U.S. capacity factors: The oldest reactors keep pace

BY E. MICHAEL BLAKE

The overall performance of the U.S. nuclear fleet has stayed at the level that was set starting in 2000, including the performance of the oldest reactors.

IT IS CLEAR that 2011 was not as productive a year for the U.S. power reactor fleet as other recent years have been. The total output, 790 terawatt-hours, was the lowest since the 2006 total of 788 TWh, and it came from reactors that have grown to an all-time peak in potential production, thanks mainly to power uprates. (If every reactor had run at 100 percent power for the entire year, the total output would have been 904 TWh.) There was substantial downtime at reactors with issues that drew mainstream media attention, and extreme weather events in plant vicinities that were viewed in the context of the Fukushima Daiichi accident in Japan. Still, with all the numbers thoroughly crunched, the median three-year net capacity factor for 2009 through 2011 was 90.18, down from the 90.60 recorded in 2006–2008, but not by enough to be statistically significant.

This annual survey looks almost entirely at medians within groups over three-year periods, but the exceptional nature of 2011 merits at least a brief viewing of the single year, and of an average rather than a median. The Missouri River surrounded Fort Calhoun. A beyond-design-basis earthquake was recorded at North Anna. Concrete repairs at Crystal River-3 will continue until at least 2014. Yet for the 104 power reactors as a whole, the average capacity factor in 2011 was 87.4 percent. This is what counts as an off-year for power plants that during their construction periods decades ago were routinely included in rate bases with the expectation of capacity factors of around 65 percent.

Overall, the story of the last three-year period is about the same as in the three three-year periods before it. A 90 percent capacity factor is pretty much the norm, and the vast majority of reactors have factors of over 85 percent. The accompanying tables could lead to comparisons, bragging rights, and so forth, but, as always, we caution the reader not to obsess over the numbers, especially to differentiate one reactor from another. Even if a utility's top management can make a case that a percentage-point drop in capacity factor translates to a missed opportunity to garner some amount of revenue, the U.S. nuclear fleet is not only remarkably productive now (and is thus pro-

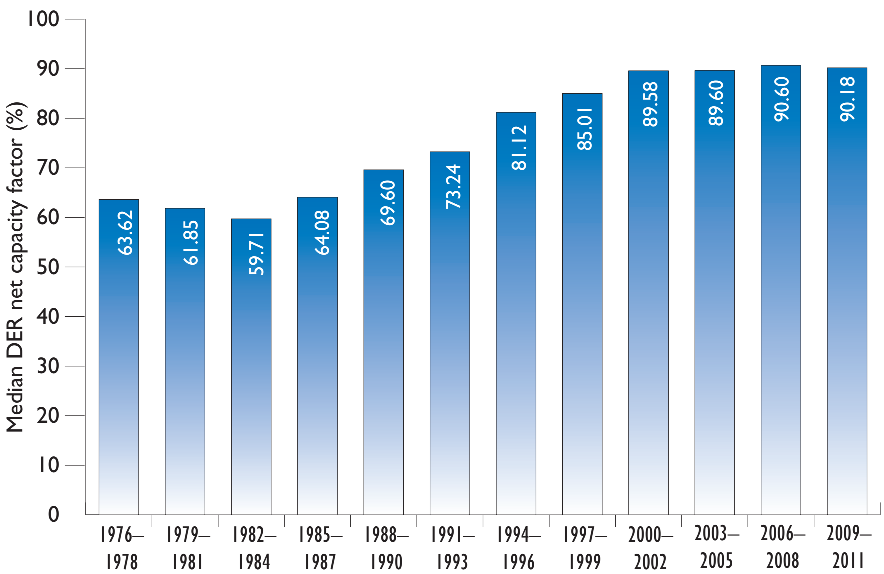

Fig. 1: All reactors. The similarity of the capacity factor medians in the last four periods strongly suggests that the power community as a whole has found a level that is both high and sustainable. The chart, like the others in this survey, shows only reactors that are still in operation. In 1976–1978, there were 40 operating reactors, and in each succeeding period there were 52, 59, 70, 91, 102, 103, and 104 in each of the last five. If closed reactors were included to show the median factor for the industry as it was at the time, the medians in the first seven periods would be 63.39 percent (51 reactors), 60.60 (63), 59.51 (71), 63.62 (81), 69.02 (100), 72.44 (108), and 80.64 (109).

viding electricity that is low-cost, as well as zero-carbon), but it has been that way for more than a decade.

