



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

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April 21, 1980

MORANDUM FOR: Chairman Ahearne  
Commissioner Gilinsky  
Commissioner Kennedy  
Commissioner Hendrie  
Commissioner Bradford

FROM: Edward J. Hanrahan *EJH*

SUBJECT: POPULATION DENSITIES NEAR REACTOR SITES ABROAD: COMPARISON WITH U.S.

Introduction

At the Chairman's request -- and a similar request to SD by Commissioner Gilinsky -- we have made a quick, rough comparison of population densities near power reactors in several European countries and Japan with those around U.S. nuclear power plants. This memorandum presents the results. SD collaborated with us in preparing it. IP helped with the literature search.

Sources and Limitations of the Comparison

We used NUREG-0348 (Ref. 1) for benchmark information on population density near U.S. reactors. We know of nothing comparable on an international scale. The foreign data we used came from various sources that we were able to find quickly (Refs. 2 to 7).

The age, bases, and quality of the foreign data vary. Sometimes the bases are not fully known to us. For some countries (notably Japan) the data are incomplete and come from secondary sources. In some cases nearby populations across a border may not have been included.

The various foreign-site data that we were able to find went out to only 5 to 25 miles from the reactors; we do not know what comparisons for greater distances (up to, say, 50 miles) would show.

The comparisons are thus necessarily imprecise. However, we believe that they should reasonably serve your immediate purpose of gaining a rough, general feel for similarities and differences.

CONTACT:  
George Sege (OPE)  
634-3302  
Richard Grill (SD)  
443-5966

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## Results

The principal results are presented in Table 1 and Figure 1.

Table 1 shows comparative statistics for data that we were able to find on total population out to various specified distances from reactors. Data for the U.S., France, the Federal Republic of Germany, Japan, Spain, Switzerland, and the United Kingdom are presented in comparison to population densities around three U.S. reactors selected as benchmarks. The benchmarks are Palo Verde, representative of a relatively isolated site; Vermont Yankee, intermediate; and Indian Point, in a relatively highly populated area.

Table 1 shows that reactor sites in the foreign countries indicated are often located in more densely populated areas than is typical for the U.S. A number of German, British, and Swiss sites have higher nearby populations than Indian Point. The data we found for Japan, Spain, and France show nearby population densities that differ less sharply from U.S. figures.

It should be noted that the six foreign countries involved have much higher average population densities than the U.S. (See Enclosure 1.)

Figure 1 presents plots of cumulative population vs. distance for selected reactors: one for Japan and two each (one relatively high and one relatively low-population) for France, West Germany, and the U.K. Plots for Vermont Yankee and Indian Point are shown for comparison.

Enclosure 2 includes data on population levels around foreign reactor sites excerpted directly from some of the sources that we used in the comparison.

Enclosure 3 presents, for comparison, data for nine U.S. reactor sites, taken from NUREG-0348 (Ref. 1). Three of those sites are relatively isolated, three are intermediate, and three are located in relatively densely populated areas.

## References

### (1) For U.S.:

NUREG-0348, "Demographic Statistics Pertaining to Nuclear Power Reactor Sites." NRC, 10/79.

### (2) For France:

B. Clement, Service Centrale de Surete des Installations Nucleaires, France: "Safety Analysis of French Nuclear Power Plants and Criteria." (About 1975; from NRC-IP files.)

Table 1

POPULATION AROUND REACTOR SITES IN U.S. AND ABROAD:  
STATISTICAL COMPARISONS

Relative Total Population (A = lowest population; see Legend)	Country	Number of Nuclear Power-Plant Sites with Indicated Relative Total Population Within X Miles**			
		X = <u>2</u>	<u>5</u>	<u>10</u>	<u>20</u>
A	U.S.	12	5	4	3
	France	*	*	*	*
	Germany (FRG)	0	0	0	*
	Japan	*	*	*	*
	Spain	0	0	1	1
	Switzerland	0	0	*	*
	U.K.	0	0	0	*
B	U.S.	81	74	49	41
	France	1	2	*	*
	FRG	5	0	0	*
	Japan	3	2	*	*
	Spain	6	5	4	3
	Switzerland	2	0	*	*
	U.K.	6	3	3	*
C	U.S.	18	31	58	67
	France	*	4	7	7
	FRG	14	15	15	*
	Japan	1	1	4	1
	Spain	0	1	1	1
	Switzerland	3	1	1	2
	U.K.	3	5	7	*
D	U.S.	0	1	0	0
	France	*	1	*	*
	FRG	4	8	8	*
	Japan	*	1	*	*
	Spain	0	0	0	1
	Switzerland	2	6	1	*
	U.K.	2	3	1	*

\*) No data.

