# RADIOLOGICAL DATA PREPARED FOR THE RESOLUTION OF USI A-46

ST LUCIE UNIT 1 AND TURKEY POINT UNITS 3 AND 4
NUCLEAR POWER PLANT SITES

Prepared By

Ebasco Services Inc.

Greensboro, North Carolina

# UNRESOLVED SAFETY ISSUE A-46 OFFSITE IMPACT ANALYSIS

## ST. LUCIE UNIT 1 AND TURKEY POINT UNITS 3 & 4

### 1. INTRODUCTION

The issue of Seismic Qualification of Mechanical and Electrical Equipment in Operating Nuclear Power Plants was designated by the Nuclear Regulatory Commission (NRC) as Unresolved Safety Issue A-46 (USI A-46) in December, 1980. In order to address USI A-46, the NRC determined that each licensee of an operating plant not previously reviewed to current seismic criteria would be required to perform a seismic verification review of that plant. Furthermore, the NRC determined that this requirement is a backfit as defined by 10 CFR 50.109 and must therefore be justified by a value/impact analysis.

As required by the backfit rule, a generic value/impact analysis was performed by the NRC. The results of this analysis, which are presented in NUREG-1211 [1]*, show that a seismic review will result in a significant safety benefit. The value/impact analysis consists of a qualitative assessment and quantitative examples. One of the quantitative examples discussed in the NUREG is the analysis of the failure of an electrical cabinet anchorage following a safe shutdown earthquake (SSE) and the subsequent release of radioactive material.

Based on the conclusions drawn in NUREG-1211, the NRC published a list of power plants that are required to perform a seismic verification review. Florida Power and Light has three reactors on the list: St. Lucie Unit 1 and Turkey Point Units 3 & 4. To help determine whether a seismic review is cost-effective for St. Lucie Unit 1 and Turkey Point Units 3 & 4, plant-specific analyses of the ten hypothetical PWR accidents described in WASH-1400 were performed for the two sites. Since the Turkey Point reactors have the same specifications, a single set of analyses were performed for the two units, which will be hereafter referred to simply as Turkey Point.

---

*Numbers in square brackets are reference numbers, followed (in some cases) by page or table number

## 2. METHODOLOGY

The Calculation of Reactor Accident Consequences, Version 2 (CRAC2) computer code was used to assess releases of radioactive materials from hypothetical accidents involving St. Lucie 1 or Turkey Point. The CRAC computer code was originally developed by Sandia National Laboratories to support the Reactor Safety Study, WASH-1400. Version 2 of the code contains corrections and improvements over the original code used in the preparation of WASH-1400.

### 2.1 Input Data

The code includes all necessary data to perform generic analyses. To perform a plant-specific analysis, certain of these data sets had to be modified. These included the radionuclide core inventory of each reactor, the population distribution in the area surrounding the site, and the local meteorology.

#### 2.1.1 Radionuclide core inventories

WASH-1400 [2:3-3] lists a radionuclide inventory for a typical Westinghouse four-loop PWR with a power level of 3200 Mwt. These data are included with the CRAC2 code. The most recent available data on the St. Lucie 1 core inventory is contained in an Exxon Nuclear report [3:Table 3.3]. That report, however, lists values only for radioisotopes of iodine, cesium, tellurium and the noble gases; CRAC2 requires a much longer list of radionuclides. Since the buildup of radionuclides in the core depends on the power level, it is reasonable to calculate the core inventory of a given reactor by multiplying the WASH-1400 inventories by the ratio of the power level of that reactor to the power level of the WASH-1400 reactor.

St. Lucie 1 has a stretch power level of 2700 MWt. To model accidents involving this plant, each of the WASH-1400 core inventory was multiplied by the factor 2700/3200 = 0.84. The power levels of the Turkey Points Units 3 & 4 are rated at 2200 MWt. The Turkey Point inventory was calculated by multiplying the WASH-1400 activities by the ratio 2200/3200 = .69. The validity of this approximation for St. Lucie 1 was verified by comparing the inventories of three radiologically significant radionuclides listed in the Exxon report to the values calculated for the CRAC2 analyses. These calculated invetories are shown in Table 1, below.

Table 1

COMPARISON OF CORE INVENTORY CALCULATIONS FOR ST. LUCIE 1

| Nuclide | Core Inventory (curies) | | |
|---|---|---|---|
| | WASH-1400[a] | Exxon[b] | CRAC2 |
| I-131 | 8.5E+7 | 7.84E+7 | 7.17E+7 |
| I-133 | 1.7E+8 | 1.47E+8 | 1.43E+8 |
| Xe-133 | 1.7E+8 | 1.47E+8 | 1.43E+8 |

[a]See ref. [2:3-3]

[b]See ref. [3:Table 3.3].

The inventories of all three nuclides, as calculated for use by the CRAC2 code, are close to those in the Exxon report.

2.1.2 Meteorological data

Site-specific meteorological data was used for both the St. Lucie 1 and Turkey Point analyses. The St. Lucie Unit 2 Updated FSAR [6] contains comprehensive meteorological data for the St. Lucie site, which is occupied by both units. This data, which is in the form of a joint frequency distribution, is shown in Table 2, below. Since CRAC2 only recognizes six Pasquill stability classes, the frequencies for class G were added to those of class F in the input data file.

Table 2

ST. LUCIE SITE

PERCENT JOINT FREQUENCY OF OCCURRENCE OF WIND SPEED AND STABILITY CLASS

| Stability Class | Wind Speed Range (Meters per Second) | | | | | |
|---|---|---|---|---|---|---|
| | 0.0-1.5 | 1.5-3.0 | 3.0-5.0 | 5.0-7.5 | 7.5-10.0 | >10.0 |
| A | .12 | 2.34 | 7.96 | 1.59 | .01 | .00 |
| B | .09 | 1.18 | 2.21 | .32 | .04 | .00 |
| C | .15 | 1.33 | 2.16 | .34 | .02 | .00 |
| D | 1.58 | 10.28 | 14.62 | 2.85 | .24 | .01 |
| E | 7.33 | 19.66 | 15.25 | 2.70 | .14 | .02 |
| F | 1.54 | 2.29 | .32 | .02 | .00 | .00 |
| G | .69 | .63 | .01 | .00 | .00 | .00 |

A similar table was compiled for Turkey Point by utilizing data collected at the FP&L South Dade site, located about 6 1/2 miles SSW of the Turkey Point control room. Hourly data for the years 1985 and 1987 (the most recent years for which complete data were available) were used to produce a single set of joint frequencies, shown in Table 3, below.

