U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Backgrounder

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Power Uprates for Nuclear Plants

Introduction

When the NRC issues a license for a commercial nuclear power plant, the agency 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.

Background

Utilities have used power uprates since the 1970s as a way to generate more electricity from their nuclear plants. As of January 2008, the NRC has approved 116 uprates, resulting in a gain of approximately 15,600 MWt (megawatts thermal) or 5,200 MWe (megawatts electric) at existing plants. These uprates are listed in Table 1 at the end of this document. Collectively, these uprates have added generating capacity at existing plants that is equivalent to more than five new reactors.

Discussion

To increase the power output of a reactor, typically a utility will refuel a reactor 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, driving a turbine generator to produce electricity. In order to accomplish this, components such as pipes, valves, pumps, heat exchangers, electrical transformers and generators must be able to accommodate the conditions that would exist at the higher power level. For example, a higher power level usually involves higher steam and water flow through the systems used in converting the thermal power into electric power. These systems must be capable of accommodating the higher flows.

In some instances, licensees will modify and/or replace components in order to accommodate a higher power level. Depending on the desired increase in power level and original equipment design, this can involve major modifications to the plant such as the replacement of main turbines. All of these factors must be analyzed by the licensee as part of their request to amend their license 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 analyses, which span many technical disciplines and may be complex, before approving a request for a power uprate.

Types of Power Uprates

The design of every U.S. commercial reactor has excess capacity needed to potentially allow for an uprate, which can fall into one of three categories: 1) measurement uncertainty recapture power uprates, 2) stretch power uprates and 3) extended power uprates.

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

2) Stretch power uprates are typically between 2 percent and 7 percent, with the actual increase in power 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.

3) 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/or transformers.

Review Process

Since uprates affect a reactor's licensed power level, utilities apply for 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. These regulations are available on the agency's Web site at: http://www.nrc.gov/reading-rm/doc-collections/cfr/part050/ . 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, NRC reviews data and accident analyses submitted by a licensee to confirm that the plant can operate safely at the higher power level. Reviews of power uprate requests are a high priority.

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 considering applying for an extended uprate.

After a licensee submits an uprate application, the NRC places a notice in the *Federal Register* to notify the public 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 thoroughly reviews the application and any public comments, while the Atomic Safety and Licensing Board (ASLB) considers any requests for hearings. NRC technical staff complete their review while considering and addressing any public comments, issuing a

safety evaluation and another *Federal Register* notice to inform the public. If the ASLB determines a hearing is required, a separate legal process takes place, and NRC staff provides technical information, if 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, and an updated list of approved uprates is available on the NRC's Web site at: http://www.nrc.gov/reactors/operating/licensing/power-uprates/approved-applications.html .

The NRC usually has several applications for power uprates under review at any given time. The latest list of applications under review is on the NRC's Web site at: http://www.nrc.gov/reactors/operating/licensing/power-uprates/pending-applications.html .

Expected Uprate Applications

Licensee responses to a September 2007 NRC survey indicate they plan to submit 24 power uprate applications in the next five years, including 17 extended uprates and 7 measurement uncertainty recapture uprates. If these applications are approved, the resulting uprates would add another 5,254 MWt (1,751 MWe) to the nation's generating capacity. Anticipated future applications can be found in Table 3 at the end of this fact sheet, and updates will be on the NRC's Web site at: http://www.nrc.gov/reactors/operating/licensing/power-uprates/expected-applications.html .

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 Web site at this address: http://www.nrc.gov/reading-rm/doc-collections/acrs/agenda/ .
- 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 draft environmental assessment.

