

June 2, 2005

MEMORANDUM TO: Bruce A. Boger, Director
Division of Inspection Program Management

THRU: Stephen Klementowicz, Team Leader */RA/*
Health Physics Team, IPSB
Division of Inspection Program Management

FROM: Charles S. Hinson, Senior Health Physicist */RA/*
Health Physics Team, IPSB
Division of Inspection Program Management

SUBJECT: LWR OCCUPATIONAL DOSE DATA FOR 2004 AND THREE-YEAR
ROLLING AVERAGE COLLECTIVE DOSE DATA AND QUARTILE DATA
FOR 2002-2004

Enclosed for your information is a compilation of the 2004 occupational collective doses as well as the three-year rolling average collective doses for operating U.S. nuclear power plant facilities. This data, which was derived from individual worker dose reports submitted to the Commission in accordance with 10 CFR 20.2206, is provided for each of the 104 operating commercial nuclear plants (69 PWRs and 35 BWRs) in the U.S.

The average collective dose in 2004 for LWRs was 100 person-cSv (person-rem) per reactor. This is the lowest average annual dose per reactor ever recorded for U.S. LWRs. This average dose is one half of the average LWR dose recorded ten years ago (in 1994) and is nearly one eighth of the maximum LWR average dose of 790 person-cSv (person-rem) per reactor recorded in 1980. These record low average collective doses reflect industries' continuing commitment to the lowering of plant doses by implementing effective exposure reduction initiatives.

Also in this report is a listing of the nuclear plants ranked by quartile, as determined by their three-year rolling average collective doses. The baseline inspection procedures for the Occupational Radiation Safety cornerstone utilize the plant's quartile ranking to help in determining inspection resources and the minimum inspection requirement sample size. A plant's three-year rolling average collective dose is also used as one of the metrics in the Occupational Radiation Safety SDP.

This report was compiled by Charles Hinson, NRR, NRC. The collective doses for 2004 were compiled by our contractor, ORAU. Any questions concerning the content of this report should be directed to Charles Hinson at (301) 415-1845.

Attachment: As stated

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LWR OCCUPATIONAL DOSE DATA FOR 2004
AND THREE-YEAR ROLLING AVERAGE COLLECTIVE DOSE DATA
AND QUARTILE DATA FOR 2002-2004

This report contains a compilation of the 2004 occupational collective doses for operating U.S. nuclear power plant facilities, the three-year rolling average collective dose data for 2002-2004, and a listing of the three-year rolling average collective dose rankings for 2002-2004 by quartile for PWRs and BWRs.

2004 Collective doses

The occupational collective dose information was derived from individual worker dose reports submitted to the Commission in accordance with 10 CFR 20.2206. The number of operating reactors in the U.S. in 2004 remained the same as in the year 2003, at 104 reactors. The total collective dose for these 104 LWRs in 2004 was 10,367 person-cSv (person-rem), a 13% decrease from last year's total of 11,955 person-cSv (person-rem). This collective dose total is less than the collective dose total in 1973, when there were only 24 operating LWRs in the U.S. The resulting average collective dose of 100 person-cSv (person-rem) per reactor for LWRs for 2004 is the lowest average collective dose ever recorded for U.S. LWRs (the second lowest LWR average collective dose per reactor of 107 person-cSv (person-rem) was recorded in 2001).

In 2004, the total collective dose for PWRs was 4,916 person-cSv (person-rem) for 69 reactors. The resulting average collective dose per reactor for PWRs in 2004 was 71 person-cSv (person-rem) per reactor. This represents a 22% decrease from the 2003 value of 91 person-cSv (person-rem) per reactor and it is the lowest average dose recorded to date for US PWRs. This is the sixth time that this average has been under 100 person-cSv (person-rem) per reactor. The collective dose information for PWRs is shown in Table 1.

The total collective dose for BWRs in 2004 was 5,451 person-cSv (person-rem) for 35 reactors. The resulting average collective dose for BWRs in 2004 was 156 person-cSv. The BWR average collective dose for 2004 is the second lowest recorded average dose per unit for BWRs (the lowest average BWR dose of 138 person-cSv (person-rem) per unit was recorded in 2001). The collective dose information for BWRs is shown in Table 2.