\*\*) Additional sites may well exist that are not included in these numbers, since information used is likely to be incomplete.

Legend:

Relative population density:

A: Palo Verde or lower

B: Higher than Palo Verde, but not higher than Vermont Yankee

C: Higher than Vermont Yankee, but not higher than Indian Point

D: Higher than Indian Point

The population data for the three benchmark U.S. reactors are as follows:

X =	<u>Population out to X miles (thousands) (1979 est.)</u>			
	<u>2</u>	<u>5</u>	<u>10</u>	<u>20</u>
Palo Verde	0.002	0.2	1.9	10
Vermont Yankee	2.1	6.6	23	88
Indian Point	9.3	53	218	888

Data Sources:

References 1 to 7.



(3) For FRG:

K.P. Bachus and H. Schnurer, Federal Ministry of the Interior, FRG: "Safety Policy for Siting Nuclear Power Stations in the Federal Republic of Germany." Published in "Siting of Nuclear Power Facilities: Proceedings of a Symposium, Vienna, 9-13 December 1974." IAEA, 1975.

(4) For Japan:

J. Tadmor and H.L. Striem: "Quantitative Comparison of Siting Policies for Nuclear Reactors." Israel Journal of Earth Sciences, 1974. (From files of B. Grimes, NRC-NRR.) Note: This source presents data on three sites. Data on a fourth site (Tokai Mura) were taken from Ref. 6.

(5) For Spain:

Perez del Moral, Junta de Energia Nuclear, Spain: "Criteria Adopted in Selecting the Sites for Three Nuclear Power Stations in Spain." In Spanish. Published in "Siting of Nuclear Facilities," IAEA, 1975.

(6) For Switzerland:

R. Veya, Nordostschweizerische Kraftwerke AG, Switzerland: "Siting of Nuclear Power Plants in Switzerland." About 1975. (From files of B. Grimes, NRC-NRR.)

(7) For U.K.:

W.S. Gronow, Nuclear Installations Inspectorate, U.K.: "The Development of Siting Policy for Nuclear Power Stations in the United Kingdom." 10/78. (From files of R. Vollmer, NRC-NRR.)

Enclosures:

1. Population Densities of Countries
2. Excerpts from Refs. 2 to 7
3. Population Near Some U.S. Power Reactors

cc: Leonard Bickwit, OGC  
Samuel Chilk, SECY  
William Dircks, EDO  
Robert Minogue, SD  
Harold Denton, NRR  
Robert Budnitz, RES  
James Shea, IP  
Raymond Fraley, ACRS

POPULATION PER SQUARE MILE (1974)

U.S.	- 59
France	- 249
West Germany	- 648
Japan	- 764
Spain	- 181
Switzerland	- 407
United Kingdom	- 593