To put it more bluntly, if you happen to be a top manager and your reactor personnel are having trouble keeping up with maintenance because you have been reluctant to provide sufficient resources, maybe you should recognize success for what it is. These high capacity factors are not the background noise of the industry, a decade-plus drone, but a major achievement every time they are delivered. Besides, you're going to have to open your wallet anyway to comply with the post-Fukushima orders and regulations that are on the way, so you might as well get used to it now. At the end of the day/year/decade, the power reactors will still be your strongest assets.

So what can be said about the 2009–2011 performance, compared to that of 2006–2008? By any reasonable criterion, it was pretty much the same. If you insist, you can find a drop of about half a percentage point in many of the medians within groups, and it should be noted that 59 of the 104 reactors had lower factors in 2009–2011 than they had in 2006–2008, although 73 of the reactors had factor changes, up or down, of less than 5 percentage points. As yet, however, there is no indication that the fleet as a whole is not keeping up the standard it has set for about the past 12 years.

Among all 104 power reactors, the median capacity factor in 2009–2011 was 90.18, down from 90.60 in 2006–2008. The

TABLE I.
2009–2011 DER NET CAPACITY FACTORS OF INDIVIDUAL REACTORS

Rank	Reactor	Factor[1]	Design Electrical Rating (DER), MWe[2]	Type	Owner[3]
1.	Comanche Peak-1	98.35	1218	PWR	Luminant
2.	Calvert Cliffs-1	98.28	845	PWR	Constellation
3.	FitzPatrick	97.94	816	BWR	Entergy
4.	Comanche Peak-2	97.91	1207	PWR	Luminant
5.	Surry-1	97.68	788	PWR	Dominion
6.	South Texas-1	97.54	1250.6	PWR	STPNOC
7.	Quad Cities-2	97.08	957.3	BWR	Exelon
8.	Peach Bottom-2	96.96	1138	BWR	Exelon
9.	Dresden-2	95.73	867	BWR	Exelon
10.	Dresden-3	95.52	867	BWR	Exelon
11.	Byron-2	95.05	1155	PWR	Exelon
12.	Quad Cities-1	94.93	866	BWR	Exelon
13.	Nine Mile Point-2	94.88	1143.3	BWR	Constellation
14.	Calvert Cliffs-2	94.78	845	PWR	Constellation
15.	Braidwood-2	94.78	1155	PWR	Exelon
16.	Vogtle-2	94.48	1169	PWR	Southern
17.	South Texas-2	94.28	1250.6	PWR	STPNOC
18.	River Bend-1	94.08	967	BWR	Entergy
19.	LaSalle-1	94.06	1178	BWR	Exelon
20.	Farley-1	93.81	854	PWR	Southern
21.	Clinton	93.77	1062	BWR	Exelon
22.	Kewaunee	93.47	574	PWR	Dominion
23.	Prairie Island-2	93.21	557	PWR	NSP
24.	LaSalle-2	93.11	1178	BWR	Exelon
25.	Vogtle-1	93.09	1169	PWR	Southern
26.	Catawba-2	93.09	1145	PWR	Duke
27.	Vermont Yankee	93.07	617	BWR	Entergy
28.	Byron-1	92.73	1187	PWR	Exelon
29.	Beaver Valley-1	92.70	911	PWR	FENOC
30.	Salem-2	92.30	1181	PWR	PSEG
31.	Nine Mile Point-1	92.22	613	BWR	Constellation
32.	Grand Gulf-1	92.20	1279	BWR	Entergy
