

Power Uprates for Nuclear Plants

When the NRC licenses a commercial nuclear power plant, it sets limits on the maximum heat output, or power level, for the reactor core. This power level plays an important role in many of the analyses that demonstrate plant safety, so the NRC's permission is required before a plant can change its maximum power level. A "power uprate" only occurs after the NRC approves a commercial nuclear power plant's request to increase its power.

Utilities have used power uprates since the 1970s as a way to generate more electricity from their nuclear plants. As of April 2014, the NRC has approved 154 uprates, resulting in a gain of approximately 21,105 MWt (megawatts thermal) or 7,035 MWe (megawatts electric). These uprates are listed in Table 1 at the end of this document. Collectively, these uprates have added generating capacity equivalent to about seven new reactors.

To increase the power output of a reactor, typically a utility will refuel with either slightly more enriched uranium fuel or a higher percentage of new fuel. This enables the reactor to produce more thermal energy and therefore more steam, which drives a turbine to generate electricity. Components such as pipes, valves, pumps, heat exchangers, electrical transformers and generators must be able to accommodate the higher power level. For example, a higher power level usually involves greater steam and water flow through the systems used to convert heat into electric power. These systems must be able to handle the increased flows.

Some licensees modify or replace components in order to accommodate a higher power level. Depending on the desired power increase and original equipment design, this may involve major plant modifications, such as the replacement of main turbines. All of these factors must be analyzed by the licensee as part of its license amendment request for the uprate. The analyses must demonstrate that the proposed new configuration remains safe and that measures continue to be in place to protect the health and safety of the public. The NRC's technical and legal staffs review these complex technical analyses before approving an uprate request.



Calvert Cliffs in Maryland was the first U.S. nuclear power plant to implement an uprate.

Types of Power Uprates

U.S. commercial reactors are designed with excess capacity to allow for a potential uprate. There are three types of uprates: 1) measurement uncertainty recapture power uprates, 2) stretch power uprates, and 3) extended power uprates.

Measurement uncertainty recapture power uprates increase the licensed power level by less than 2 percent. They are achieved by implementing improved techniques for calculating reactor power. This involves the use of state-of-the-art devices to more precisely measure the feedwater flow used to calculate reactor power. More precise measurements reduce the degree of uncertainty in the power level, helping analysts predict the ability of the reactor to be safely shut down under possible accident conditions.

Stretch power uprates are typically between 2 percent and 7 percent, with the actual increase depending on a plant design's specific operating margin. Stretch power uprates usually involve changes to instrumentation settings but do not involve major plant modifications.

Extended power uprates are greater than stretch power uprates and have been approved for increases as high as 20 percent. Extended power uprates usually require significant modifications to major pieces of non-nuclear equipment such as high-pressure turbines, condensate pumps and motors, main generators, and transformers.

Review Process

Since uprates change a reactor's licensed power level, utilities seek NRC permission to amend their operating license in order to implement a power uprate. The process for requesting and approving a change to a plant's power level is governed by [10 CFR 50.90-92](#).¹ The applications and reviews are complex and involve many areas of expertise in the NRC's offices of Nuclear Reactor Regulation and General Counsel. Some reviews may also involve the Office of Nuclear Regulatory Research and the Advisory Committee on Reactor Safeguards (ACRS). In evaluating a power uprate request, the NRC reviews data and accident analyses submitted by a licensee to confirm the plant can operate safely at the higher power level.

The NRC uses a review standard for extended power uprates ([RS-001, December 2003](#)) that has been endorsed by the ACRS. The standard provides a comprehensive process and technical guidance for reviews by the NRC staff, and provides useful information to licensees applying for an extended uprate.

After a licensee submits an uprate application, the NRC informs the public through a notice in the *Federal Register* that the agency is considering the application. The public has 30 days to comment on the licensee's request and 60 days to request a hearing where the application could be contested. The NRC technical staff thoroughly reviews the application and any public comments, while the Atomic Safety and Licensing Board (ASLB) considers any requests for hearings. When the staff completes its review, it issues a safety evaluation and another *Federal Register* notice to inform the public of its decision.

¹ <http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/>

If the ASLB determines a hearing is required a separate legal process takes place, and the NRC staff provides technical information as needed. The safety evaluation and any hearing rulings form the basis for the NRC's final decision on the uprate request, although the staff can authorize an uprate while a hearing is underway. The NRC issues a press release for any approved uprate.