Table 3

TURKEY POINT

PERCENT JOINT FREQUENCY OF OCCURRENCE OF WIND SPEED AND STABILITY CLASS

| Stability | Wind Speed Range (Miles per Hour) | | | | | | |
|---|---|---|---|---|---|---|---|
| Class | 0 - 3 | 3 - 7 | 7 - 12 | 12 - 15 | 15 - 18 | 18 - 24 | > 24 |
| A | 0.03 | 1.10 | 6.05 | 2.78 | 0.43 | 0.07 | 0.01 |
| B | 0.02 | 0.89 | 3.78 | 1.16 | 0.24 | 0.02 | -- |
| C | 0.06 | 1.45 | 3.68 | 0.93 | 0.28 | 0.05 | 0.01 |
| D | 0.89 | 7.45 | 12.92 | 3.28 | 0.85 | 0.21 | 0.01 |
| E | 4.06 | 17.62 | 11.83 | 1.49 | 0.37 | 0.13 | 0.02 |
| F | 4.20 | 6.56 | 0.23 | 0.01 | 0.01 | 0.00 | 0.00 |
| G | 1.22 | 3.43 | 0.09 | 0.07 | 0.02 | 0.00 | 0.00 |

Wind direction frequency data (i.e., the data which is used in constructing a wind rose) must be entered separately into the CRAC2 input files. Since this data is used in conjunction with non-uniform population distributions, it is listed along with the population distributions around the two sites in Tables 4 and 5, below.

### 2.1.3 Population distribution

St. Lucie 1

Two sets of analyses for were performed for St. Lucie 1. One set models an accident occurring at the present time. It utilized the estimated population distribution in the St. Lucie site vicinity for the year 1983, the most recent year for which such data was available. The other analyses predict the impact of a hypothetical accident occuring near the end of the plant's life, and utilized the projected distribution for the year 2030. The data for both distributions were taken from the St. Lucie 2 Updated FSAR [6:Figs. 2.1-5 & 2.1-7].

For the purpose of calculating off-site impacts, the area surrounding the site is divided into five concentric rings. Since there are no inhabitants within one mile of the center of the site, the first ring lies between one and ten miles of the center. All subsequent rings are ten miles wide, as measured from the inner to the outer radius. Each of the rings is further subdivided into 16 angular segments, one for each major direction of the compass, yeilding a total of 80 sectors. The populations of each sector are listed in Table 4, below.

Turkey Point

Two sets of analyses were also performed for Turkey Point: one utilized a distribution computed from the actual 1980 census data, while the other used the projected distribution for 2020, which was based on the 1980 data [4]. Since there are no inhabitants within three miles of the center of the site, the first ring lies between three and ten miles of the center. Otherwise, the population sectors were constructed in the same manner as those for St. Lucie. The 1980 and projected 2020 populations of each sector are listed below.

Table 4

POPULATION DISTRIBUTION AND WIND FREQUENCY IN THE ST. LUCIE SITE VICINITY

| Direction from site | Distance From Site to Outer Edge of Sector (miles): 10 | 20 | 30 | 40 | 50 | Wind Frequency[b] |
|---|---|---|---|---|---|---|
| N | 124[a] | 0 | 0 | 0 | 0 | 5.43 |
| | 380 | 0 | 0 | 0 | 0 | |
| NNE | 0 | 0 | 0 | 0 | 0 | 6.32 |
| | 0 | 0 | 0 | 0 | 0 | |
| NE | 0 | 0 | 0 | 0 | 0 | 6.20 |
| | 0 | 0 | 0 | 0 | 0 | |
| ENE | 0 | 0 | 0 | 0 | 0 | 4.21 |
| | 0 | 0 | 0 | 0 | 0 | |
| E | 0 | 0 | 0 | 0 | 0 | 3.63 |
| | 0 | 0 | 0 | 0 | 0 | |
| ESE | 0 | 0 | 0 | 0 | 0 | 4.21 |
| | 0 | 0 | 0 | 0 | 0 | |
| SE | 130 | 0 | 0 | 0 | 0 | 6.87 |
| | 295 | 0 | 0 | 0 | 0 | |
| SSE | 4491 | 11916 | 24633 | 75324 | 153388 | 6.48 |
| | 11303 | 29764 | 55348 | 184360 | 272151 | |
| S | 11859 | 28387 | 761 | 8902 | 91074 | 5.86 |
| | 25969 | 70904 | 1653 | 21948 | 223866 | |
| SSW | 39216 | 4250 | 5389 | 685 | 5478 | 4.05 |
| | 28741 | 26989 | 13460 | 1643 | 11705 | |
| SW | 10977 | 2808 | 2581 | 152 | 14380 | 5.25 |
| | 59677 | 46175 | 6446 | 379 | 30727 | |
| WSW | 15582 | 0 | 0 | 11888 | 724 | 6.40 |
| | 118839 | 44601 | 0 | 26113 | 1628 | |
| W | 2791 | 2580 | 0 | 10898 | 3205 | 6.11 |
| | 45031 | 3975 | 0 | 23936 | 6370 | |
| WNW | 7979 | 695 | 0 | 0 | 172 | 9.78 |
| | 26311 | 1169 | 0 | 0 | 411 | |
| NW | 36014 | 1620 | 1491 | 3050 | 0 | 9.81 |
| | 38055 | 32743 | 7082 | 14472 | 0 | |
| NNW | 3610 | 4749 | 5550 | 4199 | 2871 | 8.82 |
| | 17842 | 15152 | 96380 | 30301 | 36025 | |

[a]The first value for each sector is the estimated 1983 population, the value under it is the projected 2030 population.