These record low average collective doses reflect industries' continuing commitment to the lowering of plant doses by implementing effective exposure reduction initiatives such as source term reduction programs, efficient outages, online chemistry control, and effective ALARA programs.

Rolling three-year average collective dose

Since refueling outage cycles vary among U.S. plants, this results in alternating high and low collective dose years for some plants and more evenly distributed collective doses for others. Therefore, the use of the three-year rolling average collective dose (TYRA) has been a better indicator of a plant's average collective dose than the plant's annual collective dose. The TYRA is incorporated into the SDP (Significance Determination Process) for the Occupational Radiation Safety Cornerstone (Appendix C of MC 0609). Each licensee's current TYRA is

compared against the TYRA criteria contained in the Occupational Radiation Safety SDP (135 person-cSv (person-rem)/unit for PWRs and 240 person-cSv (person-rem)/unit for BWRs) to help evaluate the significance of inspection findings in terms of the licensee's overall ALARA performance.

Tables 1 and 2 provide the three-year rolling average collective doses for 2002-2004 (under the column entitled "3 Yr Avg") for each of the operating reactors. (The last column shows the previous TYRA (for 2001-2003)). These tables also show the collective doses by reactor for each of the years 2002 through 2004.

For PWRs, the TYRA for 2002-2004 decreased at 26 reactor sites and increased at 14 sites from last year's values (the TYRA for 2 sites did not change). The PWR site with the lowest TYRA for 2002-2004 was Indian Pt. 3 with a TYRA of 36 person-cSv (person-rem). The PWR site with the highest TYRA for 2002-2004 was Davis Besse with a TYRA of 210 person-cSv (person-rem)(this high TYRA is due primarily to a high annual collective dose of 403 person-cSv (person-rem) accrued in the year 2002). For the 2002-2004 three-year period, three PWRs exceeded the SDP criterion of 135 person-rem/unit for PWRs. These three PWRs are Davis Besse - 210 person-rem, Palisades - 199 person-rem, and Indian Pt. 2 - 152 person-rem. Two of these PWRs, Davis-Besse and Palisades, also exceeded the 135 person-rem/unit criterion for the 2001-2003 three-year period.

For BWRs, the TYRA for 2002-2004 decreased at 14 reactor sites and increased at 10 sites from last year's values. The BWR site with the lowest TYRA for 2002-2004 was Duane Arnold with a TYRA of 59 person-cSv (person-rem). Quad Cities 1,2 was the BWR site with the highest TYRA for the third year in a row, with a TYRA of 456 person-cSv (person-rem)/unit. Quad Cities' high TYRA is based primarily on its high collective dose of 1786 person-cSv (person-rem) accrued in 2002. An unexpected reaction between the injection of Noble Metals and Depleted Zinc in the RCS at Quad Cities resulted in unusually high levels of cobalt 60 in the reactor coolant and resulting high dose rates (high dose rates resulting from this reaction were first measured in the year 2000). Problems with the steam dryers also led to 25-100% increases in Main Steam System dose rates. These higher dose rates, coupled with the fact that Quad Cities performed two power uprate outages plus six other unplanned outages in 2002, were the primary reason for the elevated doses in 2002. Although Quad Cities has stabilized its water chemistry problems and taken many steps to reduce the source term (e.g., fuel cleaning and removal of stellite coated LP turbine blades), extensive steam dryer repairs and other maintenance work over the past two years, combined with high dose rates in the drywell, has resulted in collective doses of 438 and 511 person-rem in 2003 and 2004, respectively. Quad Cities estimates that its 2005 dose will be approximately 900 person-rem. This will be the result of extensive outage work performed at Unit 1 (which has dose rates higher than Unit 2) and steam dryer replacement at both units.

For the 2002-2004 three-year period, there were only two BWR sites (3 reactors) which exceeded the SDP criterion of 240 person-rem/unit for BWRs (Quad Cities 1,2 - 456 person-rem/unit and Perry - 250 person-rem). (For the previous three-year period (2000-2002), these same three BWRs also exceeded this criterion).