Uprates—Completed, Under Review, Expected

The NRC has approved 154 uprates and typically has several applications for power uprates under review at any given time. Licensees responding to a December 2012 NRC survey indicated they plan to submit 3 applications for measurement uncertainty recapture uprates in the next five years. If these applications are approved, the resulting uprates would add another 172 MWt (58 MWe) to the nation's generating capacity. Lists of uprate applications approved, under review, and anticipated can be found in the three tables at the end of this fact sheet, and on the NRC's [website](#).²

Public Involvement

The NRC welcomes public involvement in our activities as part of our strong, fair oversight of the nuclear industry. The public's opportunities to participate in the power uprate arena include:

- Pre-application meetings, where licensees discuss their uprate plans with NRC staff (some portions of these meetings may be closed to the public to discuss proprietary information).
- Comments related to an application and requests for a hearing on the application.
- Briefings to the ACRS on the results of the staff's review of the applications (some portions of these meetings may be closed to the public to discuss proprietary information). ACRS meeting schedules are available on the NRC's [website](#).³

For each extended power uprate, the NRC staff typically issues a draft environmental assessment for a 30-day public comment period. The NRC staff considers and addresses all comments before finalizing the environmental assessment.

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² <http://www.nrc.gov/reactors/operating/licensing/power-uprates/status-power-apps.html>

³ <http://www.nrc.gov/reading-rm/doc-collections/acrs/agenda>

Table 1 - Approved Power Uprates as of April 2014

(TYPE – S = Stretch; E = Extended; MU = Measurement Uncertainty Recapture)

NO.	PLANT	% UPRATE	MWt	DATE APPROVED	UPRATE TYPE
1	Calvert Cliffs 1	5.5	140	09/09/1977	S
2	Calvert Cliffs 2	5.5	140	10/19/1977	S
3	Millstone 2	5	140	06/25/1979	S
4	H. B. Robinson	4.5	100	06/29/1979	S
5	Fort Calhoun	5.6	80	08/15/1980	S
6	Crystal River 3	3.8	92	07/21/1981	S
7	St. Lucie 1	5.5	140	11/23/1981	S
8	St. Lucie 2	5.5	140	03/01/1985	S
9	Duane Arnold	4.1	65	03/27/1985	S
10	Salem 1	2	73	02/06/1986	S
11	North Anna 1	4.2	118	08/25/1986	S
12	North Anna 2	4.2	118	08/25/1986	S
13	Callaway	4.5	154	03/30/1988	S
14	TMI-1	1.3	33	07/26/1988	S
15	Fermi 2	4	137	09/09/1992	S
16	Vogtle 1	4.5	154	03/22/1993	S
17	Vogtle 2	4.5	154	03/22/1993	S
18	Wolf Creek	4.5	154	11/10/1993	S
19	Susquehanna 2	4.5	148	04/11/1994	S
20	Peach Bottom 2	5	165	10/18/1994	S
21	Limerick 2	5	165	02/16/1995	S
22	Susquehanna 1	4.5	148	02/22/1995	S
23	Nine Mile Point 2	4.3	144	04/28/1995	S
24	Columbia	4.9	163	05/02/1995	S
25	Peach Bottom 3	5	165	07/18/1995	S
26	Surry 1	4.3	105	08/03/1995	S
27	Surry 2	4.3	105	08/03/1995	S
28	Hatch 1	5	122	08/31/1995	S
29	Hatch 2	5	122	08/31/1995	S
30	Limerick 1	5	165	01/24/1996	S
31	V. C. Summer	4.5	125	04/12/1996	S
32	Palo Verde 1	2	76	05/23/1996	S
33	Palo Verde 2	2	76	05/23/1996	S
34	Palo Verde 3	2	76	05/23/1996	S
35	Turkey Point 3	4.5	100	09/26/1996	S
36	Turkey Point 4	4.5	100	09/26/1996	S
37	Brunswick 1	5	122	11/01/1996	S
38	Brunswick 2	5	122	11/01/1996	S
39	Fitzpatrick	4	100	12/06/1996	S

