2.22E-01	NA	1	1	1.38E-06	2.05E-09	1.29E-01
10	1.1	15	2.39E-01	4.43E-02	2.70E-03	2.22E-01	0.05	1	1	3.17E-07	4.70E-10	2.95E-02
										1.70E-06	2.52E-09	1.58E-01
13	1.1	5	7.97E-02	1.25E-05	2.70E-03	2.22E-01	NA	NA	NA	5.97E-10	8.85E-13	5.55E-05
12	1.1	5	7.97E-02	1.25E-05	2.70E-03	2.22E-01	NA	NA	1	5.97E-10	8.85E-13	5.55E-05
11	1.1	5	7.97E-02	9.65E-03	2.70E-03	2.22E-01	NA	0.05	1	2.31E-08	3.42E-11	2.14E-03
10	1.1	5	7.97E-02	4.43E-02	2.70E-03	2.22E-01	0.05	0.05	1	5.29E-09	7.83E-12	4.91E-04
										2.95E-08	4.38E-11	2.75E-03
13	1.1	45	7.17E-01	1.25E-05	2.70E-03	2.22E-01	NA	NA	NA	5.38E-09	7.96E-12	5.00E-04
12	1.1	45	7.17E-01	1.25E-05	2.70E-03	2.22E-01	NA	NA	0.05	2.69E-10	3.98E-13	2.50E-05
11	1.1	45	7.17E-01	9.65E-03	2.70E-03	2.22E-01	NA	0.05	0.05	1.04E-08	1.54E-11	9.64E-04
10	1.1	45	7.17E-01	4.43E-02	2.70E-03	2.22E-01	0.05	0.05	0.05	2.38E-09	3.52E-12	2.21E-04
										1.84E-08	2.73E-11	1.71E-03
										1.75E-06	2.60E-09	1.63E-01

Heat 69 Crack Growth - Low Weibull Shape Factor

Leak Initiates	Initiation Frequency (yr)	CRDM in Group	Initiation Frequency (yr)	Nozzle Failure Probability	CCDP	Probability Circ Crack	10 RFO Insp. Fails	11 RFO Insp. Fails	12 RFO Insp. Fails	CDF (yr)	LERF (yr)	REM (yr)
13	4.39E-03	4	8.79E-03	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	6.53E-11	9.67E-14	6.07E-06
12	4.10E-03	4	8.19E-03	1.25E-05	2.70E-03	2.20E-01	NA	NA	1	6.08E-11	9.01E-14	5.66E-06
11	3.92E-03	4	7.84E-03	9.65E-03	2.70E-03	2.20E-01	NA	1	1	4.49E-08	6.66E-11	4.18E-03
10	1.51E-02	4	3.03E-02	4.43E-02	2.70E-03	2.20E-01	1	1	1	7.96E-07	1.18E-09	7.40E-02
										8.41E-07	1.25E-09	7.82E-02
13	4.50E-03	15	3.37E-02	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	2.51E-10	3.71E-13	2.33E-05
12	4.18E-03	15	3.13E-02	1.25E-05	2.70E-03	2.20E-01	NA	NA	1	2.33E-10	3.45E-13	2.16E-05
11	3.98E-03	15	2.99E-02	9.65E-03	2.70E-03	2.20E-01	NA	1	1	1.71E-07	2.53E-10	1.59E-02
10	1.51E-02	15	1.14E-01	4.43E-02	2.70E-03	2.20E-01	0.05	1	1	1.49E-07	2.21E-10	1.39E-02
										3.21E-07	4.75E-10	2.98E-02
13	4.50E-03	5	1.12E-02	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	8.35E-11	1.24E-13	7.76E-06
12	4.18E-03	5	1.04E-02	1.25E-05	2.70E-03	2.20E-01	NA	NA	1	7.75E-11	1.15E-13	7.21E-06
11	3.98E-03	5	9.95E-03	9.65E-03	2.70E-03	2.20E-01	NA	0.05	1	2.85E-09	4.22E-12	2.65E-04
10	1.51E-02	5	3.79E-02	4.43E-02	2.70E-03	2.20E-01	0.05	0.05	1	2.49E-09	3.69E-12	2.31E-04
										5.50E-09	8.15E-12	5.11E-04
13	4.50E-03	45	1.01E-01	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	7.52E-10	1.11E-12	6.99E-05
12	4.18E-03	45	9.40E-02	1.25E-05	2.70E-03	2.20E-01	NA	NA	0.05	3.49E-11	5.17E-14	3.24E-06
11	3.98E-03	45	8.96E-02	9.65E-03	2.70E-03	2.20E-01	NA	0.05	0.05	1.28E-09	1.90E-12	1.19E-04
10	1.51E-02	45	3.41E-01	4.43E-02	2.70E-03	2.20E-01	0.05	0.05	0.05	1.12E-09	1.66E-12	1.04E-04
										3.19E-09	4.73E-12	2.97E-04
										1.13E-06	1.67E-09	1.05E-01