33.	Braidwood-1	92.11	1187	PWR	Exelon
34.	Hope Creek	92.09	1228.1	BWR	PSEG
35.	Catawba-1	91.89	1145	PWR	Duke
36.	Oconee-3	91.72	886	PWR	Duke
37.	Surry-2	91.67	788	PWR	Dominion
38.	Beaver Valley-2	91.64	904	PWR	FENOC
39.	Limerick-1	91.56	1191	BWR	Exelon
40.	Waterford-3	91.43	1173	PWR	Entergy
41.	Indian Point-2	91.43	1035	PWR	Entergy
42.	Farley-2	91.33	855	PWR	Southern
43.	Peach Bottom-3	91.32	1138	BWR	Exelon
44.	Harris-1	91.30	941.7	PWR	Progress
45.	Hatch-1	91.28	885	BWR	Southern
46.	Oconee-2	91.05	886	PWR	Duke
47.	ANO-1	90.96	850	PWR	Entergy
48.	Salem-1	90.81	1169	PWR	PSEG
49.	Indian Point-3	90.44	1048	PWR	Entergy
50.	Pilgrim	90.44	690	BWR	Entergy
51.	Ginna	90.39	585	PWR	Constellation
52.	Millstone-3	90.30	1229	PWR	Dominion
53.	Limerick-2	90.06	1191	BWR	Exelon
54.	McGuire-1	90.02	1180	PWR	Duke
55.	Palo Verde-2	89.96	1336	PWR	APS
56.	Palisades	89.82	805	PWR	Entergy
57.	Sequoyah-2	89.69	1151	PWR	TVA
58.	McGuire-2	89.64	1180	PWR	Duke
59.	Diablo Canyon-1	89.56	1138	PWR	PG&E
60.	Watts Bar-1	89.53	1155	PWR	TVA
61.	Brunswick-1	89.28	983	BWR	Progress
62.	Summer-1	89.14	972.7	PWR	SCE&G
63.	ANO-2	88.91	1032	PWR	Entergy
64.	Callaway-1	88.84	1228	PWR	Ameren
65.	Palo Verde-3	88.81	1334	PWR	APS
66.	Diablo Canyon-2	88.66	1151	PWR	PG&E
67.	Sequoyah-1	88.61	1173	PWR	TVA
68.	Three Mile Island-1	88.48	819	PWR	Exelon
69.	Arnold	87.87	621.9	BWR	FPL
70.	Cook-2	87.80	1107	PWR	IMP
71.	San Onofre-3	87.79	1080	PWR	SCE
72.	Millstone-2	87.39	883.5	PWR	Dominion
73.	Oyster Creek	87.12	650	BWR	Exelon
74.	Turkey Point-4	87.07	720	PWR	FPL
75.	Prairie Island-1	87.06	557	PWR	NSP
76.	Browns Ferry-1	86.94	1120	BWR	TVA
77.	Palo Verde-1	86.84	1333	PWR	APS
78.	Turkey Point-3	86.83	720	PWR	FPL
79.	North Anna-2	86.67	913	PWR	Dominion
80.	Browns Ferry-3	86.42	1120	BWR	TVA
81.	Seabrook	85.69	1248	PWR	FPL
82.	Cooper	85.42	815	BWR	NPPD/Entergy
83.	Susquehanna-1	85.38	1287	BWR	PPL
84.	North Anna-1	84.71	913	PWR	Dominion
85.	St. Lucie-1	84.47	856	PWR	FPL
86.	Susquehanna-2	84.37	1287	BWR	PPL
87.	Oconee-1	84.29	886	PWR	Duke
88.	Point Beach-1	84.15	615	PWR	FPL
89.	Browns Ferry-2	82.80	1120	BWR	TVA
90.	Wolf Creek	82.77	1223	PWR	WCNOC
91.	Point Beach-2	81.88	615	PWR	FPL
92.	Robinson-2	81.75	765	PWR	Progress
93.	Brunswick-2	80.56	980	BWR	Progress
94.	Perry	80.46	1268	BWR	FENOC
95.	Davis-Besse	80.41	908	PWR	FENOC
96.	San Onofre-2	80.25	1070	PWR	SCE
97.	Fermi-2	79.73	1150	BWR	Detroit
98.	Hatch-2	78.21	908	BWR	Southern
99.	Monticello	77.36	600	BWR	NSP
100.	St. Lucie-2	76.42	856	PWR	FPL
101.	Fort Calhoun	69.30	502	PWR	OPPD
102.	Columbia	68.25	1153	BWR	Northwest
103.	Cook-1	55.42	1084	PWR	IMP
104.	Crystal River-3	23.84	860	PWR	Progress

[1] These figures are rounded off. There are no ties. For example, Calvert Cliffs-2 is in 14th, with 94.7827, and Braidwood-2 is in 15th, with 94.7806.