It should be noted that when the SDP TYRA criteria of 135 person-cSv (person-rem)/unit for PWRs and 240 person-cSv (person-rem)/unit for BWRs were established in the late 1990s they

represented the median points for the 1995-1997 TYRA for PWRs and BWRs, respectively (i.e., the TYRA for 50% the PWRs and 50% the BWRs exceeded these values). For the current TYRA (2002-2004) only 7% of the PWR sites and 8% of the BWR sites exceed these criteria (see Table 3).

Plants ranked by TYRA quartile

The baseline inspection procedures for ALARA Planning and Controls, IP 71121.02 (under the Occupational Radiation Safety cornerstone) utilize the plant’s quartile ranking (based on the three-year rolling average collective doses) to help in determining plant inspection resources (see Section 04, “Resource Estimate”, of IP 71121.02) and the minimum inspection requirement sample size (see Section 05, “Completion Status”, of IP 71121.02).

The plant rankings by quartile listed below are based on the TYRA for 2002-2004. These rankings should remain in effect until the new TYRA for the years 2003-2005 are available. Note that last year’s (2001-2003) TYRA rankings for each site are shown in parentheses (“(-)” indicates no change in the quartile rankings from last year). Tables 4 and 5 show a history of the TYRA and plant quartile information for the past seven three-year periods (1996-1998 through 2002-2004). It should be noted that plant quartile information was first officially calculated for the 2000-2002 three-year period, when this data was calculated for input into the ROP.

PWRs

<u>Top Quartile</u> (lowest TYRA)	<u>2nd Quartile</u>	<u>3rd Quartile</u>	<u>Bottom Quartile</u> (highest TYRA)
Indian Pt. 3 (2)	Palo Verde 1,2,3 (1)	McGuire 1,2 (1)	South Texas 1,2 (-)
Harris (3)	Byron 1,2 (1)	Callaway 1 (2)	Sequoyah 1,2 (-)
Crystal River 3 (3)	Pt. Beach 1,2 (1)	St. Lucie 1,2 (-)	Cook 1,2 (2)
Summer 1 (-)	Wolf Creek 1 (1)	North Anna 1,2 (-)	Calvert Cliffs 1,2 (-)
Seabrook (-)	Vogtle 1,2 (-)	Robinson 2 (2)	San Onofre 2,3 (2)
Farley 1,2 (3)	Waterford 3 (-)	Arkansas 1,2 (2)	Millstone 2,3 (-)
Ginna (-)	Catawba 1,2 (1)	Beaver Valley 1,2 (-)	Ft. Calhoun (-)
TMI 1 (4)	Comanche Pk 1,2 (1)	Watts Bar 1 (-)	Indian Pt. 2 (3)
Prairie Island 1,2 (-)	Braidwood 1,2 (-)	Surry 1,2 (4)	Palisades (-)
Kewaunee (3)	Turkey Pt. 3,4 (-)	Diablo Canyon 1,2 (1)	Davis-Besse (-)
		Oconee 1,2,3 (4)	
		Salem 1,2 (-)	

BWRs

<u>Top Quartile</u> (lowest TYRA)	<u>2nd Quartile</u>	<u>3rd Quartile</u>	<u>Bottom Quartile</u> (highest TYRA)
Duane Arnold (-)	Pilgrim (3)	Vermont Yankee (2)	Brown's Ferry 1,2,3*(3)
Cooper Station (2)	Fermi 2 (-)	Fitzpatrick (2)	Dresden 2,3 (-)
Limerick 1,2 (-)	Grand Gulf (-)	Peach Bottom 2,3 (4)	Clinton (1)
Monticello (3)	Brunswick 1,2 (3)	River Bend 1 (-)	LaSalle 1,2 (-)
Hatch 1,2 (-)	Susquehanna 1,2 (-)	Oyster Creek (2)	Nine Mile Pt. 1,2 (-)
Columbia (WNP 2) (3)	Hope Creek 1 (1)		Perry (-)
			Quad Cities 1,2 (-)

(* Note: Even though Brown's Ferry, Unit 1 has been shut down since 1985, it is scheduled to restart in the Spring of 2007 and dose is being expended at Unit 1 in this restart effort. Therefore, Brown's Ferry is counted as a three-unit site for purposes of calculating the TYRA.)