Heat 69 Crack Growth - High Weibull Shape Factor

Leak Initiates	Initiation Frequency (yr)	CRDM in Group	Initiation Frequency (yr)	Nozzle Failure Probability	CCDP	Probability Circ Crack	10 RFO Insp. Fails	11 RFO Insp. Fails	12 RFO Insp. Fails	CDF (yr)	LERF (yr)	REM (yr)
13	3.52E-01	4	7.03E-01	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	5.22E-09	7.73E-12	4.85E-04
12	5.30E-02	4	1.06E-01	1.25E-05	2.70E-03	2.20E-01	NA	NA	1	7.86E-10	1.17E-12	7.31E-05
11	4.97E-03	4	9.94E-03	9.65E-03	2.70E-03	2.20E-01	NA	1	1	5.70E-08	8.44E-11	5.30E-03
10	3.00E-04	4	6.01E-04	4.43E-02	2.70E-03	2.20E-01	1	1	1	1.58E-08	2.34E-11	1.47E-03
										7.88E-08	1.17E-10	7.32E-03
13	3.73E-01	15	2.80E+00	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	2.08E-08	3.08E-11	1.93E-03
12	5.32E-02	15	3.99E-01	1.25E-05	2.70E-03	2.20E-01	NA	NA	1	2.96E-09	4.39E-12	2.76E-04
11	4.97E-03	15	3.73E-02	9.65E-03	2.70E-03	2.20E-01	NA	1	1	2.14E-07	3.17E-10	1.99E-02
10	3.00E-04	15	2.25E-03	4.43E-02	2.70E-03	2.20E-01	0.05	1	1	2.96E-09	4.39E-12	2.75E-04
										2.40E-07	3.56E-10	2.23E-02
13	3.73E-01	5	9.33E-01	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	6.93E-09	1.03E-11	6.44E-04
12	5.32E-02	5	1.33E-01	1.25E-05	2.70E-03	2.20E-01	NA	NA	1	9.88E-10	1.46E-12	9.19E-05
11	4.97E-03	5	1.24E-02	9.65E-03	2.70E-03	2.20E-01	NA	0.05	1	3.56E-09	5.28E-12	3.31E-04
10	3.00E-04	5	7.51E-04	4.43E-02	2.70E-03	2.20E-01	0.05	0.05	1	4.93E-11	7.31E-14	4.59E-06
										1.15E-08	1.71E-11	1.07E-03
13	3.73E-01	45	8.40E+00	1.25E-05	2.70E-03	2.20E-01	NA	NA	NA	6.24E-08	9.24E-11	5.80E-03
12	5.32E-02	45	1.20E+00	1.25E-05	2.70E-03	2.20E-01	NA	NA	0.05	4.45E-10	6.59E-13	4.13E-05
11	4.97E-03	45	1.12E-01	9.65E-03	2.70E-03	2.20E-01	NA	0.05	0.05	1.60E-09	2.37E-12	1.49E-04
10	3.00E-04	45	6.76E-03	4.43E-02	2.70E-03	2.20E-01	0.05	0.05	0.05	2.22E-11	3.29E-14	2.06E-06
										6.44E-08	9.55E-11	5.99E-03
										3.32E-07	4.92E-10	3.09E-02