[2] The rating shown is effective as of December 31, 2011. If the reactor's rating has changed during the three-year period, the capacity factor is computed with appropriate weighting.

[3] As of December 31, 2011. In most cases this also means the reactor's operator, but Entergy is the contracted operator of Cooper.

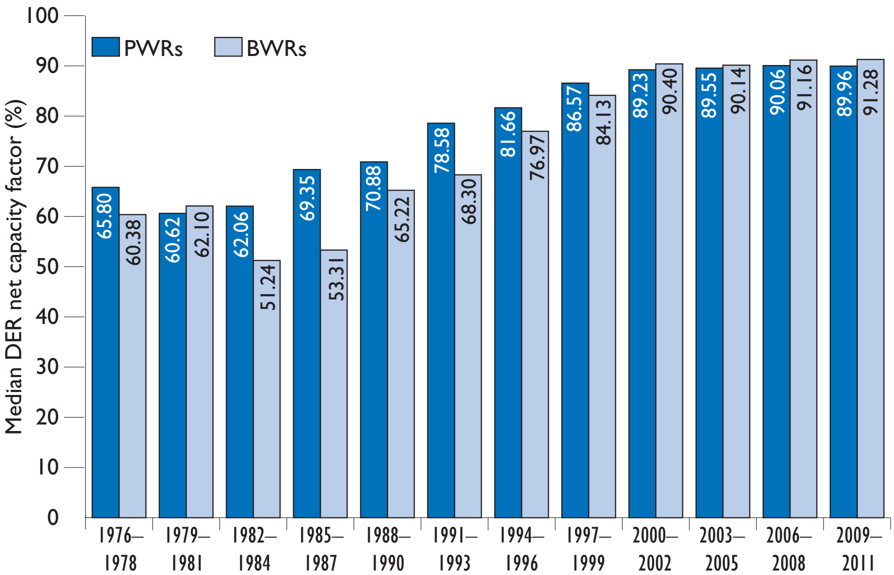

Fig. 2: Reactors by type. The narrow lead in capacity factors that boiling water reactors have maintained over pressurized water reactors has expanded slightly but remains small from a statistical perspective. If closed plants were included, the trends would look about the same, with all medians within two percentage points of the medians shown above.

top and bottom quartiles were also lower in 2009–2011, at 93.08 (vs. 93.13) and 86.75 (vs. 87.82). The 35 boiling water reactors increased their lead over the 69 pressurized water reactors, with the BWR median of 91.28 a slight improvement over the 91.16 for this group in 2006–2008, and the PWR median edging down to 89.96 from the 90.06 in the previous three-year period.

The explanation

Before this proceeds any further, here are the details of what this survey is and where the data came from. Each year, *Nuclear News* (which is to say, the author of this article) calculates the three-year capacity factor for each licensed power reactor in the United States. A three-year period, in our judgment, gives a better view of sustained performance than a single year. Each reactor is measured in terms of its design electrical rating (DER), which (also in our judgment) is the industry-wide metric that most closely reflects what the customers are paying for. The quantities of the electricity produced, and the DERs, are compiled by the Nuclear Regulatory Commission in quarterly collections of monthly operating reports. The NRC then posts this information on its ADAMS online document retrieval system, at <www.nrc.gov>, and it is treated as raw data for this survey.

Other organizations have their own ways of assessing performance, each with their own criteria, which is why the numbers you see here may not correspond to those you see elsewhere. As it happens, however, over the long term, each survey usually shows the same changes (or lack thereof) over the various time intervals examined. Figure 1 can be pretty much summarized as follows: A young industry just starting to find its way was set back by the Three Mile Island -2 accident in 1979, had various other growing pains, spent about two decades improving, reached an unexpected level, and has plateaued at that level for about a decade.