[b]Wind frequency in percent, calculated from data in the ref. [6:Table 2.3-28]

Table 5

POPULATION DISTRIBUTION AND WIND FREQUENCY IN THE TURKEY POINT SITE VICINITY[a]

| Direction from site | Distance From Site to Outer Edge of Sector (miles): 10 | 20 | 30 | 40 | 50 | Wind Frequency[b] |
|---|---|---|---|---|---|---|
| N | 7367 | 195780 | 349855 | 237122 | 285429 | 4.12 |
| | 10091 | 265232 | 469171 | 339939 | 529725 | |
| NNE | 0 | 8945 | 420427 | 330024 | 182125 | 3.37 |
| | 0 | 11277 | 565446 | 446225 | 283476 | |
| NE | 0 | 0 | 0 | 0 | 0 | 3.44 |
| | 0 | 0 | 0 | 0 | 0 | |
| ENE | 0 | 0 | 0 | 0 | 0 | 2.97 |
| | 0 | 0 | 0 | 0 | 0 | |
| E | 0 | 0 | 0 | 0 | 0 | 3.64 |
| | 0 | 0 | 0 | 0 | 0 | |
| ESE | 0 | 0 | 0 | 0 | 0 | 3.62 |
| | 0 | 0 | 0 | 0 | 0 | |
| SE | 0 | 0 | 0 | 0 | 0 | 5.26 |
| | 0 | 0 | 0 | 0 | 0 | |
| SSE | 649 | 0 | 0 | 0 | 0 | 9.09 |
| | 1029 | 0 | 0 | 0 | 0 | |
| S | 0 | 2161 | 196 | 0 | 0 | 6.13 |
| | 0 | 3457 | 313 | 0 | 0 | |
| SSW | 6 | 6 | 5515 | 4997 | 1369 | 2.67 |
| | 8 | 8 | 8808 | 7937 | 2157 | |
| SW | 6 | 0 | 0 | 0 | 0 | 5.98 |
| | 8 | 0 | 0 | 0 | 0 | |
| WSW | 12 | 29 | 0 | 0 | 0 | 8.51 |
| | 16 | 40 | 0 | 0 | 0 | |
| W | 7505 | 2570 | 0 | 0 | 0 | 15.91 |
| | 10260 | 3467 | 0 | 0 | 0 | |
| WNW | 33795 | 11057 | 0 | 0 | 0 | 12.30 |
| | 46066 | 14843 | 0 | 0 | 0 | |
| NW | 23859 | 8797 | 0 | 0 | 0 | 7.68 |
| | 32687 | 12029 | 0 | 0 | 0 | |
| NNW | 11061 | 69005 | 10773 | 0 | 0 | 5.31 |
| | 15155 | 96065 | 14867 | 0 | 0 | |

[a]Data are from reference [4]. The first value for each sector is the 1980 census population, the value under it is the projected 2020 population.

[b]Wind frequencies in percent, calculated from data collected at South Dade site (see text).

## 3. VERIFICATION

To check the validity using CRAC2 to perform the value/impact analyses, the code was used to calculate the conditional public dose resulting from a hypothetical PWR 2 release from the Byron plant, using the assumptions listed in NUREG-1211 in the discussion of the seismic failure of an electrical cabinet anchorage. The object of this analysis was to compare the CRAC2 calculated dose to that stated in the NUREG.

### 3.1 Input Data

For this case the data used are from NUREG-1211 (i.e., a power level of 1120 MWe and a uniform population density of 340 persons per square mile). When data were not specified in NUREG-1211, data from WASH-1400 were used. The latter include the core inventory [2:3-3] and joint frequency meteorological data for a central midwest plains site [2:5-4], listed in Table 6, below.

Table 6

CENTRAL MIDWEST PLAIN SITE

PERCENT JOINT FREQUENCY OF OCCURRENCE OF WIND SPEED AND STABILITY CLASS

| Stability Class | Wind Speed Range (Meters per Second) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 - 1 | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | > 7 |
| A No Rain | .41 | 1.43 | 1.92 | 2.05 | 2.08 | 1.24 | .75 | .98 |
| Rain | .01 | .03 | .06 | .01 | .03 | .05 | .03 | .03 |
| B No Rain | .35 | .78 | .65 | .76 | .63 | .20 | .18 | .26 |
| Rain | .02 | .00 | .01 | .00 | .00 | .03 | .02 | .00 |
| C No Rain | .59 | 1.13 | 1.00 | .82 | .94 | .42 | .25 | .35 |
| Rain | .02 | .02 | .06 | .07 | .05 | .02 | .00 | .01 |
| D No Rain | 3.87 | 5.95 | 6.22 | 5.57 | 5.22 | 2.05 | 1.78 | 2.16 |
| Rain | .18 | .50 | .56 | .71 | .51 | .31 | .32 | .33 |
| E No Rain | 5.48 | 5.75 | 4.81 | 3.18 | 2.13 | 1.13 | .04 | 1.11 |
| Rain | .24 | .20 | .40 | .37 | .18 | .06 | .02 | .00 |
| F No Rain | 9.46 | 3.77 | 1.77 | .38 | .09 | .01 | .00 | .03 |
| Rain | .15 | .07 | .02 | .03 | .01 | .00 | .00 | .00 |

### 3.2 Result of Verification

The conditional public dose calculated by CRAC2 was 4.4E+6 man-rem. This compares favorably with the NUREG-1211 value of 5E+6 man-rem, particularly if, as is likely, the NUREG-1211 value is the NUREG/CR-3568 [5] value of 4.8E+6 man-rem rounded to one significant figure. The difference in the two values might be explained if the NUREG/CR-3568 analysis utilized hourly averaged data from the Byron site rather than the joint frequency table shown above. In any case, the values are sufficiently close to justify the use of the CRAC2 methodology for the site-specific value/impact analysis.

## 4. RESULTS

The calculated collective radiological absorbed dose-equivalents to the populations within 50 miles of the St. Lucie and the Turkey Point sites, respectively, due to the ten postulated reactor accidents are listed in Table 7, below. Also listed is the average dose-equivalent, calculated by weighting each of the ten values by the probability of occurrence of that accident. A complete description of each of the accident scenarios can be found in ref. [2:2-1] (attached).

Table 7

COLLECTIVE ABSORBED DOSE-EQUIVALENTS WITHIN 50 MILES (MAN-REM)

| Release Category[a] | Site: | St. Lucie | | Turkey Point | |
|---|---|---|---|---|---|
| | Year: | 1983 | 2030 | 1980 | 2020 |
| PWR 1A | | 2.5E+6 | 7.5E+6 | 3.2E+6 | 4.4E+6 |
| PWR 1B | | 1.2E+6 | 3.4E+6 | 2.2E+6 | 2.9E+6 |
| PWR 2 | | 1.7E+6 | 4.8E+6 | 2.5E+6 | 3.3E+6 |
| PWR 3 | | 2.1E+6 | 5.8E+6 | 2.9E+6 | 3.9E+6 |
| PWR 4 | | 9.9E+5 | 2.8E+6 | 1.4E+6 | 1.9E+6 |
| PWR 5 | | 4.7E+5 | 1.4E+6 | 5.5E+5 | 7.4E+5 |
| PWR 6 | | 7.5E+4 | 2.0E+5 | 7.2E+4 | 9.1E+4 |
| PWR 7 | | 1.3E+3 | 3.0E+3 | 1.3E+3 | 1.6E+3 |
| PWR 8 | | 4.3E+4 | 1.1E+5 | 3.8E+4 | 4.8E+4 |
| PWR 9 | | 7.4E+1 | 1.5E+2 | 7.0E+1 | 8.2E+1 |
| Weighted Average | | 3.6E+4 | 1.0E+5 | 4.9E+4 | 6.6E+4 |

[a]See ref. [2:2-1]

## 5. CONCLUSIONS

The calculation presented in NUREG-1211 [5:19], used as a quantitative example of potential value/impact, employed a conditional public dose of 5E+6 man-rem for a PWR 2 release. All four PWR 2 releases calculated in the present study result in doses that are less than or equal to this value.

