# Attachment B

*Southern California Edison Company*

SAN ONOFRE NUCLEAR GENERATING STATION

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April 12, 1984

U. S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region V
1450 Maria Lane, Suite 210
Walnut Creek, California 94596-5358

Attention: Ray Fish, Team Leader
Emergency Preparedness Facility Appraisal

Subject: Docket No. 50-206/361/362
Dose Assessments for Scenarios Nos. 2, 5, 19 and 20
from NUREG/CR 3012, Volume 3
San Onofre Nuclear Generating Station, 1, 2 and 3

Per your request at the exit interview for the Emergency Preparedness Facility Appraisal, I have completed dose assessments using the EARS program for scenarios numbers 2, 5, 19 and 20 from NUREG/CR 3012, Volume 3. Copies of computer printouts of these assessments are attached for your review. The results of these dose assessments were compared to the results obtained from the IRADAM model utilized in the NUREG, and the following points were noted:

1) EARS currently uses a recirculation factor in the calculation of $^{X}/_{Q}$. The value of this factor varies from about 4 at the site boundary to 1.1 at 10 miles. As a result of the recirculation effect, the $^{X}/_{Q}$ value calculated by EARS is slightly higher than the $^{X}/_{Q}$ calculated by IRDAM.

2) EARMAN utilizes a mixing depth (inversion layer) value which acts as an upper boundary for reflection of a plume. This value is a variable and is entered by the user during meterological input. The current default for the mixing depth is 101 meters, as suggested by the Corporate Meterologist. I performed two runs of each scenario utilizing mixing depths of 101 meters and 1000 meters to demonstrate the effect of different mixing depths on the calculated $^{X}/_{Q}$ values. When the mixing depth is low, the $\sigma_z$ value quickly approaches the mixing height but cannot expand beyond this layer. As a result, the vertical dispersion is reduced and the concentration downwind is increased.

3) The dose rates at a distance downwind calculated by IRDAM are performed at slightly different locations than those calculated by EARS. For instance, EARS calculates the EAB dose rate at a distance of 580 meters, while IRDAM's first comparable calculation distance is for 500 meters.

4) Scenarios 19 and 20 were calculated by IRDAM as elevated releases; however, EARS calculates all releases at ground level. As a result of this difference in release height, the $^{X}/_{Q}$ values calculated by EARS are higher than those calculated by IRDAM for these two scenarios.

When all the differences noted in points 1 through 4 have been addressed, the values calculated by EARS agree to within a factor of 2 or better with the values calculated by IRDAM. This comparison has been tabulated in Attachment 1 for scenarios 2 and 5. Comparisons between EARS (with L equal to 1000) and IRDAM can be made directly at distances of 2 and 5 miles, and indirectly from the hand calculation at any other distance.

Similar extensive comparisons with EARS printouts and hand calculations have been done to verify that the computer calculations are performed correctly, however, these are contained in various memos and log books. We are currently assimilating these documents and the validations on meterological and RMS inputs performed by the Computer Group into one record. If you have any further questions regarding these or any other dose assessments provided, please contact me at (714) 492-7700, ext. 59-108.

Sincerely,

LINDA BRAY
Health Physics Engineer

Enclosures

cc: E. Branigan (USNRC Headquarters)

Table of Dose Rate (mr/hr) Calculations

| Scenario / Distance | 2 | EARS (L=101m) | EARS (L=1000m) | Hand Calculation* With Recirc Factor L = 101 | Hand Calculation* With Recirc Factor L = 1000 | Hand Calculation* Without Recirc Factor L = 101 | Hand Calculation* Without Recirc Factor L = 1000 | IRDAM |
|---|---|---|---|---|---|---|---|---|
| 0.3 mi. | | | | 19 | 19 | 4.8 | 4.8 | 4.97 |
| 0.36 mi. | | 7 | 9 | 16 | 16 | 4 | 4 | |
| 1 | | 2.6 | .8 | 2 | 1.65 | 0.7 | 0.5 | |
| 1.2 | | | | 1.52 | 1.25 | 0.5 | 0.38 | 0.189 |
| 2 | | 0.9 | .09 | 0.7 | 0.13 | 0.35 | 0.07 | 0.06 |
| 5 | | 0.3 | .03 | 0.13 | 0.01 | 0.13 | 0.01 | 0.01 |
| 10 | | 0.1 | .01 | 0.07 | 0.01 | 0.07 | 0.01 | |
| 12.4 | | | | 0.05 | 0.007 | 0.05 | 0.007 | 0.005 |
| 0.3 | 5 | | | 5.6E4 | 5.6E4 | 1.4E4 | 1.4E4 | 1.6E4 |
| 0.36 | | 5E4 | 8E4 | 4.7E4 | 4.7E4 | 1.2E4 | 1.2E4 | |
| 1 | | 1.1E4 | 3.6E3 | 5E3 | 4.7E3 | 1.7E3 | 1.6E3 | |
| 1.2 | | | | | | 1.3E3 | 1.2E3 | 6.18E2 |
| 2 | | 3.5E3 | 3.6E2 | 2E3 | 4E2 | 1E3 | 2E2 | 1.97E2 |
| 5 | | 9.8E2 | 1.E2 | 4E2 | 4E1 | 4E2 | 4E1 | 3.6E1 |
| 10 | | 4.6E2 | 4.7E1 | 2E2 | 2E1 | 2E2 | 2E1 | |
| 12.4 | | | | 1.4E2 | 1.4E1 | 1.4E2 | 1.4E1 | 1.6E1 |

