

BFN SEIS ANALYSIS

NUREG 1437 Vol. 1 Section 4.6.3 Occupational Radiation Dose

- I. Overview
 - A. Cumulative annual occupational dose baseline trend.
 - B. Projected increments to occupational dose due to extended plant operation.
 - C. Projections compared with 10CFR20 limit.
 - D. Compare projections with current experience
 - E. Estimate cancer risk
 - F. Compare projected cancer risk to spontaneous cancer risk
- II. Cumulative annual occupational dose baseline trend.
 - A. Industry annual average individual dose (rem/person-yr):
 1. NUREF-1437, Vol. 1, 4.6.3.1 Table 4.10;
 - a) BWR Average 1973-1992: 0.635
 - b) NUREG00713, 1992: 0.28 rem
 - c) 1992 NUREG-0713 # People; 4rem<Dose<5 rem: 3
 - d) 1992 NUREG-0713 % People > 2 rem: 0.5%
 2. NUREG-0713 Vol. 21, 1999 Commercial power Reactors (Table 3.2)
 - a) Average Annual Individual Dose; 0.091 rem
 - b) # People, 4 rem<Dose<5 rem: 0
 - c) % People > 2 rem: 0.017%; > 3 rem: 0.0013%
 - d) BWR Average Annual Individual Dose: 0.111 rem
 - e) % People (BWR) > 2 rem; 0.029%; > 3 rem: 0.0%
 3. BFE (1994-2000)
 - a) Average Annual individual Dose; 0.192 rem
 - b) Average % People > 2 rem: 0.056 %
 - c) # People; 2 rem < Dose < 3 rem; 18
 - d) # People >3 rem: 0
 4. BFN Data Calendar Year 2000
 - a) Average Individual Dose: 0.122 rem
 - b) % Monitored Personnel > 2 rem: 0.0%
 5. 10CFR20 Annual TEDE Dose Limit: 5 rem/yr
 - B. Maximum annual dose activities (10 year period)
 1. NUREG-1437, Vol. 1, 4.6.3.2 Greatest increment to occupational dose; 10 year In Service inspection (10y ISI): average BWR 10y ISI dose increment: 91 person-rem (Table 2.8 typical Scenario); 108 person-rem (Table 2.11 Conservative Scenario)
 2. **BFN RG-1.16 Data (1991-2000)**

BFN Average Individual Dose	
<u>Category</u>	<u>Rem/Person¹</u>
Routine Operations and Surveillance	0.139
Routine Plant Maintenance	0.243
In-Service Inspection	0.173
Special Maintenance	0.156
Waste Processing	0.130
Refueling	0.134
All Categories	0.193

¹ Monitored persons with cumulative dose greater than 0.1 rem during the monitoring year. NUREG-1437 assumes 10 year ISI to be conducted during one year of the 10 year inspection interval. BFN protracts the 10 year in service inspection scope uniformly on the fuel cycles within the service interval.