## REFERENCES

1. Chang, T. Y. and N. R. Anderson, 1987: Regulatory Analysis for Resolution of Unresolved Safety Issue A-46, Seismic Qualification of Equipment in Operating Plants. NUREG-1211, U.S. Nuclear Regulatory Commission.

2. Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, App. VI. WASH-1400, U.S. Nuclear Regulatory Commission, 1975.

3. Exxon Nuclear Company, Inc.: St. Lucie Unit 1 Radiological Assessment of Postulated Accidents. XN-NF-84-85(P), Rev. 1.

4. Bolch, W. E., 1986: Population Density Within a Fifty Mile Radius of the Turkey Point Nuclear Facility. (Unpublished).

5. Battelle Pacific Northwest Laboratory: Handbook for Value-Impact Assessment. NUREG/CR-3568, U.S. Nuclear Regulatory Commission, 1983.

6. Florida Power & Light Company: St. Lucie Plant Unit No. 2, Updated Final Safety Analysis Report.

## ANALYSIS AND CONCLUSIONS

A. Generic Letter 81-14 (Seismic Qualification of Auxiliary Feedwater Systems)

Before discussing Generic Letter 87-02, it is instructive to review the NRC staff's use of risk analysis technology and Value/Impact studies, under the umbrella of 10CFR50.109, to resolve Generic Letter 81-14 at Oconee Units 1, 2, and 3, on a plant specific basis. A copy of the analysis prepared by the Reliability and Risk Assessment Branch is enclosed in this section.

(1) The NRC staff accepted the use of plant specific data in response to the Generic Letter.

(2) The plant specific data, using risk analysis technology, and Value/Impact studies performed by the NRC, provided an upper bound estimate of the risk worth as being $540,000 worth of safety improvement.

(3) The NRC staff agreed to conclude the issue without requiring the Oconee units to seismically qualify their two seismically unqualified AFWS pumps because to do so would exceed $540,000. Instead, a course of action based upon risk analysis technology and unrelated to the seismic qualification of the AFWS pumps but costing less than $540,000 was agreed upon, and a Safety Evaluation Report was written.

B. Unresolved Safety Issue (USI) A-45 (Shutdown Decay Heat Removal

It is also instructive to review the use of risk analysis technology and Value/Impact studies under the umbrella of

10CFR50.109 to resolve USI A-45. Studies to date show that it would not be prudent management of the nuclear industry's resources if the "dedicated system" or other proposed physical changes were to be imposed on the industry.

FPL participated with Sandia National Laboratories in its A-45 evaluations at both St. Lucie Unit 1 (NUREG/CR-4710) and at Turkey Point Units 3/4 (NUREG/CR-4762). Many similarities exist between (the seismic portion of) A-45 and A-46 and the NRC has also recognized this by providing many references from A-45 in NUREG 1211.

In the referenced NUREGs, Sandia prepared seismic risk assessments for St. Lucie Unit 1 and Turkey Point Units 3/4, and performed extensive seismic walkdowns in 1986. The Sandia conclusions may be summarized as follows:

NUREG/CR-4710

St. Lucie Unit 1 (SSE=0.10g)

(1) The region is seismically benign

(2) Appendix A to 10CFR.100 mandates a minimum SSE of 0.10g, otherwise the SSE might be 0.09g as calculated by Sandia.

(3) All components examined had median failure acceleration levels above the SSE.

(4) The components with the minimum seismic margin were:

(a) Refueling Water Storage Tank .

Buckling with Anchor Bolt Yielding at 0.24g

(b) Condensate Storage Tank

Buckling with Anchor Bolt Yielding at 0.26g

(5) The present potential radiation exposure to the public due to seismic hazard is 1.83 man-rem/year. At a value of $1,000 per man-rem, this is $1830 at a seismic level of 0.24g. Sandia calculated this value using the probabilistically generated sum of all WASH 1400 release categories.

NUREG/CR-4762

Turkey Point Units 3/4 (SSE = 0.15g)

(1) The region is seismically benign

(2) If the procedures in Appendix A to 10CFR100 were applied to Turkey Point, a value of peak ground acceleration based on earthquake history of less than 0.10g would be obtained and hence the SSE would be set at the prescribed minimum of 0.10g. The actual value calculated by Sandia was 0.06g. (It is FPL's intention to make application for a SSE of 0.10g at Turkey Point at a future date.)

(3) All components examined had median failure acceleration levels above the SSE.

(4) The components with the minimum seismic margins were:

(a) Refueling Water Storage Tank .

Buckling with Anchor Bolt Yielding at 0.24g

(b) Condensate Storage Tank

Buckling with Anchor Bolt Yielding at 0.26g

(c) Component Cooling Water Heat Exchangers

Support Failure at 0.39g

(d) Diesel Generator Control Panels

Support Failure at 1.0g

(5) The potential radiation exposure to the public due to seismic hazard is 1.31 man-rem/year. At a value of $1,000 per man-rem this is $1,310 at a seismic level of 0.24g. Sandia calculated this value using the probabilistically generated sum of all WASH 1400 release categories.

From the foregoing, it can be clearly seen that St. Lucie Unit 1 and Turkey Point Units 3/4 do not pose undue risk to the public health and safety at this time.

C. NUREG 1211

As mentioned previously, in October of 1986 the CRGR instructed the NRC staff to prepare a generic Value/Impact analysis to justify the information request contained in Generic Letter 87-02. This generic analysis may be found in Section V of NUREG 1211.

General Comments

(1) The generic analysis only addresses the information request, and does not apply to the correction of any "deficiencies" for which case by case additional analyses will be required. (Section V, Page 16)

(2) The generic analysis "is based on the cost effectiveness, considering how much risk reduction is achieved for the money spent". (Section V, Page 16)

(3) The generic analysis adopts USI A-45 data as being appropriate. (Section V, Page 18)

Comments on Generic Quantitative Example (Section V, Part A)

(1) The generic initiating event, P (i), is a SSE with a return frequency of 2.5E - 4/RY. Although not stated, the source was from work done by Dr. M. P. Bohn of Sandia using averages for SSE's east of the Rocky Mountains.