NO.	PLANT	% UPRATE	MWt	DATE APPROVED	UPRATE TYPE
40	Farley 1	5	138	04/29/1998	S
41	Farley 2	5	138	04/29/1998	S
42	Browns Ferry 2	5	164	09/08/1998	S
43	Browns Ferry 3	5	164	09/08/1998	S
44	Monticello	6.3	105	09/16/1998	E
45	Hatch 1	8	205	10/22/1998	E
46	Hatch 2	8	205	10/22/1998	E
47	Comanche Peak 2	1	34	09/30/1999	MU
48	LaSalle 1	5	166	05/09/2000	S
49	LaSalle 2	5	166	05/09/2000	S
50	Perry	5	178	06/01/2000	S
51	River Bend	5	145	10/06/2000	S
52	Diablo Canyon 1	2	73	10/26/2000	S
53	Watts Bar	1.4	48	01/19/2001	MU
54	Byron 1	5	170	05/04/2001	S
55	Byron 2	5	170	05/04/2001	S
56	Braidwood 1	5	170	05/04/2001	S
57	Braidwood 2	5	170	05/04/2001	S
58	Salem 1	1.4	48	05/25/2001	MU
59	Salem 2	1.4	48	05/25/2001	MU
60	San Onofre 2	1.4	48	07/06/2001	MU
61	San Onofre 3	1.4	48	07/06/2001	MU
62	Susquehanna 1	1.4	48	07/06/2001	MU
63	Susquehanna 2	1.4	48	07/06/2001	MU
64	Hope Creek	1.4	46	07/30/2001	MU
65	Beaver Valley 1	1.4	37	09/24/2001	MU
66	Beaver Valley 2	1.4	37	09/24/2001	MU
67	Shearon Harris	4.5	138	10/12/2001	S
68	Comanche Peak 1	1.4	47	10/12/2001	MU
69	Comanche Peak 2	0.4	13	10/12/2001	MU
70	Duane Arnold	15.3	248	11/06/2001	E
71	Dresden 2	17	430	12/21/2001	E
72	Dresden 3	17	430	12/21/2001	E
73	Quad Cities 1	17.8	446	12/21/2001	E
74	Quad Cities 2	17.8	446	12/21/2001	E
75	Waterford 3	1.5	51	03/29/2002	MU
76	Clinton	20	579	04/05/2002	E
77	South Texas 1	1.4	53	04/12/2002	MU
78	South Texas 2	1.4	53	04/12/2002	MU
79	ANO-2	7.5	211	04/24/2002	E
80	Sequoyah 1	1.3	44	04/30/2002	MU

NO.	PLANT	% UPRATE	MWt	DATE APPROVED	UPRATE TYPE
81	Sequoyah 2	1.3	44	04/30/2002	MU
82	Brunswick 1	15	365	05/31/2002	E
83	Brunswick 2	15	365	05/31/2002	E
84	Grand Gulf	1.7	65	10/10/2002	MU
85	H. B. Robinson	1.7	39	11/05/2002	MU
86	Peach Bottom 2	1.62	56	11/22/2002	MU
87	Peach Bottom 3	1.62	56	11/22/2002	MU
88	Indian Point 3	1.4	42.4	11/26/2002	MU
89	Point Beach 1	1.4	21.5	11/29/2002	MU
90	Point Beach 2	1.4	21.5	11/29/2002	MU
91	Crystal River 3	0.9	24	12/04/2002	S
92	D.C. Cook 1	1.66	54	12/20/2002	MU
93	River Bend	1.7	52	01/31/2003	MU
94	D.C. Cook 2	1.66	57	05/02/2003	MU
95	Pilgrim	1.5	30	05/09/2003	MU
96	Indian Point 2	1.4	43	05/22/2003	MU
97	Kewaunee	1.4	23	07/08/2003	MU
98	Hatch 1	1.5	41	09/23/2003	MU
99	Hatch 2	1.5	41	09/23/2003	MU
100	Palo Verde 2	2.9	114	09/29/2003	S
101	Kewaunee	6	99	02/27/2004	S
102	Palisades	1.4	35.4	06/23/2004	MU
103	Indian Point 2	3.26	101.6	10/27/2004	S
104	Seabrook	5.2	176	02/28/2005	S
105	Indian Point 3	4.85	148.6	03/24/2005	S
106	Waterford	8	275	04/15/2005	S
107	Palo Verde 1	2.9	114	11/16/2005	S
108	Palo Verde 3	2.9	114	11/16/2005	S
109	Vermont Yankee	20	319	03/02/2006	E
110	Seabrook	1.7	61	05/22/2006	MU
111	Ginna	16.8	255	07/11/2006	E
112	Beaver Valley 1	8	211	07/19/2006	E
113	Beaver Valley 2	8	211	07/19/2006	E
114	Browns Ferry 1	5	165	03/06/2007	S
115	Crystal River 3	1.6	41	12/26/2007	MU
116	Susquehanna 1	13	463	01/30/2008	E
117	Susquehanna 2	13	463	01/30/2008	E
118	Vogtle 1	1.7	60.6	02/27/2008	MU
119	Vogtle 2	1.7	60.6	02/27/2008	MU
120	Hope Creek	15	501	05/14/2008	E
121	Comanche Peak 1	4.5	154	06/27/2008	S