During 2011, the DERs of 11 reactors were raised by their licensees, continuing the process whereby the nuclear community raises its own bar. Power uprates were established or completed at Comanche Peak -1 and -2, Point Beach-1 and -2, Quad Cities-2, Susquehanna-2, and Wolf Creek, while the new ratings at LaSalle-1 and -2 and Prairie Island-1 and -2 reflect not just small measurement uncertainty recapture uprates but also heat rate improvements. (A reactor's peak is defined in its license as its thermal output, and the electrical output is whatever the licensee can derive from the heat.) With all of these changes put in place, the nuclear fleet's total peak electrical capacity is now 571.3 MWe higher than it was at the end of 2010. The changes became of-

Table II.
Capacity Factor Change, 2006–2008 to 2009–2011

Rank	Reactor	Change (percentage points)	Rank	Reactor	Change (percentage points)	Rank	Reactor	Change (percentage points)	Rank	Reactor	Change (percentage points)
1.	Browns Ferry-1	+42.86	27.	Salem-2	+2.71	53.	Braidwood-2	-0.93	79.	Indian Point-3	-4.48
2.	Palo Verde-1	+19.41	28.	Oconee-3	+2.67	54.	Turkey Point-4	-1.09	80.	Ginna	-4.52
3.	River Bend-1	+11.31	29.	Calvert Cliffs-1	+2.64	55.	ANO-2	-1.09	81.	San Onofre-2	-4.77
4.	Kewaunee	+9.45	30.	Catawba-1	+2.37	56.	Cook-2	-1.18	82.	Seabrook	-4.84
5.	Palo Verde-3	+9.40	31.	Catawba-2	+2.35	57.	Susquehanna-1	-1.20	83.	Cooper	-4.84
6.	San Onofre-3	+9.38	32.	McGuire-2	+2.30	58.	Sequoyah-2	-1.34	84.	Peach Bottom-3	-4.85
7.	Vogtle-2	+8.79	33.	Palisades	+2.05	59.	Summer-1	-1.46	85.	Arnold	-5.27
8.	Watts Bar-1	+7.61	34.	Quad Cities-1	+1.97	60.	North Anna-2	-1.86	86.	Robinson-2	-5.76
9.	McGuire-1	+6.34	35.	Beaver Valley-1	+1.56	61.	Hope Creek	-1.87	87.	St. Lucie-2	-6.06
10.	Palo Verde-2	+6.33	36.	Browns Ferry-3	+1.47	62.	Limerick-2	-1.92	88.	Brunswick-2	-6.17
11.	Quad Cities-2	+5.86	37.	Harris-1	+1.46	63.	South Texas-1	-1.99	89.	Susquehanna-2	-6.24
12.	Prairie Island-2	+4.30	38.	Oconee-1	+1.14	64.	Farley-2	-1.99	90.	Browns Ferry-2	-6.37
13.	Peach Bottom-2	+4.26	39.	Byron-2	+0.88	65.	Sequoyah-1	-2.16	91.	St. Lucie-1	-7.32
14.	Surry-1	+4.10	40.	Clinton	+0.80	66.	Pilgrim	-2.23	92.	Diablo Canyon-1	-7.41
15.	Grand Gulf-1	+4.04	41.	Comanche Peak-2	+0.64	67.	Prairie Island-1	-2.23	93.	Perry	-7.42
16.	Comanche Peak-1	+3.96	42.	Dresden-3	+0.59	68.	Turkey Point-3	-2.24	94.	Davis-Besse	-8.00
17.	Hatch-1	+3.86	43.	Dresden-2	+0.51	69.	Millstone-2	-2.30	95.	North Anna-1	-8.74
18.	Diablo Canyon-2	+3.84	44.	Beaver Valley-2	+0.10	70.	Calvert Cliffs-2	-2.64	96.	Wolf Creek	-8.94
19.	Brunswick-1	+3.80	45.	Vermont Yankee	+0.10	71.	Salem-1	-3.03	97.	Three Mile Island-1	-10.10
20.	Farley-1	+3.74	46.	Waterford-3	-0.08	72.	LaSalle-2	-3.40	98.	Point Beach-2	-10.64
21.	Nine Mile Point-2	+3.71	47.	Limerick-1	-0.12	73.	Nine Mile Point-1	-3.52	99.	Monticello	-12.25
22.	Vogtle-1	+3.07	48.	Byron-1	-0.39	74.	Point Beach-1	-3.73	100.	Hatch-2	-13.36
23.	FitzPatrick	+3.04	49.	Callaway-1	-0.46	75.	Braidwood-1	-3.76	101.	Fort Calhoun	-16.02
24.	LaSalle-1	+3.00	50.	Indian Point-2	-0.52	76.	South Texas-2	-3.94	102.	Columbia	-19.81
25.	Oyster Creek	+2.98	51.	ANO-1	-0.69	77.	Surry-2	-4.25	103.	Cook-1	-23.57
26.	Oconee-2	+2.85	52.	Millstone-3	-0.70	78.	Fermi-2	-4.35	104.	Crystal River-3	-67.34