Using the EPRI/SOG approved methodology, FPL has calculated the site specific values for P (i) to be 1.27E - 5/RY at St. Lucie Unit 1 and 4.97 E-6/RY at Turkey Point Units 3/4. These values are substantially lower than the generic value and reflect the seismically benign nature of FPL's sites.

(2) Using CRAC 2, the NRC staff has calculated the generic conditional public dose "R(D/CR)" to be 5E+6 man-rem, based on a WASH 1400 Category 2 release, a 1120 MWe PWR and Byron (mid-west) meteorology and demographics.

Using CRAC 2, FPL has calculated the site specific conditional public dose to be 1.7 E + 6 for St. Lucie Unit 1 and 3.6E + 6 for Turkey Point Units 3/4. FPL also used a

WASH 1400 Category 2 release to allow comparability, however it is FPL's position that the implicit assumption of a probability of 1.0 by the NRC staff that there would be a Category 2 release should be reviewed, because, for example, there is no postulated failure of the containment spray system which would be condition precedent for a Category 2 release. One alternative would be to use the probabilistically generated sum of all WASH 1400 release categories as was done by Sandia in NUREG/CR-4710 for St. Lucie Unit 1 and in NUREG/CR-4762 for Turkey Point Units 3/4. Another alternative would be to use a Category 5 release which is suitable for the postulated leakage type failure mode. The result would be substantially reduced conditional public doses for both the NRC and FPL analyses.

(3) The generic risk potential was calculated at 940 man-rem per reactor and the safety benefit from the A-46 verification program was assumed by the NRC staff to reduce the seismic risk potential by more than an order of magnitude. This means that 94 man-rem of risk would remain and that the reduction would be 846 man-rem, as opposed to the full 940 man-rem used by the NRC staff to justify (at $1,000 per man-rem) an expenditure of up to $940,000 per reactor to implement the information request contained in Generic Letter 87-02.

(4) The probabilities of failures of equipment anchorages "P(AF)"; of electrical cabinet failure "P(C/AF)"; cabinet relationship to hot shutdown "P(HF/C)"' core melt "P(CM/HF)"; and containment failure "P(CR/CM)" are subjectively based and should be reviewed. For example, when the first four are combined with P(i), the core melt probability is over one third of the total core melt probability from all causes calculated for some plants. The result of the review, using more realistic assumptions,

would be substantially reduced conditional public doses for both the NRC and FPL analyses.

Summarizing the foregoing, at the present time FPL has only substituted site specific values for P(i); fission product inventory; meteorology; demographics and remaining reactor life. With these substitutions, and using the balance of the NRC assumptions and methodology, and considering the risk worth of safety improvement, no more than $15,000 and $8,000 can be prudently justified to implement the information request at St. Lucie Unit 1 and Turkey Point Units 3/4, respectively.

In addition, further reductions are most likely if the potential WASH 1400 release categories are reviewed and if the assumed probabilities are reviewed.

Comments on Example 1 (Section V, Part B)

Combustion Engineering PWR with SSE = 0.10g

Although not stated in NUREG 1211, this is St. Lucie Unit 1, and the NUREG 1211, using information from NUREG/CR 4710, states that St. Lucie Unit 1 is not expected to experience any seismic problems up to 0.24g which is 240% of the level of the SSE. The SSE is the highest seismic level of concern to A-46.

NUREG/CR 4710 stated that stiffening the Refueling Water Storage Tank and Condensate Storage Tank (present seismic margins 0.24g and 0.26g) could reduce the conditional public dose from 1.83 man-rem/year ($1,830) to 0.13 man-rem/year ($130).

The NRC staff, in NUREG 1211, performed a Value/Impact study to illustrate that up to $50,000 could be prudently justified to make these changes.

Since only $50,000 could be prudently justified by the NRC to reduce potential risk at the 0.24g - 0.26g level, it follows that less if anything could be prudently justified at the SSE (0.10g) level.

Additionally, it is difficult to understand the rationale of using examples of seismic levels beyond the SSE to justify taking action in an issue whose upper seismic level is the SSE, particularly when the regulatory analysis states that no problems are expected at the seismic level of the SSE. Even at the 0.24g - 0.26g level, the regulatory analysis states that St. Lucie Unit 1 is "a plant where few if any modifications would be required" (Section V, Page 24).

Conclusions

1. St. Lucie Unit 1 and Turkey Point Units 3/4 provide adequate protection of the public health and safety at this time.

2. St. Lucie Unit 1 and Turkey Point Units 3/4 have, in 1986, undergone extensive seismic scrutiny, including walkdowns and risk assessments whose results have been published in NUREG/CR-4710 and NUREG/CR-4762, respectively. These results indicate that the sites are seismically benign.

3. St. Lucie Unit 1 and Turkey Point Units 3/4 would have to spend at least $750,000 per plant to implement the information request in Generic Letter 87-02, which would involve a self assessment to identify "deficiencies" against new generic seismic criteria. Using the NRC staff's methodology and site specific data, FPL has calculated that no more than $15,000 and $8,000 .could be prudently justified.

4. St. Lucie Unit 1 and Turkey Point Units 3/4 do not fall within the "envelope" of plants covered by the NRC staff's Value/Impact analysis.

5. The NRC staff should affirm that satisfactory resolution of Generic Letter 87-02 and USI A-46 has been achieved for St. Lucie Unit 1 and Turkey Point Units 3/4.

# APPLICATION OF EARTHQUAKE EXPERIENCE TO LOW SEISMICITY SITES

THE INTENT OF THIS PRESENTATION IS TO DEMONSTRATE THAT EVEN IF A MAXIMUM EVALUATION EARTHQUAKE WERE TO OCCUR AT EITHER THE ST. LUCIE OR THE TURKEY POINT SITES A COMPARISON WITH THE EXPERIENCE DATA FOR STRONG MOTION EARTHQUAKE SHOWS THAT NO SEISMIC INDUCED DAMAGE WOULD RESULT EVEN FOR EQUIPMENT AND DISTRIBUTION SYSTEMS WHICH ARE NOT DESIGNED TO BE EARTHQUAKE RESISTANT.