The collective doses for the year 2004 that appear in this paper are based on a compilation of the individual doses that the licensees submitted to the NRC in accordance with 10 CFR 20.2206. A listing of the 2004 doses and 2002-2004 TYRA, along with breakdowns of individual plant doses and dose trends will be contained in Volume 26 of NUREG-0713, Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2004, which is scheduled to be published in the Fall of 2005.

This paper was compiled by Charles Hinson, NRR, NRC. The collective doses for 2004 were compiled by our contractor, ORAU. Any questions concerning the content of this report should be directed to Charles Hinson at (301) 415-1845.

Table 1-PWR Collective Doses and TYRA

PWR	2002	2003	2004	3 Yr Avg (prev 3-yr)	
Indian Pt. 3	7	96	4	36	74
Harris	7	68	57	44	109
Crystal River 3	5	127	4	45	93
Summer 1	60	71	10	47	66
Seabrook	67	71	6	48	49
Farley 1,2	96	111	107	52	88
GINNA	80	75	7	54	55
TMI 1	7	155	4	55	120
Prairie Island 1,2	128	61	144	55	52
Kewaunee	4	73	91	56	93
Palo Verde 1,2,3	140	211	199	61	59
Byron 1,2	195	87	89	62	57
Pt. Beach 1,2	181	85	110	63	66
Wolf Creek 1	100	89	3	64	65
Vogtle 1,2	244	84	81	68	76
Waterford 3	109	95	3	69	70
Catawba 1,2	81	211	123	69	68
Comanche Pk 1,2	225	66	135	71	68
Braidwood 1,2	91	245	95	72	73
Turkey Pt. 3,4	74	247	117	73	70
McGuire 1,2	181	71	196	75	65
Callaway	96	8	121	75	70
St. Lucie 1,2	156	142	159	76	88
North Anna 1,2	143	187	130	77	107
Robinson 2	111	5	118	78	80
Arkansas 1,2	265	99	106	78	78
Beaver Valley 1,2	90	277	157	87	92
Watts Bar 1	94	166	6	88	88
Surry 1,2	88	326	120	89	124
Diablo Canyon 1,2	149	135	254	90	67
Oconee 1,2,3	225	245	368	93	117
Salem 1, 2*	293	124	149	94	95
South Texas 1,2	329	143	120	99	118
Sequoyah 1,2	108	431	86	104	114
Cook 1,2	278	210	156	107	86
Calvert Cliffs 1,2	245	265	144	109	113
San Onofre 2,3	136	164	407	118	72
Millstone 2,3*	292	323	136	125	132
Ft. Calhoun	164	212	22	133	201
Indian Pt. 2	248	12	196	152	94
Palisades	24	203	371	199	197
Davis-Besse	403	220	7	210	209
Avg. Annual Dose	87	91	71		
No. of Reactors	69	69	69		
Total Dose	6018	6296	4916		

*Dose calculated using RG 1.16 ratio

Table 2-BWR Collective Doses and TYRA

BWR	<u>2002</u>	<u>2003</u>	<u>2004</u>	3 Yr Avg	(prev 3-yr)
Duane Arnold	35	124	19	59	99
Cooper Station	39	135	47	74	114
Limerick 1,2	160	147	149	76	86
Monticello	40	169	35	81	143
Hatch 1,2	214	168	180	94	102
Columbia (WNP 2)	47	205	66	106	160
Pilgrim	38	250	41	110	156
Fermi 2	38	168	145	117	125
Grand Gulf	176	31	158	122	131
Brunswick 1,2	276	249	245	128	138
Susquehanna 1,2	260	250	272	130	133
Hope Creek 1*	26	139	239	135	107
Vermont Yankee	150	54	212	139	116
Fitzpatrick	231	51	186	156	115
Peach Bottom 2,3	333	356	265	159	172
River Bend 1	35	217	236	163	153
Oyster Creek	266	43	227	179	118
Brown's Ferry 1,2,3	358	603	673	181	139
Dresden 2,3	355	357	381	182	185
Clinton	208	57	283	183	100
LaSalle 1,2	450	464	359	212	166
Nine Mile Pt. 1,2	517	375	449	223	206
Perry	70	607	73	250	312
Quad Cities 1,2	1786	438	511	456	395
Avg. Annual Dose	175	162	156		
No. of Reactors	35	35	35		
Total Dose	6108	5659	5451		
*Dose calculated using RG 1.16 ratio					