III. Projected Dose increments

- A. Assume linear proportional increase plant aging influence {NuReg 1437 V1:
Conservative scenario Table 2.11 and Table 3.12 [example ISI: $(451-360)/360 = 0.253$]}
1. Typical 1.5E6 man-h/y site operation and maintenance
 2. Typical BWR License Renewal (2.6.3.2 Table 2.8): 250 - 500 person-rem;
annualized basis (20 years) ~ 3-4% relative to current reactor operating
exposure
 3. Conservative BWR license Renewal (2.6.4.2 Table 2.11): 2300 - 2400 person-
rem; annualized basis (20 years) ~ 20-30% relative to current reactor operating
exposure
 4. Extended operation (20 year):
 - a) BFN U 2&3 Average Annual collective Dose (1994-2000): 438.126
person-rem
 - b) BFN Average Annual Collective Dose per Unit: 219.063 person-rem
 - c) BFN Three Year Rolling Average Collective Dose per Unit (1998-2000):
185 person-rem
 - d) Projected BFN Average Annual Collective Dose; Units 1, 2, 3 Operation
(219.063 X 3); 657.189 Person-rem
 - e) BFN U1,2,3 20y Extended operation (657.189*20): 12144 person-rem
 - f) NUREG-0713 Vol. 21 Annual Collective Dose per Unit (1973-1999):
560.317; Three Unit Operation Forecast: 1680.951
 - g) NUREG-0713 Vol. 21 Annual Collective Dose per Unit (1999): 184;
Three Unit Forecast: 552
 - h) BFN Dose Mitigation Initiatives: Chemical Decon, Zinc Pacification,
Stelite Removal, HWC & Noble Metals
 5. No age impact for BFN Units 2 & 3 (NUREG 1737 section 2.3)
 6. BFN Unit 1 Recovery: 7,385,000 man0hours in the radiological controlled areas,
protracted over 5 years (60 months)
 7. Unit 1 Recovery (shutdown ~ 15 years)
 - a) Estimate Unit 1 average dose rate from BFN radiation work permit data
average (1998 - May 2001), us current nuclide distribution to establish
radioactive decay factor
 - b) Estimated U1 recovery dose:
 $7.385E6 \text{ man-h} \times 0.73 \text{ mrem/h} \times 0.1446 = 780 \text{ person-rem}$
 - c) Annualized (20 years): 39 person-rem/year
 - d) Annualized (5 years): 152 person-rem/year
 8. NUREG-0713 Vol 21 BWR Data:
 - a) Annual collective dose per BWR unit (1999): 184 person-rem.
 - b) Average collective dose per BWR Unit (1973-1999): 560 person-rem
 - c) Average BWR Annual Collective dose (1973-1999): 15,502 person-rem
 9. Compare annualized U1 recovery dose projection to:
 - a) Annual collective dose per BWR Unit (1999) ~ 22%; within the bounded
condition of the "Conservative Scenario"
 - b) Average collective dose per BWR Unit (1973-1999) ~ 7%; comparable to
the "Typical Scenario" but not within the bounding conditions
 10. Compare BFN Facility extended operation (20y) {U1 Recovery + Projected
Operation}: (13144+ 780 = 13,923 person-rem)
 - a) BWR Collective Dose (1973-1999): 418,551 person-rem (3.3%)
 - b) BFN Facility Collective Dose (1971-2000): 28,138 person-rem (49.8%)

- B. Risk Analysis
1. US population natural background ~ 75 million person-rem/year; {1990 BEIR-V}; there may be no risk; estimate site annual collective dose also not significant.
 2. NUREG-0713 Vol. 21 Table 4.1;
 - a) BWR collective Dose (Person-rem); 1973-1999: 418,551
 - b) Average BWR Collective Dose (Person-rem); 1973-1999: 1550
 3. BFN Life of the Facility Total Collective Dose (1971 - 2000): 28128 person-rem.
 - a) U1 recovery ~ 2.7% of Collective BFN Facility Dose (780/28138)
 - b) Extended operations Collective Facility Dose (20 year): 13144 person-rem; excluding U1 recovery: ~ 46.7% current Collective Facility dose (13144/28138)
 - c) Total Facility Collective dose (Extended operations + U1 Recovery): 42062 person-rem.
 4. Fatal cancer risk $4E-4 \text{ rem}^{-4}$ Relative to U.S. Background:
 - a) US Background $75E6 \text{ person-rem/y}$; 30,000
 - b) BWR Collective ($75E6 + 418,557$): 30,168 ~ 0.56%
 - c) BFN U1 Recovery + 20 y extended operation ($7.5E7 + 13924$): 3005.57, <0.02% increase
 - d) BFN Collective + U1 Recovery + 20y extended ($75E6 + 28,138 + 13,923$): 30,017 ~ 0.056% increase
 - e) BWR Collective + BFN U1 Recovery + 20y extended operation ($75E6 + 13923 + 418557$): 30,173 ~ 0.57% increase.
 5. Fatal Cancer risk Relative to BWR Collective Dose:
 - a) BWR Collective (418,557): 167
 - b) BFN U1 Recovery = 20y extended operation (13,924 + 418557 person-rem): 173 ~ 3% increase
 - c) BFN Facility Collective dose + U1 Recovery _ U1,2,3 Extended operation ($418557 + 28138 + 13924$): 184, ~ 10% increase

- IV. Conclusions
- A. BFN annual dose accrual (Unit and Person) is comparable with current industry performance.
 - B. BFN radiation dose control program is compliant with federal guidance and ensures individual radiation dose remains below federal limits.
 - C. There are no age impact issues identified for Units 2 & 3 extended (20 year) operation.
 - D. Total occupational dose for Unit 1 restoration and three unit extended operation is 13,924 person-rem; ~ 3.3% increase relative to the BWR collective dose (1973-1999).
 1. Unit 1 Recovery: 780 person-rem
 2. Units 1,2,3 extended operation: 13144 person-rem
 - E. The proposed Unit 1 recovery ;and extended 10 year operation impact is bounded by the conditions defined by GEIS (NUREG-1437 Vol. 1).