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Source: 1977 world Almanac

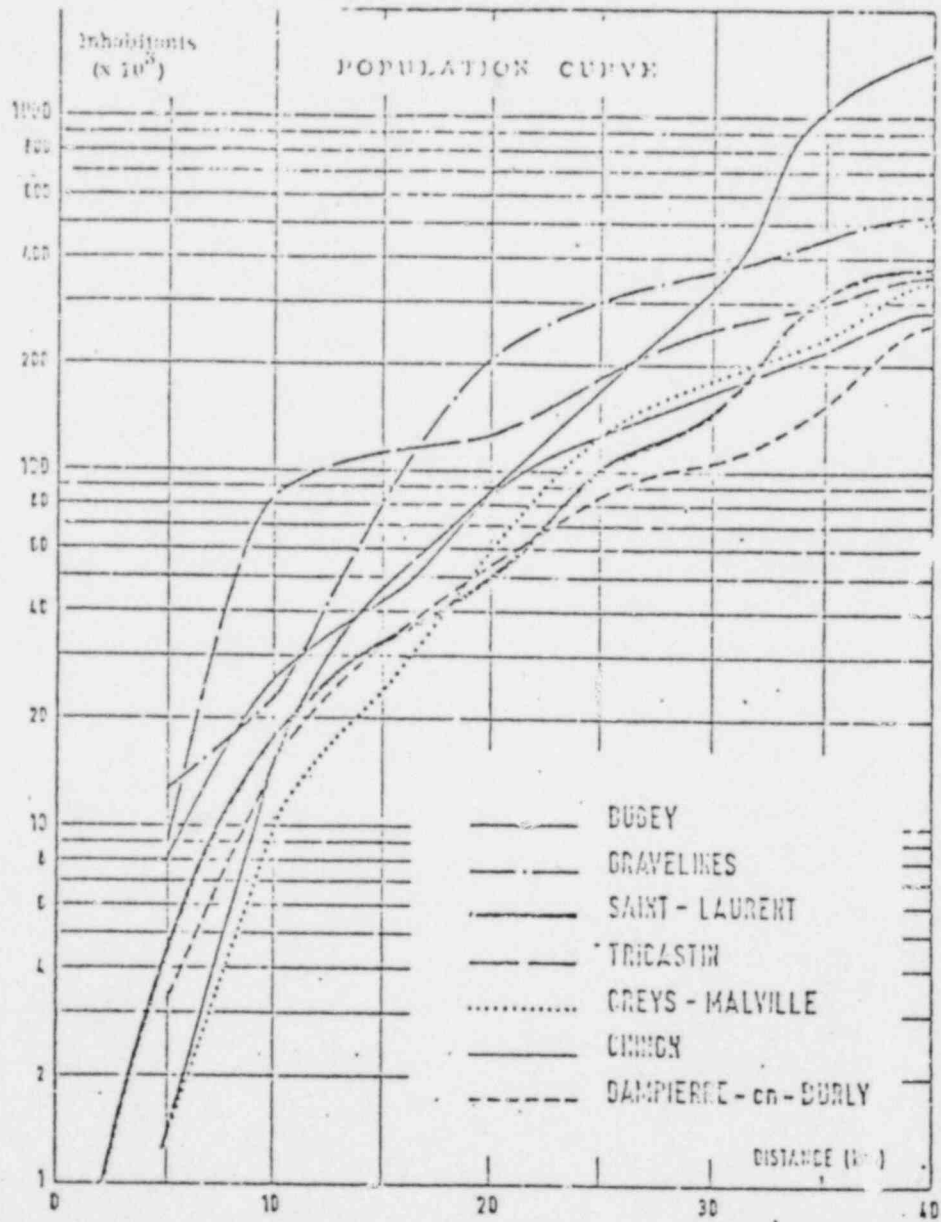
EXCERPTS FROM REFERENCES 2 TO 7



FRANCE

Thousands of Inhabitants vs. Distance (km)

From Reference 2



From Reference 3

Note: Item 1 (BASF) has been canceled; not counted in Table 1 of OPE memo.