Table 1 - Approved Power Uprates, February 2008

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

No.	Plant	% Uprate	MWt	Year Approved	TYPE
1	Calvert Cliffs 1	5.5	140	1977	S
2	Calvert Cliffs 2	5.5	140	1977	S
3	Millstone 2	5	140	1979	S
4	H. B. Robinson	4.5	100	1979	S
5	Fort Calhoun	5.6	80	1980	S
6	St. Lucie 1	5.5	140	1981	S
7	St. Lucie 2	5.5	140	1985	S
8	Duane Arnold	4.1	65	1985	S
9	Salem 1	2	73	1986	S
10	North Anna 1	4.2	118	1986	S
11	North Anna 2	4.2	118	1986	S
12	Callaway	4.5	154	1988	S
13	TMI-1	1.3	33	1988	S
14	Fermi 2	4	137	1992	S
15	Vogtle 1	4.5	154	1993	S
16	Vogtle 2	4.5	154	1993	S
17	Wolf Creek	4.5	154	1993	S
18	Susquehanna 2	4.5	148	1994	S
19	Peach Bottom 2	5	165	1994	S
20	Limerick 2	5	165	1995	S
21	Susquehanna 1	4.5	148	1995	S
22	Nine Mile Point 2	4.3	144	1995	S

No.	Plant	% Uprate	MWt	Year Approved	TYPE
23	WNP-2	4.9	163	1995	S
24	Peach Bottom 3	5	165	1995	S
25	Surry 1	4.3	105	1995	S
26	Surry 2	4.3	105	1995	S
27	Hatch 1	5	122	1995	S
28	Hatch 2	5	122	1995	S
29	Limerick 1	5	165	1996	S
30	V. C. Summer	4.5	125	1996	S
31	Palo Verde 1	2	76	1996	S
32	Palo Verde 2	2	76	1996	S
33	Palo Verde 3	2	76	1996	S
34	Turkey Point 3	4.5	100	1996	S
35	Turkey Point 4	4.5	100	1996	S
36	Brunswick 1	5	122	1996	S
37	Brunswick 2	5	122	1996	S
38	Fitzpatrick	4	100	1996	S
39	Farley 1	5	138	1998	S
40	Farley 2	5	138	1998	S
41	Browns Ferry 2	5	164	1998	S
42	Browns Ferry 3	5	164	1998	S
43	Monticello	6.3	105	1998	E
44	Hatch 1	8	205	1998	E
45	Hatch 2	8	205	1998	E
46	Comanche Peak 2	1	34	1999	MU
47	LaSalle 1	5	166	2000	S

No.	Plant	% Uprate	MWt	Year Approved	TYPE
48	LaSalle 2	5	166	2000	S
49	Perry	5	178	2000	S
50	River Bend	5	145	2000	S
51	Diablo Canyon 1	2	73	2000	S
52	Watts Bar	1.4	48	2001	MU
53	Byron 1	5	170	2001	S
54	Byron 2	5	170	2001	S
55	Braidwood 1	5	170	2001	S
56	Braidwood 2	5	170	2001	S
57	Salem 1	1.4	48	2001	MU
58	Salem 2	1.4	48	2001	MU
59	San Onofre 2	1.4	48	2001	MU
60	San Onofre 3	1.4	48	2001	MU
61	Susquehanna 1	1.4	48	2001	MU
62	Susquehanna 2	1.4	48	2001	MU
63	Hope Creek	1.4	46	2001	MU
64	Beaver Valley 1	1.4	37	2001	MU
65	Beaver Valley 2	1.4	37	2001	MU
66	Shearon Harris	4.5	138	2001	S
67	Comanche Peak 1	1.4	47	2001	MU
68	Comanche Peak 2	0.4	13	2001	MU
69	Duane Arnold	15.3	248	2001	E
70	Dresden 2	17	430	2001	E
71	Dresden 3	17	430	2001	E
72	Quad Cities 1	17.8	446	2001	E