ficial at various times during the year, and the capacity factor computations shown here have been weighted accordingly.

This survey always makes a point of trying to get licensees to raise their DERs after they have had uprates, and most licensees do this routinely. Still, there continue to be a few holdouts that have had uprates of more than 4 percent but have left their DERs unchanged, making their capacity factors appear a few points higher than they probably should. Readers should take this into account when looking at the numbers for Calvert Cliffs-1 and -2, FitzPatrick, North Anna-1 and -2, and Surry-1 and -2.

It is gratifying, however, to note that one reactor that was in that group in previous years has now come around. Wolf Creek Nuclear Operating Corporation received approval from the NRC in 1993 for a 4.5 percent uprate for Wolf Creek, and in 2011, the company finally changed the reactor's DER from 1170 MWe to 1223 MWe, an increase of 4.5 percent. It seems unlikely that the annual chiding in this survey had anything to do with that, but the change should be welcomed as a triumph for relevance in statistics.

Table III.
DER Net Capacity Factor of Multireactor Sites[1]

Rank	Site	Factor	Owner	Rank	Site	Factor	Owner
1.	Comanche Peak	98.13	Luminant	19.	Prairie Island	90.13	NSP
2.	Calvert Cliffs	96.53	Constellation	20.	ANO	89.84	Entergy
3.	Quad Cities	96.03	Exelon	21.	McGuire	89.83	Duke
4.	South Texas	95.91	STPNOC	22.	Sequoyah	89.14	TVA
5.	Dresden	95.62	Exelon	23.	Diablo Canyon	89.11	PG&E
6.	Surry	94.67	Dominion	24.	Millstone	89.08	Dominion
7.	Peach Bottom	94.14	Exelon	25.	Oconee	89.02	Duke
8.	Nine Mile Point	94.14	Constellation	26.	Palo Verde	88.54	APS
9.	Byron	93.87	Exelon	27.	Turkey Point	86.95	FPL
10.	Vogtle	93.79	Southern	28.	North Anna	85.69	Dominion
11.	LaSalle	93.58	Exelon	29.	Browns Ferry	85.39	TVA
12.	Braidwood	93.43	Exelon	30.	Brunswick	84.93	Progress
13.	Farley	92.57	Southern	31.	Susquehanna	84.88	PPL
14.	Catawba	92.49	Duke	32.	Hatch	84.66	Southern
15.	Beaver Valley	92.18	FENOC	33.	San Onofre	84.04	SCE
16.	Hope Creek/Salem	91.73	PSEG	34.	Point Beach	83.00	FPL
17.	Indian Point	90.93	Entergy	35.	St. Lucie	80.45	FPL
18.	Limerick	90.81	Exelon	36.	Cook	71.78	IMP

[1] Because Nine Mile Point and FitzPatrick have different owners, Nine Mile Point is listed here as a multireactor site, but FitzPatrick is not included, even though the plants are on adjacent properties; combined, Nine Mile Point and FitzPatrick would have a 2009–2011 factor of 95.22. Hope Creek and Salem are treated as a single site because they are adjacent and have the same owner; the two-reactor Salem had a 2009–2011 factor of 91.56.

Aging, and management

At the end of 2011, eight reactors had officially entered their renewed license periods. One way to hazard a guess about the prospects for upholding what can be seen as the industry standard for capacity factor as the fleet ages might be to look at these eight reactors' numbers. At least this is a place to start.