TABLE II. POPULATION ROUND NUCLEAR POWER PLANTS IN THE FEDERAL REPUBLIC OF GERMANY; NUMBER OF INDIVIDUALS WITHIN RADIUS

No.		Radius (km)								
		0 - 1	0 - 2	0 - 3	0 - 4	0 - 6	0 - 8	0 - 10	0 - 15	0 - 20
1	BASF-Mitte		7 000	60 700	129 700	310 100	467 300	561 600	616 700	1 113 900
2	Biblis		500	2 260	7 615	23 640	6 190	120 190	222 930	426 130
3	Erlisech			976	1 104	8 516	12 073	16 551	45 585	91 257
4	Emsdorf	160	563	875	1 627	5 632	10 434	40 693	99 656	145 498
5	Emmeltetal	54	1 143	3 564	7 248	13 371	18 129	23 590	56 606	111 156
6	DKR	30	2 080	12 330	45 620	91 100	111 380	161 070	569 670	1 052 170
7	Erfanenheinfeld	20	481	5 216	10 955	27 640	62 057	109 564	156 137	194 754
8	Erohnde		2 370	5 682	7 704	12 684	36 009	78 425	146 801	208 772
9	Gundremkingen	24	984	1 984	3 902	18 242	33 470	42 330	145 520	217 070
10	Jülich	132	2 107	4 153	9 864	35 165	54 435	92 345	289 305	513 295
11	Kahl	724	12 335	38 614	45 909	70 639	114 313	180 207	446 567	886 727
12	Karlsruhe		51	3 240	16 707	32 109	70 630	200 116	481 116	683 646
13	Kröxeel	373	2 087	3 117	15 801	29 416	34 289	48 156	120 458	302 653
14	Lingen	30	602	3 332	9 560	37 273	45 851	52 366	76 694	163 694
15	W. Thela-Kärlich	27	5 990	30 040	41 271	78 499	153 359	224 875	352 059	459 243
16	Keckelwesthela		5 428	9 373	18 739	47 521	65 728	120 870	352 871	591 651
17	Kiedersichbach	567	1 885	2 711	4 226	9 826	17 676	26 276	122 646	179 566
18	Obrighela	150	5 031	7 238	14 426	32 661	42 215	57 864	125 009	257 754
19	Philippsburg	4	3 187	8 480	19 300	28 103	55 441	122 526	205 554	480 982
20	Schwehausen	504	1 771	2 286	3 962	11 112	24 031	77 644	260 987	387 593
21	Stade	100	750	1 100	3 250	40 535	44 530	55 875	142 180	377 560
22	Unterweser	50	300	1 431	5 907	14 891	31 170	55 297	133 151	157 745
23	Völpassen	18	3 114	8 023	13 483	21 469	28 749	41 152	81 700	157 530
24	Vyhl		10	2 430	4 200	7 295	17 261	29 508	72 553	136 803

JAPAN

From Reference 4

TABLE 1  
WISH Index in Different Countries

Country Nuclear Station Thermal Power (Mw)	Population and WISH for areas enclosed within radii (distances in km) of:											WISH
	≤ 2 km	2 - 3	3 - 4	4 - 5	5 - 7	7 - 10	10 - 15	15 - 20	population			
JAPAN Yutopu 966 Mw	240	130	120	130	120	1420	24	113000	120120	248120	124	798
Mihama 1020 Mw	40	60	200	400	1600	5400	33	58300	11700	77700	12	310
Fukushima 1200 Mw	100	650	700	6450	5500	20700	147	9500	22500	67500	27	1134
FRANCE EDF - 5 1700 Mw	100	280	600	1020	3300	9700	84	(35000)	(60000)	(110000)	(102)	(921)
SAUDI ARABIA Kinghalah 2460 Mw	220	330	500	750	800	1400	21	11000	28000	43000	69	1323
Borsback 1740 Mw	170	160	210	260	1300	3300	34	294000	1350000	1651000	2350	4145
UNITED KINGDOM Heysham 1500 Mw	5000	4700	7000	9000	24000	40000	472	42000	40000	180000	60	18665
Hartlepool 1500 Mw	1000	3300	8700	18000	80000	300000	2700	109000	95000	615000	142	30319
GERMANY Wurgassen 1912 Mw	2400	10000	13500	16100	42000	86000	915	(170000)	(340000)	(680000)	(648)	(17660)
Biblis 3462 Mw	492	1908	5065	5235	22300	93000	1970	170000	290000	610000	1000	11679
UNITED STATES Indian Point 3293 Mw	2300	6700	9000	13000	13000	32000	633	64000	85000	225000	280	22151
Zion 3391 Mw	3000	11500	9500	7500	14500	39000	773	95000	120000	300000	612	30082
UNCERTIFIED Soreh-Vartan 1500 Mw	37000	59000	64000	110000	200000	250000	2270	430000	150000	1300000	225	123635
Germany-BASF 1800 Mw	64000	38000	48000	60000	133000	187000	2070	300000	320000	1150000	576	207066
ISRAEL S. of Ashqelon 1000 Mw	-	200	200	950	6598	67275	403	188633	38483	302309	39	1069
S. of Ashdod 1000 Mw	-	170	436	-	806	83372	500	19147	21038	124969	21	651
Nahal Soreq 1000 Mw	-	-	-	-	17517	39740	239	113319	227332	391908	227	900
S. of Haifa 1000 Mw	40	1527	2411	-	900	9309	56	29363	258425	301975	759	3002