Table 3

Number of Plants Exceeding the 3-Yr Average Dose Criteria

<u>3-yr period</u>	<u>PWRs > 135 person-rem</u>		<u>BWRs > 240 person-rem</u>	
	<u>Sites (%)</u>	<u>Units (%)</u>	<u>Sites (%)</u>	<u>Units (%)</u>
1995-1997	20 (47%)	33 (46%)	13 (50%)	19 (51%)
1996-1998	14 (34%)	22 (32%)	10 (42%)	14 (40%)
1997-1999	13 (31%)	20 (29%)	4 (17%)	6 (17%)
1998-2000	5 (12%)	6 (9%)	3 (13%)	4 (11%)
1999-2001	6 (14%)	7 (10%)	1 (4%)	1 (3%)
2000-2002	4 (10%)	4 (6%)	2 (8%)	3 (9%)
2001-2003	3 (7%)	3 (4%)	2 (8%)	3 (9%)
2002-2004	3 (7%)	3 (4%)	2 (8%)	3 (9%)

Table 4 - Seven Year History of TYRA and Plant Quartile Data for PWRs*

PWR	1996-1998	1997-1999	1998-2000	1999-2001	2000-2002	2001-2003	2002-2004
Arkansas 1,2	82	78	99	89	102 (3)	78 (2)	78 (3)
Beaver Valley 1,2	136	77	83	104	102 (3)	92 (3)	87 (3)
Braidwood 1,2	152	121	100	73	64 (1)	73 (2)	72 (2)
Byron 1,2	162	126	118	82	75 (2)	57 (1)	62 (2)
Callaway 1	154	178	179	148	73 (2)	70 (2)	75 (3)
Calvert Cliffs 1,2	109	101	86	82	91 (3)	113 (4)	109 (4)
Catawba 1,2	122	91	75	70	64 (1)	68 (1)	69 (2)
Comanche Peak 1,2	111	105	93	74	70 (1)	68 (1)	71 (2)
Cook 1,2	145	138	102	89	107 (4)	86 (2)	107 (4)
Crystal River 3	184	150	95	138	56 (1)	93 (3)	45 (1)
Davis Besse 1	111	64	117	67	192 (4)	209 (4)	210 (4)
Diablo Canyon 1,2	95	140	134	125	75 (2)	67 (1)	90 (3)
Farley 1,2	157	150	164	145	129 (4)	88 (3)	52 (1)
Fort Calhoun	164	141	139	140	142 (4)	201 (4)	133 (4)
Ginna	88	90	89	87	56 (1)	55 (1)	54 (1)
Harris	100	99	83	123	120 (4)	109 (3)	44 (1)
Indian Pt 2	194	233	299	210	279 (4)	94 (3)	152 (4)
Indian Pt 3	90	122	47	81	45 (1)	74 (2)	36 (1)
Kewaunee	90	50	64	102	102 (3)	93 (3)	56 (1)
McGuire 1,2	145	148	89	88	75 (2)	65 (1)	75 (3)
Millstone 2,3	82	103	85	95	102 (3)	132 (4)	125 (4)
North Anna 1,2	110	77	71	78	86 (3)	107 (3)	77 (3)
Oconee 1,2,3	94	88	93	117	120 (4)	117 (4)	93 (3)
Palisades	194	161	154	202	138 (4)	197 (4)	199 (4)
Palo Verde1,2,3	82	65	55	54	53 (1)	59 (1)	61 (2)
Pt Beach 1,2	90	76	84	78	75 (2)	66 (1)	63 (2)
Prairie Island 1,2	67	61	49	51	60 (1)	52 (1)	55 (1)
Robinson 2	117	102	101	86	81 (2)	80 (2)	78 (3)
Salem 1,2	86	89	93	111	107 (4)	95 (3)	94 (3)
San Onofre 2,3	111	148	111	100	64 (1)	72 (2)	118 (4)
Seabrook	72	104	65	61	48 (1)	49 (1)	48 (1)
Sequoyah 1,2	156	142	131	111	102 (3)	114 (4)	104 (4)
South Texas 1,2	99	119	113	122	133 (4)	118 (4)	99 (4)
St. Lucie 1,2	194	159	68	84	80 (2)	88 (3)	76 (3)
Summer 1	91	99	100	119	99 (3)	67 (1)	47 (1)
Surry 1,2	120	108	87	110	102 (3)	124 (4)	89 (3)
TMI 1	79	125	60	120	71 (1)	119 (4)	55 (1)
Turkey Pt 3,4	126	116	84	75	66 (1)	70 (2)	73 (2)
Vogtle 1,2	129	91	85	80	82 (2)	76 (2)	68 (2)
Waterford 3	66	98	93	87	82 (2)	70 (2)	69 (2)
Watts Bar 1		72	75	76	74 (2)	88 (3)	88 (3)
Wolf Creek 1	149	141	101	99	83 (2)	65 (1)	64 (2)