NO.	PLANT	% UPRATE	MWt	DATE APPROVED	UPRATE TYPE
122	Comanche Peak 2	4.5	154	06/27/2008	S
123	Cooper	1.6	38	06/30/2008	MU
124	Davis-Besse	1.6	45	06/30/2008	MU
125	Millstone 3	7	239	08/12/2008	S
126	Calvert Cliffs 1	1.4	37	07/22/2009	MU
127	Calvert Cliffs 2	1.4	37	07/22/2009	MU
128	North Anna 1	1.6	47	10/22/2009	MU
129	North Anna 2	1.6	47	10/22/2009	MU
130	Prairie Island 1	1.6	27	08/18/2010	MU
131	Prairie Island 2	1.6	27	08/18/2010	MU
132	LaSalle 1	1.6	57	09/16/2010	MU
133	LaSalle 2	1.6	57	09/16/2010	MU
134	Surry 1	1.6	41	09/24/2010	MU
135	Surry 2	1.6	41	09/24/2010	MU
136	Limerick 1	1.6	57	04/08/2011	MU
137	Limerick 2	1.6	57	04/08/2011	MU
138	Point Beach 1	17	260	05/03/2011	E
139	Point Beach 2	17	260	05/03/2011	E
140	Nine Mile Point 2	15	521	12/22/2011	E
141	Shearon Harris	1.7	48	05/30/2012	MU
142	Turkey Point 3	15.0	344	06/15/2012	E
143	Turkey Point 4	15.0	344	06/15/2012	E
144	St. Lucie 1	11.9	320	07/09/2012	E
145	Grand Gulf 1	13.1	510	07/18/2012	E
146	St. Lucie 2	11.9	320	09/24/2012	E
147	McGuire 1	1.7	58	05/16/2013	MU
148	McGuire 2	1.7	58	05/16/2013	MU
149	Monticello	12.9	229	12/09/2013	E
150	Braidwood 1	1.6	58.4	02/07/2014	MU
151	Braidwood 2	1.6	58.4	02/07/2014	MU
152	Byron 1	1.6	58.4	02/07/2014	MU
153	Byron 2	1.6	58.4	02/07/2014	MU
154	Fermi 2	1.6	56	02/10j/2014	MU
	Total MWt		21,104.8		
	Total MWe		7,034.9		

Table 2 - Pending Applications for Power Uprates as of April 2014

(TYPE – S = Stretch; E = Extended; MU = Measurement Uncertainty Recapture)

NO.	PLANT	% UPRATE	MWt	SUBMITTAL DATE	PROJECTED COMPLETION DATE	TYPE
1	Browns Ferry 2	14.3	494	06/25/2004	On Hold ⁴	E
2	Browns Ferry 3	14.3	494	06/25/2004	On Hold ⁴	E
3	Browns Ferry 1	14.3	494	06/28/2004	On Hold ⁴	E
4	Oconee 1	1.6	42	09/20/2011	On Hold ⁵	MU
5	Oconee 2	1.6	42	09/20/2011	On Hold ⁵	MU
6	Oconee 3	1.6	42	09/20/2011	On Hold ⁵	MU
7	Peach Bottom 2	12.4	437	09/28/2012	September 2014	E
8	Peach Bottom 3	12.4	437	09/28/2012	September 2014	E
	Total MWt		2,482			
	Total MWe		827.3			

Table 3 – Expected Power Uprate Applications

(Based on a December 2012 survey of licensees.)

Fiscal Year	Total Power Uprates Expected	Measurement Uncertainty Recapture Power Uprates	Stretch Power Uprates	Extended Power Uprates	Megawatts Thermal	Approximate Megawatts Electric
2013	0	0	0	0	0	0
2014	2	2	0	0	116	39
2015	0	0	0	0	0	0
2016	1	1	0	0	56	19
2017	0	0	0	0	0	0
TOTAL	3	3	0	0	172	58

⁴ [NRC letter dated February 28, 2014, to Tennessee Valley Authority regarding Browns Ferry Power Uprate.](#)

⁵ [NRC letter dated August 31, 2012, to Duke Energy regarding Oconee Power Uprate.](#)