1. IN FIGURE 1 IS SHOWN THE FOUR ACTUAL RESPONSE SPECTRA ON WHICH THE SSRAP EXPERIENCE DATA BOUNDING SPECTRUM IS BASED.

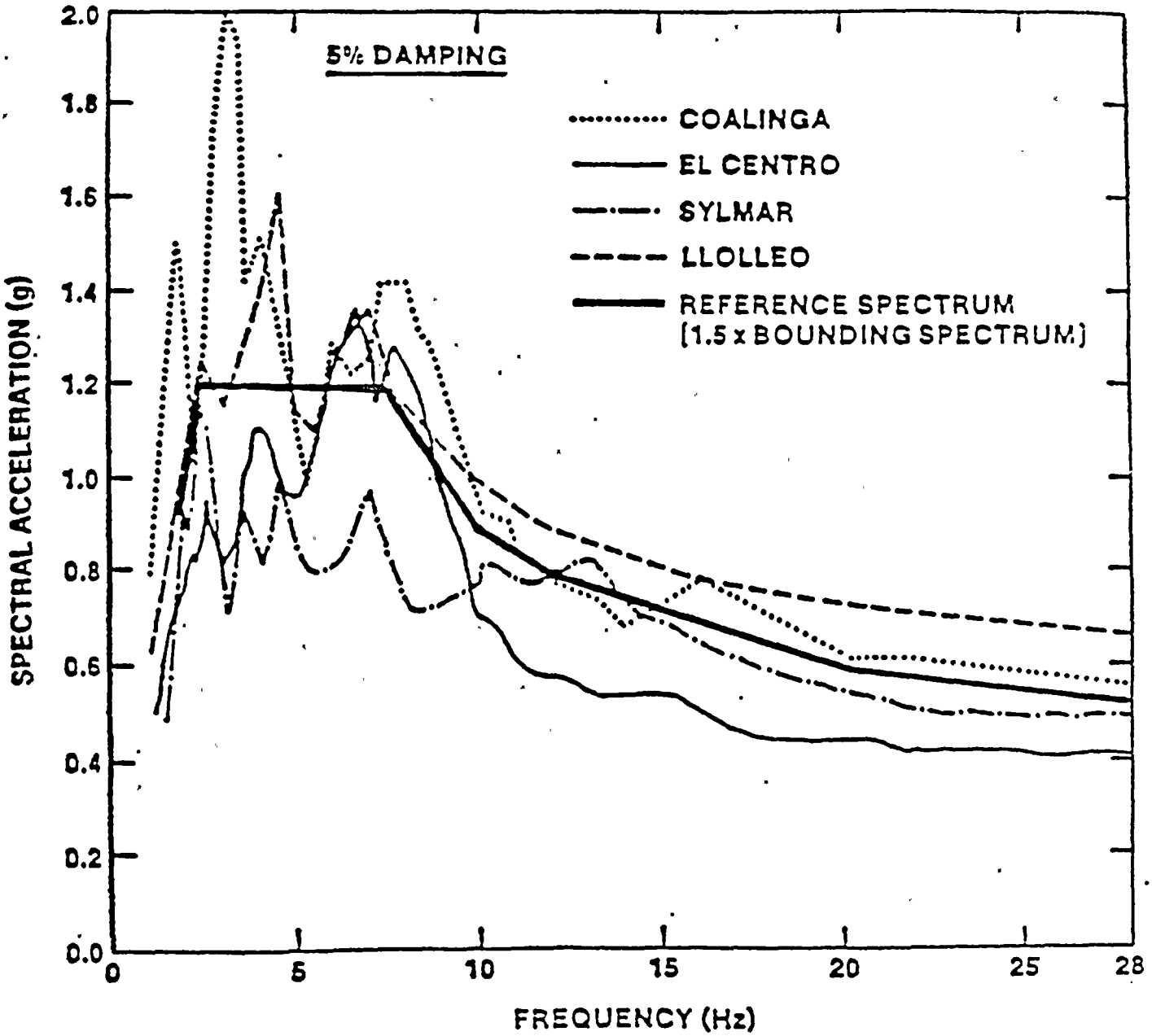


FIGURE 1 HORIZONTAL RESPONSE SPECTRA

2. IN FIGURE 2 IS SHOWN THE SSRAP DEVELOPED "DRAFT" BOUNDING SPECTRUM. THIS BOUNDING SPECTRUM REPRESENTS APPROXIMATELY TWO-THIRDS OF THE ESTIMATED AVERAGE FREE-FIELD ACCELERATION TO WHICH EQUIPMENT WAS ACTUALLY EXPOSED AT SITES WITH ESTIMATED MEAN PEAK GROUND ACCELERATION IN EXCESS OF ABOUT 0.4g.

IN RESPONSE TO EARTHQUAKES OF THIS INTENSITY THERE WERE A VERY LIMITED AMOUNT OF DAMAGE AND FAILURES (LESS THAN 0.01 PERCENT OF COMPONENTS AT RISK) OR A CONDITIONAL PROBABILITY OF FAILURE, $P_f \leq 10\text{-}4$. ALL SUCH FAILURES WOULD HAVE BEEN ELIMINATED IF SSRAP CAVEATS WERE FOLLOWED.