The very small size of the sample made up of Dresden-2 and -3, Ginna, Monticello, Nine Mile Point-1, Oyster Creek, Point Beach-1, and Robinson-2, gives us a median for 2009–2011 of 88.75, about a point and a half lower than the median for all 104 reactors. It is also three and a half points lower than the median of the same eight-reactor group in 2006–2008, but that median (92.26) was a point and a half higher than the median for all 104 reactors in that three-year period, so what we appear to be seeing here is more likely a statistical fluctuation from the use of only eight data points, rather than an indicator of a performance trend.

Let's try a larger sample and a longer time frame. Forty reactors had completed at least 36 years of commercial operation by the end of 2011. The "industry standard" alluded to above—a median three-year capacity factor in the neighborhood of 90 percent—has been recorded for the past four three-year periods. We have therefore dredged up the numbers for the 40 oldest reactors over the past four three-year periods and compared them to the numbers for all reactors.

Table V shows that there has been little variation over the last four periods between medians and quartiles of the oldest reactors and those of the 104 reactors as a whole. There does not even appear to be a downward trend, because in 2009–2011, the 40 oldest reactors had a median factor of 90.41, almost a quarter of a point higher than the median for all reactors. Because of this, we have not taken the further step of treating the old reactors and the not-as-old reactors as entirely separate groups. (That is, we have not compared the 40 oldest reactors with the 64 reactors that had less than 36 years of commercial operation at the end of 2011.)

The main point here is that all of these differences are very small and probably cannot be spun convincingly in any direction. This may mean that as long as aging-management programs are properly developed and scrupulously followed, there appear to be no guarantees of productivity losses after 40 years—or at least after 36.

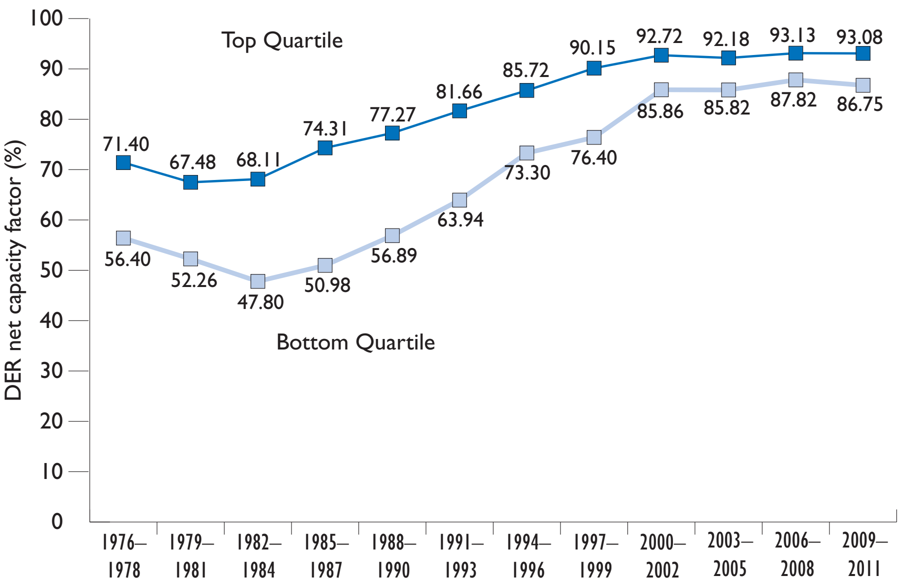

Fig. 3: All reactors, top and bottom quartiles. Both of these curves showing DER net capacity factors follow the progress of the median, right up through the most recent four periods. This indicates that the medians are reasonably representative of the progress of the entire group.