SPAIN

From Reference 5

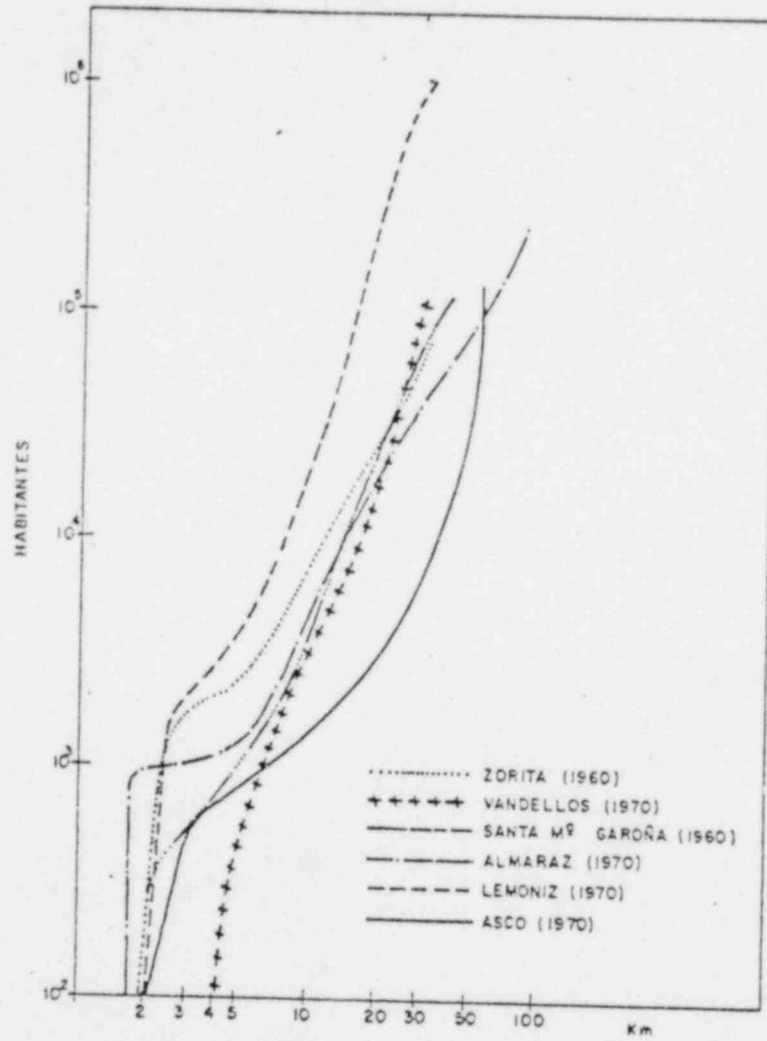


FIG.1. Población en función de la distancia a los emplazamientos de varias centrales nucleares.

From Reference 6

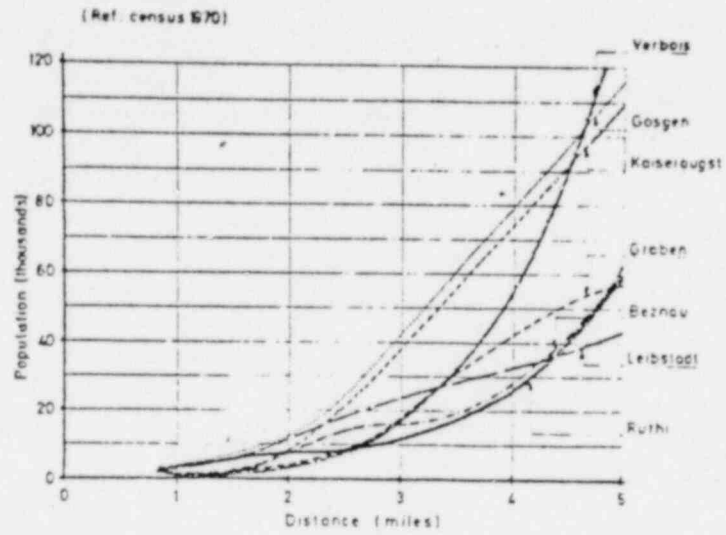


Fig. 2 Cumulative population vs. distance for Swiss sites.