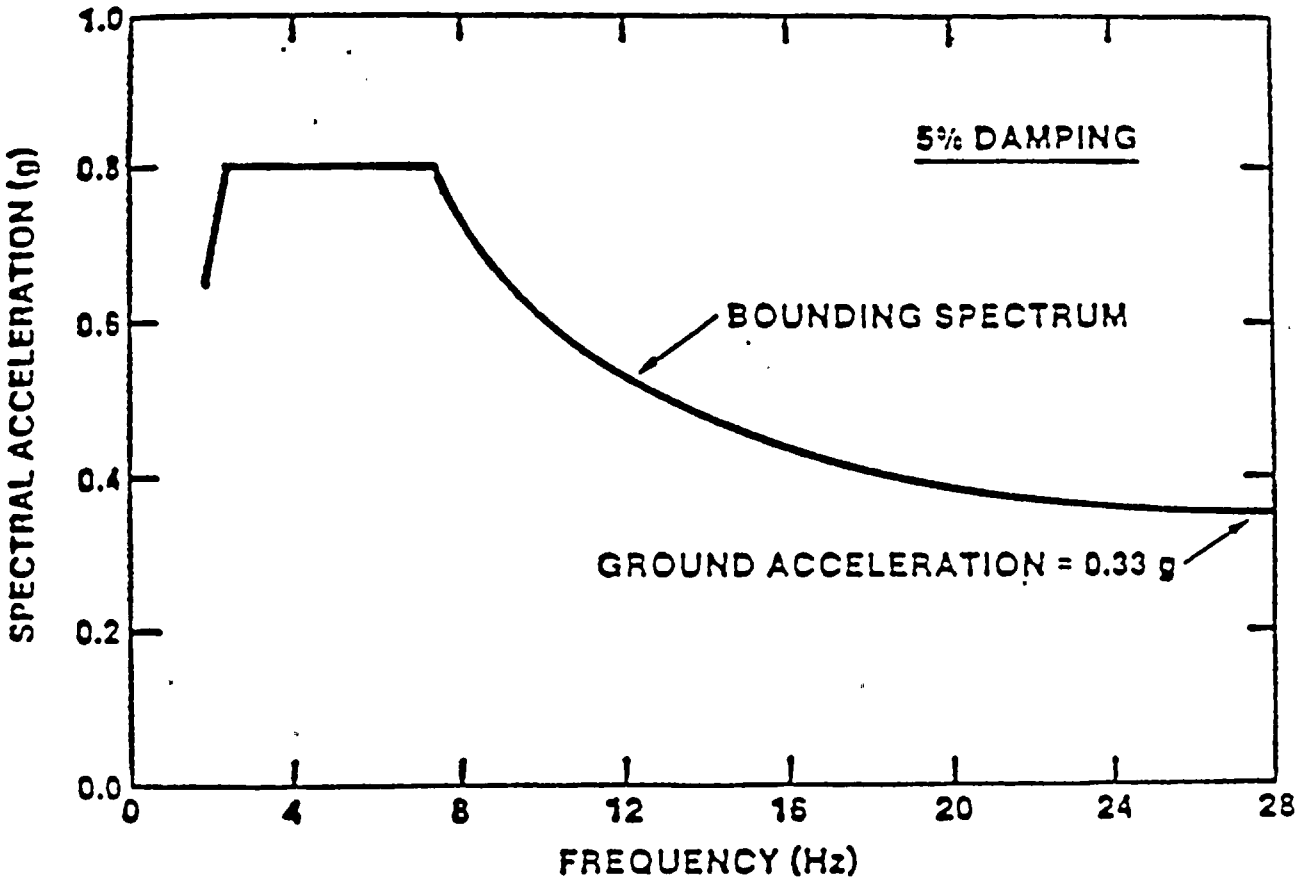


FIGURE 2 SEISMIC MOTION BOUNDING SPECTRUM
HORIZONTAL GROUND MOTION

3. IN FIGURE 3 IS SHOWN A SPECTRUM WITH A SAFETY FACTOR OF 1.5 WHICH DEFINES THE THRESHOLD OF DAMAGE TO INDUSTRIAL EQUIPMENT (USING THE BEHAVIOR OF PIPING AS A LOWER BOUND) IN EARTHQUAKES BASED ON THE 0.2g OBSERVATION PRESENTED IN NUREG 1061, VOL. 2 ADDENDUM. THIS CURVE WAS DEVELOPED BY TAKING THE SSRAP BOUNDING SPECTRA AND NORMALIZING IT TO A 0.13g ZPGA. WITHIN THE BOUNDS OF THIS SPECTRA NO DAMAGE TO CONVENTIONALLY CONSTRUCTED INDUSTRIAL EQUIPMENT IS ANTICIPATED WITHOUT RECOURSE TO CAVEAT LIMITATIONS.

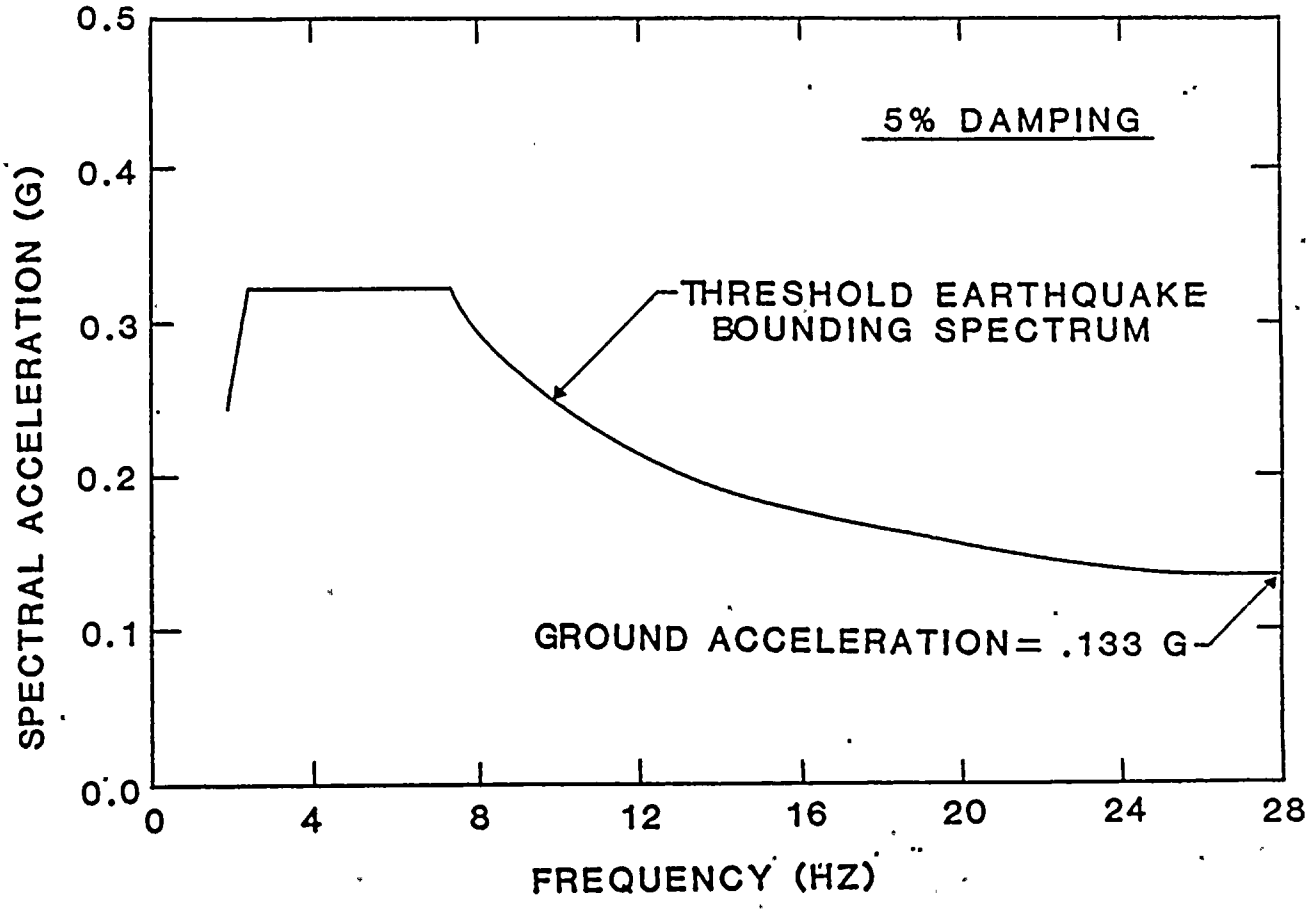


FIGURE 3 THRESHOLD EARTHQUAKE DAMAGE SPECTRUM
HORIZONTAL GROUND MOTION

4. IN FIGURE 4 IS SHOWN A COMPARISON OF THE SSRAP BOUNDING AND THE THRESHOLD EARTHQUAKE DAMAGE SPECTRA TO THE MAXIMUM EVALUATION SPECTRA USED IN THE SEISMIC QUALIFICATION OF THE ST. LUCIE AND TURKEY POINT PLANTS.