*Example Hand Calculations are included in Attachment 2.

ATTACHMENT 2

Hand Calculations of Dose Assessments
for Scenarios 2, 5, 19 and 20 of NUREG/CR 3012

1. Scenario #2

Input: Windspeed $\mu$ = 4.5 mps
Stability Class = B
Gross release rate = 1 Ci/sec total Noble gas
Initial effective age = 2 hours
Duration of release = 8 hours

Based on Stability Class B

| Distance Downwind | EAB | 1 mile | 2 miles | 5 miles | 10 miles |
|---|---|---|---|---|---|
| $\sigma_z$ | 60 | 220 | 800 | 8,600 | 44,000 |
| $\sigma_y$ | 90 | 200 | 400 | 900 | 1,700 |

With Mixing Height L

for $\sigma_z < 2L$ $\quad \chi/Q = \dfrac{K}{\pi \delta_y \sigma_z u} \left[1 + 2 \sum_{n=1}^{7} \exp\left(-2 \left(\dfrac{nL}{\delta z}\right)^2\right)\right]$

for $\delta_z \geq 2L$ $\quad \chi/Q \cong \dfrac{K}{2\pi \delta_y L u}$

where K = recirculation factor : $K = 4$ if $d \leq 1200$
$K = 1$ if $d \geq 1500$, otherwise
$K = -2.59814(\log_{10} d)^3 + 31.70108 \log_{10} d^2$
$129.38097 \log_{10} d + 177.6703$

D (whole body dose rate) = $\chi/Q \times Q \times DCF \times 1.14\ E2 \times CR$

where DCF = dose conversion factor $\dfrac{\text{mrem} - \text{m}^3}{\text{yr} \quad \mu\text{Ci}} \cong 2.94\ E2$ for Xe-133

1.14 E2 = conversion to $\dfrac{\text{mrem m}^3}{\text{hr Ci}}$

CR = correction factor for gas age $\cong$ 10

A) Case 1 : L = 101m

at EAB : $\chi/Q$ EAB $= \dfrac{4}{\pi(60)(90)(4.5)}[1 + .01] = 5\ E\text{-}5$

at 1 mile $\delta_z > 2L$, K = 3

$$\chi/Q \cong \frac{3}{2\pi(200)(101)4.5} = 5.3\ E\text{-}6$$

at 2 miles K = 2

$$\chi/Q = \frac{2}{2\pi(400)(101)4.5} = 2\ E\text{-}6$$

at 5 miles K = 1

$$\chi/Q = \frac{1}{2\pi(900)(101)4.5} = 4\ E\text{-}7$$

at 10 miles K = 1

$$\chi/Q = \frac{1}{2\pi(1,700)(101)4.5} = 2\ E\text{-}7$$

$$\therefore\ D_{EAB} = (\chi/Q)_{EAB} \times 1\ \frac{Ci}{sec} \times 2.94\ E2 \times 1.14\ E2 \times 10 = 4\ E\text{-}5 \times (3.3\ E5)$$

$$\cong 16\ \text{mrem/hr}$$

$$D_{1\ \text{mile}} = (\chi/Q)_{1\ \text{mile}} \times 3.35E5 \cong 2\ \text{mrem/hr}$$

$$D_{2\ \text{miles}} = (\chi/Q)_{2\ \text{miles}} \times 3.35E5 \cong 0.7\ \text{mrem/hr}$$

$$D_{5\ \text{miles}} = (\chi/Q)_{5\ \text{miles}} \times 3.35E5 \cong 0.13\ \text{mrem/hr}$$

$$D_{10\ \text{miles}} = (\chi/Q)_{10\ \text{miles}} \times 3.35E5 \cong 0.07\ \text{mrem/hr}$$

B) Case 2 L = 1000m (Comparable to IRDAM treatment of mixing depth, includes variable recirculation factor)

at EAB : $(\chi/Q) = \frac{4}{\pi(60)(90)(4.5)} [1 + 2 \sum_{n=1}^{7} \exp\left(-2 \left(\frac{nL}{\delta_z}\right)^2\right)]$