Life after lesson-learning

Over the past several years, this survey has examined power reactor capacity factors in a variety of ways in order to see if other influences affect them one way or the other. This time we took a closer look at license renewal and plant aging. At other times we have assessed the effects of substantial power uprates, and of the possibility that the development of new reactors would alter a licensee's focus on its existing fleet. We expect to revisit all of these possibilities in future surveys. We will also,

TABLE IV.
DER NET CAPACITY FACTORS
OF OWNERS OR OPERATORS
OF MORE THAN ONE SITE[1]

Rank	Owner/Operator	Factor
1.	Constellation Energy	94.51
2.	Exelon Generation	93.28
3.	Entergy Nuclear	91.80
4.	Southern Nuclear Operating	90.63
5.	Duke Power	90.37
6.	Dominion Energy	89.92
7.	Tennessee Valley Authority	87.36
8.	FirstEnergy Nuclear Operating	85.78
9.	Northern States Power–Minnesota	85.58
10.	FPL/NextEra	84.26
11.	Progress Energy	74.12

[1] Entergy is the contract operator of Cooper, but not its owner; Entergy with Cooper is 91.33.

however, have to add a new aspect that has not yet had an effect on power reactor performance: the modifications that will be made to plant hardware and procedures as a result of NRC and industry response to the lessons learned from the Fukushima Daiichi accident.

The changes will certainly cost some money, but exactly how much is not yet known, and the amounts will vary depending on reactor type, location, and other factors. The general consensus thus far, however, is that the expense will not greatly affect the basic economics of nuclear power in the United States. (The use of "thus far" could be seen as cautionary, however.)

It seems reasonable to expect that the physical modifications will add to downtime, perhaps mainly during refueling outages, and that this in turn will mean less time on line and thus lower capacity factors. There will also be a great deal of new training for operators and other plant personnel and additional tasks to perform, which can also affect electricity production, although perhaps only in the early stages. Overall, there could be a (perhaps slight) dip in capacity factors on either side of 2016, the target year for the last of the recommendations of the NRC's Near-Term Task Force to be put in place.

The NRC has also made it clear that the agency's Fukushima response takes precedence over licensee-requested actions, such as reviewing applications for license renewal and power uprates. This does not mean, however, that work on renewals and uprates has been dropped altogether, just that it's going more slowly in some cases. Indeed, the NRC's shifted priorities do not have much to do with the most prolonged renewal proceedings: The Indian Point hearing has not even begun yet, and when it does, a record number of contentions will have to be addressed. (There were 17 contentions at one time, but with subsequent revisions and combinations, it is no longer obvious how many separate contentions there are.)

In closing, then, the author has a proposal for addressing licensee-requested productivity improvements in the post-Fukushima era. Seventy-one reactors have been approved for license renewal, leaving 33 in various stages of application or pre-application. (It is widely expected that renewal will be sought for all 33, and that second renewals may be sought around the end of this decade for some of those already renewed once.) Under NRC regulations, once a renewal application is docketed, the reactor can continue to operate after the expiration date of the original license, even if the renewal proceeding has not been completed. At this writing, it seemed possible that this might be the case with Pilgrim, as its license expires in June, and Entergy's renewal application has not been approved more than six years after it was submitted.

Apart from Pilgrim and Indian Point, no unrenewed reactors are closing in on their expiration dates. Also, for most reactors, the renewal process has been fairly smooth and predictable. We suggest, therefore, that the NRC use the limited resources it has for licensee requests to place power uprates at a higher priority than license renewals. If a renewal has to wait an extra year or more, there should be few consequences (as long as the NRC stops charging billable hours while a renewal application gets a rest), because the renewed license will still pick up when the original one expires. If an uprate has to be delayed, however, the opportunity to generate extra electricity during that time has been lost forever. The NRC staff will still have to pay extra attention to the Pilgrim and Indian Point (and perhaps Seabrook and Davis-Besse) renewals, but for just about every other request, an uprate now would be better than a renewal now.

TABLE V.
COMPARISON OF OLDEST 40 REACTORS WITH ALL REACTORS,
LAST FOUR THREE-YEAR PERIODS

Period	Top Quartile	Median	Bottom Quartile
2000–2002	91.93 (-0.79)*	89.22 (-0.36)	83.85 (-2.01)
2003–2005	90.79 (-1.39)	88.73 (-0.87)	84.52 (-1.30)
2006–2008	93.36 (+0.23)	89.98 (-0.62)	87.82 (0.00)
2009–2011	93.14 (+0.06)	90.41 (+0.23)	86.13 (-0.62)

* In parentheses are the differences between the values of the 40 oldest reactors and those of all reactors. A minus sign indicates that the old reactors' value was lower; a plus sign means that it was higher. NN