TABLE I  
PRESENT POPULATION AROUND NUCLEAR SITES

	0-1 MILE		0-1½ MILES		0-2 MILES		0-3 MILES		0-5 MILES		0-10 MILES	
	30°	360°	30°	360°	30°	360°	30°	360°	30°	360°	30°	360°
BERKELEY	19	95	1004	1520	1900	4071	2819	9512	3244	16982	15719	86
BRADWELL	62	570	862	2008	891	2091	964	9438	1779	12218	2223	84
HUNTERSTON	30	50	90	210	125	275	4521	7575	4671	10225	40671	84
HINKLEY POINT	10	24	107	213	1093	1311	2125	2500	2975	5800	5781	45
TRAWSFYND D	101	210	327	455	337	830	380	2353	3330	8253	3380	20
DUNGENESS	35	220	255	440	378	563	878	1389	1678	3889	5578	12
SIZEWELL	0	225	465	698	3813	5083	5873	8636	6873	14136	10673	25
OLDBURY	4	30	407	659	417	679	528	1332	4518	54932	15418	9
WYLFA	84	336	1332	1747	1392	2342	1492	3258	1652	4088	5052	1
HEYSHAM	604	3972	4729	14479	9886	20785	19516	36035	41936	93635	48556	15
HARTLEPOOL	0	140	1036	1300	4946	6070	12556	24130	61116	209550	81516	52

From Reference 6

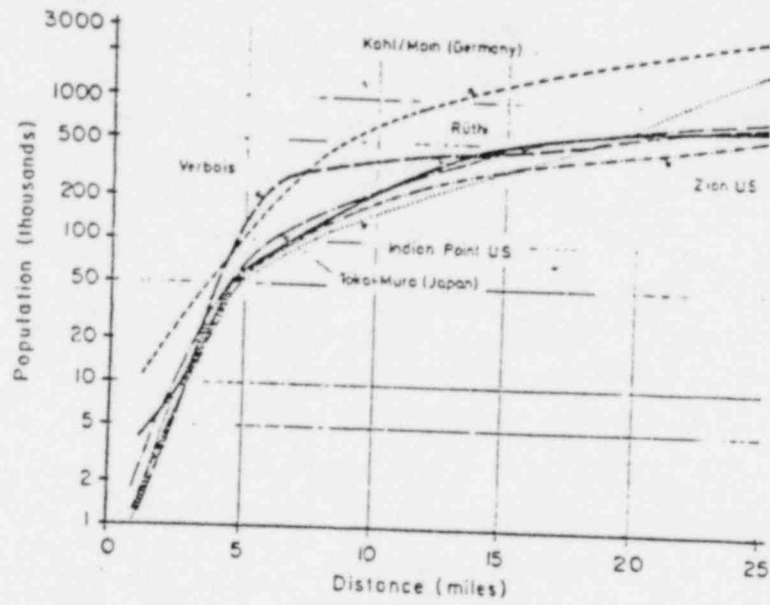


Fig. 4 Cumulative population vs. distance, international comparison

## POPULATION NEAR SOME U.S. POWER REACTORS

(From Reference 1)

<u>Reactor</u>	X =	<u>Total Population Out to X Miles (Thousands)</u>				
		<u>2</u>	<u>5</u>	<u>10</u>	<u>20</u>	<u>30</u>
WPPSS 2		0	0	0.5	48	92
Sundesert		0	0	0	0.09	0.09
Palo Verde		0.002	0.2	1.9	9.6	20
Main Yankee		0.4	3.7	26	75	197
Dresden		0.5	6.3	31	192	568
Vermont Yankee		2.1	6.6	23	88	212
Limerick		4.9	67	153	776	3,840
Zion		6.9	46	190	530	1,263
Indian Point		9.3	53	218	888	3,985