$\cong \frac{4}{\pi(60)(90)(4.5)} [1 + \cong 0]$

$\cong$ 5 E-5

at 1 mile $(\chi/Q) = \frac{3}{\pi(220)(200)4.5} [1 + \cong 0]$

= 5 E-6

at 2 miles $(\chi/Q) = \frac{2}{\pi(800)(400)4.5} [1 + \cong 0]$

= 4 E-7

at 5 miles $(\chi/Q) = \frac{1}{2\pi(900)(1000)4.5}$

= 4 E-8

at 10 miles $(\chi/Q) = \frac{1}{2\pi(1700)(1000)4.5}$

= 2 E-8

$\therefore D_{EAB}$ = 5 E-5 x 3.35E5 $\cong$ 16

$D_{1 \text{ mile}}$ = 4 E-6 x 3.35E5 $\cong$ 1.65

$D_{2 \text{ miles}}$ = 0.13

$D_{5 \text{ miles}}$ = 0.01

$D_{10 \text{ miles}}$ = 0.01

II. Scenario #5

Same meterological inputs as Scenario #2, therefore, same $^{\chi}/_{Q}$ values.

Gross release rate = 1 Ci/sec Iodine

$$D_{Thy} = (^{\chi}/_{Q}) \times Q \times THYDCF \times 3.6\ E6 \times CR$$

where THYDCF = dose conversion factor for I-131 ≅ 5.15 E2 $\frac{rem\ m^3}{sec\ Ci}$

3.6 E6 = converts rem/sec to mrem/hr

CR = correction for gas mix age ≅ 0.5

A) Case 1 : L = 101m

at EAB $D_{THY} = (^{\chi}/_{Q}) \times 1 \times 5.15\ E2 \times 3.6\ E6 \times 0.5 = {}^{\chi}/_{Q} \times 9.3\ E8$

$= 5\ E\text{-}5\ \frac{sec}{m^3} \times 9.3\ E8$

$\cong 4.7\ E4$ mrem/hr

at 1 mile $D_{THY} = 5.3\ E\text{-}6 \times 9.3\ E8 \cong 5\ E3$ mrem/hr
at 2 miles $D_{THY} = 2\ E\text{-}6 \times 9.3\ E8 \cong 2\ E3$ mrem/hr
at 5 miles $D_{THY} = 4\ E\text{-}7 \times 9.3\ E8 \cong 4\ E2$ mrem/hr
at 10 miles $D_{THY} = 2\ E\text{-}7 \times 9.3\ E8 \cong 2\ E2$ mrem/hr

B) Case 2 : L = 1000m

at EAB $D_{THY} = 5\ E\text{-}5 \times 9.3\ E8 \cong 4.7\ E4$ mrem/hr
at 1 mile $D_{THY} = 5\ E\text{-}6 \times 9.3\ E8 \cong 4.7\ E3$
at 2 miles $D_{THY} = 4\ E\text{-}7 \times 9.3\ E8 \cong 4\ E2$
at 5 miles $D_{THY} = 4\ E\text{-}8 \times 9.3\ E8 \cong 4\ E1$
at 10 miles $D_{THY} = 2\ E\text{-}8 \times 9.3\ E8 \cong 2\ E1$

# Attachment C

Message:

RADIOLOGICAL ACTION LEVEL @ 84/03/29 1900 : Alert

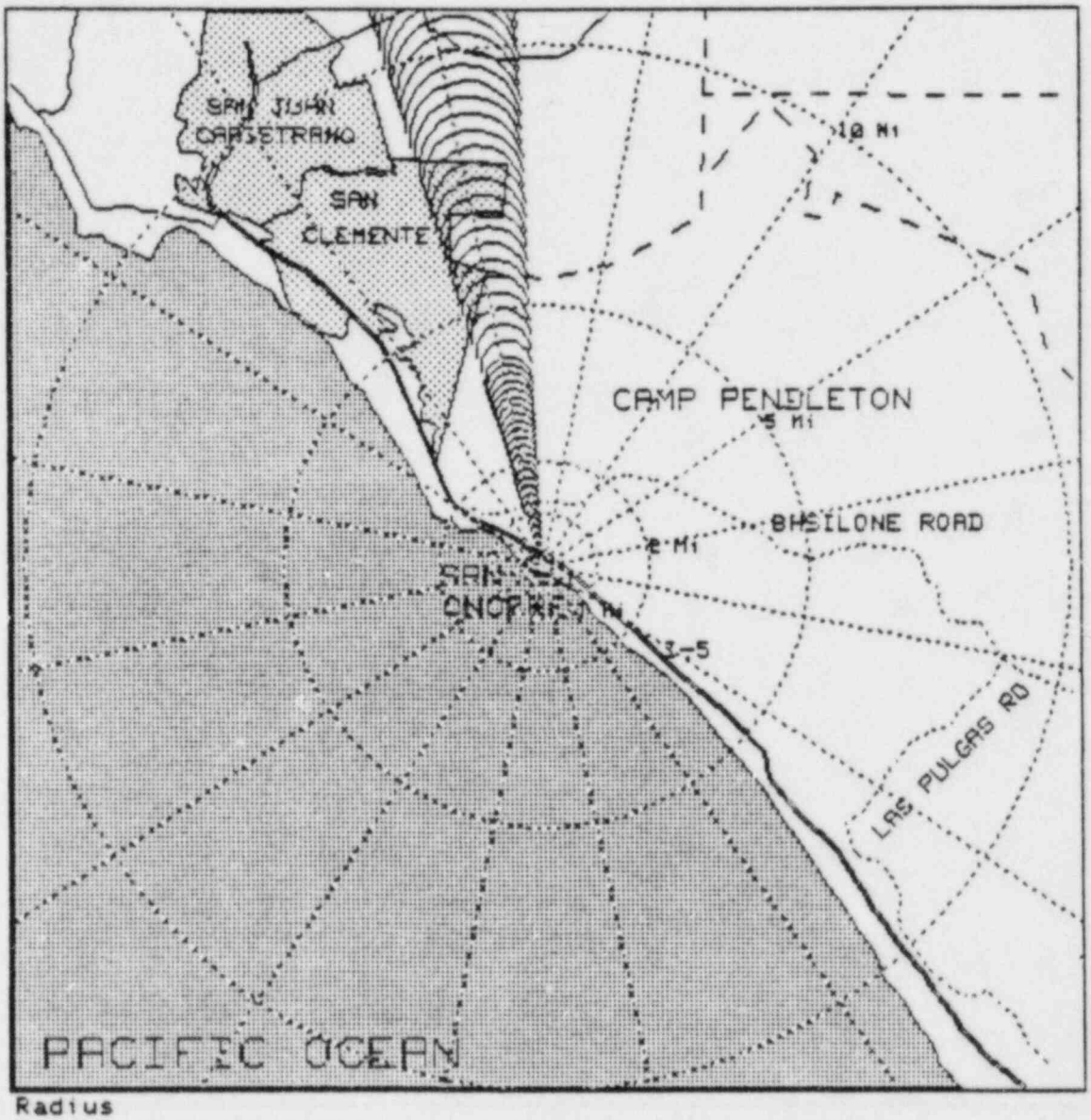
| DOSE TYPE | CLASS A MODEL CURRENT ESTIMATE @ EAB | SEC-TOR | EMERGENCY CLASS CRITERION UNUSUAL EVENT | ALERT | SITE EMERGENCY | GENERAL EMERGENCY |
|---|---|---|---|---|---|---|
| TECH SPEC. WHOLE BODY (N.GASES ONLY) | 1.7E+00 mrem/hr | A | .057* mrem/hr (A1-1) | .570* mrem/hr (A2-1) | ---- | ---- |
| TECH SPEC. SKIN | 4.0E+00 mrem/hr | A | .340* mrem/hr (A1-1) | 3.400* mrem/hr (A2-1) | ---- | ---- |
| TECH SPEC. THYROID | 8.5E-03 mrem/hr | A | .170 mrem/hr (A1-1) | 1.700 mrem/hr (A2-1) | ---- | ---- |
| EPA P.A.G. WHOLE BODY | 3.0E+00 mrem | A | ---- | ---- | 500 mrem (A3-8) | ---- |
| EPA P.A.G. THYROID | 1.7E-02 mrem | A | ---- | ---- | 5000 mrem (A3-8) | ---- |
| NUREG 0654 WHOLE BODY (ALL ISOTOPES) | 1.5E+00 mrem/hr | A | ---- | ---- | 50 mrem/hr (A3-3) | 500 mrem/hr (A4-1) |
| NUREG 0654 THYROID | 8.5E-03 mrem/hr | A | ---- | ---- | 250 mrem/hr (A3-4) | 5000 mrem/hr (A4-2) |

* Identifies Any Value Which Exceeds the Radiological Action Level

NOTE: The Above Calculations are based on a CHI/Q of 5.0E-05 Calculated from the Most Recently Entered MET Data.

NOTE: State of California Regulations Require the Site and General Emergency Values to be 500 mrem (mrem/hr) rather than 1000 mrem (mrem/hr) as recommended for Whole Body Exposure by NUREG 0654 and EPA P.A.G.

# Attachment D




10 Mile Radius
Release Start: 84/03/28 1005
Plume Update: 84/03/28 1205

Wind Speed: 4.0 M/sec
Wind Dir. : 170.0 Deg

Edge Dose Rate & Type: 6.1E-02 mrem/hr (THYROID)