*Note: Plant quartile information (plant quartile ranking by TYRA shown in parentheses) was first officially calculated for ROP purposes for the 2000-2002 three-year period

Table 5 - Seven Year History of TYRA and Plant Quartile Data for BWRs*

BWR	1996-1998	1997-1999	1998-2000	1999-2001	2000-2002	2001-2003	2002-2004
Brown's Ferry 1,2,3	140	149	128	119	109 (1)	139 (3)	181 (4)
Brunswick 1,2	254	204	189	174	150 (3)	138 (3)	128 (2)
Clinton	222	134	162	125	165 (3)	100 (1)	183 (4)
Columbia (WNP2)	303	231	165	145	109 (1)	160 (3)	106 (1)
Cooper	135	135	143	139	136 (2)	114 (2)	74 (1)
Dresden 2,3	225	248	213	209	170 (4)	185 (4)	182 (4)
Duane Arnold	190	167	161	128	72 (1)	99 (1)	59 (1)
Fermi 2	138	98	130	117	118 (2)	125 (2)	117 (2)
Fitzpatrick	269	172	242	144	198 (4)	115 (2)	156 (3)
Grand Gulf	255	212	188	149	132 (2)	131 (2)	122 (2)
Hatch 1,2	247	228	175	160	141 (3)	102 (1)	94 (1)
Hope Creek 1	188	228	174	208	123 (2)	107 (1)	135 (2)
LaSalle 1,2	260	219	210	153	132 (2)	166 (4)	212 (4)
Limerick 1,2	138	144	148	124	105 (1)	86 (1)	76 (1)
Monticello	185	128	165	169	159 (3)	143 (3)	81 (1)
Nine Mile Pt 1,2	183	209	185	179	190 (4)	206 (4)	223 (4)
Oyster Creek	269	133	321	234	309 (4)	118 (2)	179 (3)
Peach Bottom 2,3	190	196	169	166	168 (4)	172 (4)	159 (3)
Perry	207	213	141	213	128 (2)	312 (4)	250 (4)
Pilgrim	258	334	155	192	90 (1)	156 (3)	110 (2)
Quad Cities 1,2	407	269	309	206	471 (4)	395 (4)	456 (4)
River Bend 1	293	250	206	256	153 (3)	153 (3)	163 (3)
Susquehanna 1,2	181	204	187	175	147 (3)	133 (2)	130 (2)
Vermont Yankee	162	144	138	119	110 (1)	116 (2)	139 (3)

*Note: Plant quartile information (plant quartile ranking by TYRA shown in parentheses) was first officially calculated for ROP purposes for the 2000-2002 three-year period