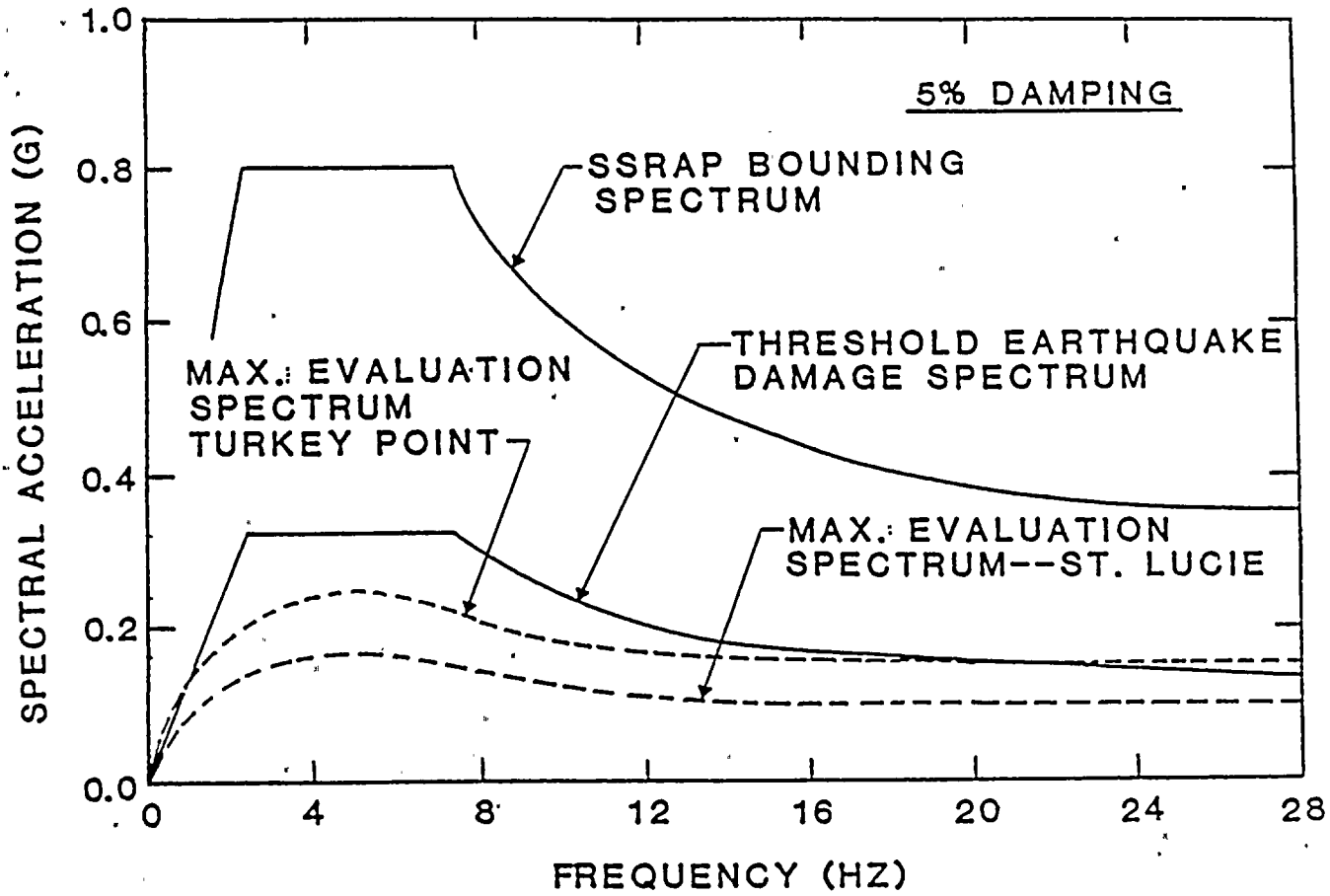


FIGURE 4 COMPARISON OF MAXIMUM EVALUATION SPECTRA FOR THE ST. LUCIE AND TURKEY POINT SITES TO BOUNDING AND THRESHOLD DAMAGE SPECTRA

OBSERVATION:

1. THE BOUNDING SPECTRA DEVELOPED BY SSRAP OBVIOUSLY ENVELOPS BY A SIGNIFICANT MARGIN THE EVALUATION BASIS AND REALISTIC SPECTRA DEFINED FOR ST. LUCIE AND TURKEY POINT SITES.

2. THE THRESHOLD DAMAGE SPECTRUM ENVELOPS THE EVALUATION BASIS SPECTRA AT ST. LUCIE AT ALL POINTS. IN ADDITION, IF CURRENT 10CFR 100 APPENDIX A REQUIREMENTS WERE USED THE EQUIVALENT SSE SPECTRA AT TURKEY POINT WOULD BE ANCHORED AT A 0.1g ZPGA AND ALL POINTS OF A TURKEY POINT SSE SPECTRUM WOULD BE ENVELOPED AS WELL.

CONCLUSION:

BECAUSE THE DESIGN BASIS (SSE EQUIVALENT) SPECTRAFOR ST. LUCIE AND TURKEY POINT PLANTS FALL WITHIN THE THRESHOLD DAMAGE SPECTRUM BASE ON EARTHQUAKE EXPERIENCE, THERE SHOULD BE NO NEED (WITH THE POSSIBLE EXCEPTION OF LARGE FLAT BOTTOM VERTICAL TANKS) TO REEVALUATE SEISMIC DESIGN ADEQUACY OF MECHANICAL AND ELECTRICAL EQUIPMENT WITHIN THE CURRENT SCOPE OF A-46 FOR THESE VERY LOW SEISMICITY PLANT SITES.