No.	Plant	% Uprate	MWt	Year Approved	TYPE
73	Quad Cities 2	17.8	446	2001	E
74	Waterford 3	1.5	51	2002	MU
75	Clinton	20	579	2002	E
76	South Texas 1	1.4	53	2002	MU
77	South Texas 2	1.4	53	2002	MU
78	ANO-2	7.5	211	2002	E
79	Sequoyah 1	1.3	44	2002	MU
80	Sequoyah 2	1.3	44	2002	MU
81	Brunswick 1	15	365	2002	E
82	Brunswick 2	15	365	2002	E
83	Grand Gulf	1.7	65	2002	MU
84	H. B. Robinson	1.7	39	2002	MU
85	Peach Bottom 2	1.62	56	2002	MU
86	Peach Bottom 3	1.62	56	2002	MU
87	Indian Point 3	1.4	42.4	2002	MU
88	Point Beach 1	1.4	21.5	2002	MU
89	Point Beach 2	1.4	21.5	2002	MU
90	Crystal River 3	0.9	24	2002	S
91	D.C. Cook 1	1.66	54	2002	MU
92	River Bend	1.7	52	2003	MU
93	D.C. Cook 2	1.66	57	2003	MU
94	Pilgrim	1.5	30	2003	MU
95	Indian Point 2	1.4	43	2003	MU
96	Kewaunee	1.4	23	2003	MU
97	Hatch 1	1.5	41	2003	MU
98	Hatch 2	1.5	41	2003	MU

No.	Plant	% Uprate	MWt	Year Approved	TYPE
99	Palo Verde 2	2.9	114	2003	S
100	Kewaunee	6.0	99	2004	S
101	Palisades	1.4	35	2004	MU
102	Indian Point 2	3.2	101.6	2004	S
103	Seabrook	5.2	176	2005	S
104	Indian Point 3	4.85	148.6	2005	S
105	Waterford	8.0	275	2005	E
106	Palo Verde 1	2.9	114	2005	S
107	Palo Verde 3	2.9	114	2005	S
108	Vermont Yankee	20	319	2006	E
109	Seabrook	107	61	2006	MU
110	Ginna	16.8	255	2006	E
111	Beaver Valley 1	8	211	2006	E
112	Beaver Valley 2	8	211	2006	E
113	Browns Ferry 1	5	165	2007	S
114	Crystal River 3	1.6	41	2007	MU
115	Susquehanna 1	13	463	2008	E
116	Susquehanna 2	13	463	2008	E

Table 2 - Power Uprates Under Review, February 2008

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

No.	Plant	% Uprate	MWt	Submittal Date	Projected Completion Date	Type
1	Browns Ferry 2	15	494	06/25/04	Spring 2008	E
2	Browns Ferry 3	15	494	06/25/04	Spring 2008	E
3	Browns Ferry 1	15	494	06/28/04	Spring 2008	E
4	Hope Creek	15	501	09/18/06	Spring 2008	E

No.	Plant	% Uprate	MWt	Submittal Date	Projected Completion Date	Type
5	Davis-Besse	1.6	45	04/12/07	TBD	MU
6	Millstone 3	7.0	239	07/13/07	08/15/08	S
7	Comanche Peak 1	4.5	154	08/28/07	07/09/08	S
8	Comanche Peak 2	4.5	154	08/27/07	07/09/08	S
9	Vogtle 1	1.7	61	08/27/07	03/01/08	MU
10	Vogtle 2	1.7	61	08/24/07	03/01/08	MU
11	Cooper	1.6	38	11/19/07	06/20/08	MU

Table 3 - Expected Future Submittals for Power Uprates, December 2007

Fiscal Year	Total Uprates Expected	Measurement Uncertainty Recapture Uprates	Stretch Power Uprates	Extended Power Uprates	Megawatts Thermal	Approximate Megawatts Electric
2008	4	2	0	2	804	268
2009	11	5	0	6	1966	655
2010	6	0	0	6	1368	456
2011	2	0	0	2	895	298
2012	1	0	0	1	221	74
TOTAL	**24**	**7**	**0**	**17**	**5,254**	**1,751**

Additional Information

Additional information and guidance for power uprate license amendment request submittals can be found on the NRC's Power Uprate Web page at this address: http://www.nrc.gov/reactors/operating/licensing/power-uprates.html .