TABLE 6-1a (METRIC). COSTS OF ESP REPLACEMENT TO CONTROL PM TO 0.10 G/DSCM FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate--ESP exit, m3/sec @8% O2	ESP plate area, m2	New SCA, m2/(m3/sec)	Downtime, d	TCI, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-1a/4a	BI	NDCE	700,000	380	93.4	9,806	105	30	$4,120,000	$19,400	$165,000	$482,000	$666,000
RF-2a/5a	BI	NDCE	1,200,000	680	168	17,638	105	30	$7,430,000	$35,000	$297,000	$869,000	$1,200,000
RF-3a/6a	BI	NDCE	1,800,000	1,000	243	25,512	105	30	$10,700,000	$50,500	$428,000	$1,250,000	$1,730,000
RF-7a	BI	DCE	400,000	230	56.2	4,794	85	30	$2,010,000	$11,700	$80,400	$286,000	$378,000
RF-8a	BI	DCE	700,000	380	93.4	7,967	85	30	$3,350,000	$19,400	$134,000	$477,000	$630,000
RF-9a	BI	DCE	1,200,000	680	168	14,331	85	30	$6,030,000	$35,000	$241,000	$859,000	$1,140,000
RF-1a/4a	Unbl	NDCE	700,000	450	93.4	9,806	105	30	$4,120,000	$19,400	$165,000	$482,000	$666,000
RF-2a/5a	Unbl	NDCE	1,200,000	820	168	17,638	105	30	$7,430,000	$35,000	$297,000	$869,000	$1,200,000
RF-3a/6a	Unbl	NDCE	1,800,000	1,200	243	25,512	105	30	$10,700,000	$50,500	$428,000	$1,250,000	$1,730,000
RF-7a	Unbl	DCE	400,000	270	56.2	4,794	85	30	$2,010,000	$11,700	$80,400	$286,000	$378,000
RF-8a	Unbl	DCE	700,000	450	93.4	7,967	85	30	$3,350,000	$19,400	$134,000	$477,000	$630,000
RF-9a	Unbl	DCE	1,200,000	820	168	14,331	85	30	$6,030,000	$35,000	$241,000	$859,000	$1,140,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-1b. Refer to Table 6-1b for footnotes, which include calculations.

TABLE 6-1b (ENGLISH). COSTS OF ESP REPLACEMENT TO CONTROL PM TO 0.044 GR/DSCF FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate--ESP exit, acfm @8% O2	ESP plate area, ft2 (b)	New SCA, ft2/1,000 acfm	Downtime, d	TCI, $ (c)	Electricity, $/yr (d)	A,I & T, $/yr (e)	Capital recovery, $/yr (f)	ITAC, $/yr (g)
RF-1a/4a	BI	NDCE	1,500,000	420	198,000	105,600	533	30	$4,120,000	$19,400	$165,000	$482,000	$666,000
RF-2a/5a	BI	NDCE	2,700,000	750	357,000	190,400	533	30	$7,430,000	$35,000	$297,000	$869,000	$1,200,000
RF-3a/6a	BI	NDCE	3,900,000	1,100	515,000	274,667	533	30	$10,700,000	$50,500	$428,000	$1,250,000	$1,730,000
RF-7a	BI	DCE	900,000	250	119,000	51,567	433	30	$2,010,000	$11,700	$80,400	$286,000	$378,000
RF-8a	BI	DCE	1,500,000	420	198,000	85,800	433	30	$3,350,000	$19,400	$134,000	$477,000	$630,000
RF-9a	BI	DCE	2,700,000	750	357,000	154,700	433	30	$6,030,000	$35,000	$241,000	$859,000	$1,140,000
RF-1a/4a	Unbl	NDCE	1,500,000	500	198,000	105,600	533	30	$4,120,000	$19,400	$165,000	$482,000	$666,000
RF-2a/5a	Unbl	NDCE	2,700,000	900	357,000	190,400	533	30	$7,430,000	$35,000	$297,000	$869,000	$1,200,000
RF-3a/6a	Unbl	NDCE	3,900,000	1,300	515,000	274,667	533	30	$10,700,000	$50,500	$428,000	$1,250,000	$1,730,000
RF-7a	Unbl	DCE	900,000	300	119,000	51,567	433	30	$2,010,000	$11,700	$80,400	$286,000	$378,000
RF-8a	Unbl	DCE	1,500,000	500	198,000	85,800	433	30	$3,350,000	$19,400	$134,000	$477,000	$630,000
RF-9a	Unbl	DCE	2,700,000	900	357,000	154,700	433	30	$6,030,000	$35,000	$241,000	$859,000	$1,140,000

(a) All costs in $1991
(b) ESP plate area = model gas flowrate x new SCA
(c) TCI = ESP plate area x ($39/ft2 plate area)
(d) For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (533 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (433 - 333 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
(e) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI
(f) For NDCE furnaces, capital recovery = 0.1169 CRF x TCI (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x TCI (based on 10-yr ESP life and 7% interest)
(g) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-2a (METRIC). COSTS OF ESP REPLACEMENT TO CONTROL PM TO 0.10 G/DSCM FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate--ESP exit, m3/sec @8% O2	ESP plate area, m2	New SCA, m2/(m3/sec)	Downtime, d	TCI, $	Pulp production losses, $	TCI+ production losses, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-1a/4a	BI	NDCE	700,000	380	93.4	9,806	105	30	$4,120,000	$1,190,000	$5,310,000	$19,400	$165,000	$621,000	$805,000
RF-2a/5a	BI	NDCE	1,200,000	680	168	17,638	105	30	$7,430,000	$2,130,000	$9,560,000	$35,000	$297,000	$1,120,000	$1,450,000
RF-3a/6a	BI	NDCE	1,800,000	1,000	243	25,512	105	30	$10,700,000	$3,120,000	$13,800,000	$50,500	$428,000	$1,610,000	$2,090,000
RF-7a	BI	DCE	400,000	230	56.2	4,794	85	30	$2,010,000	$844,000	$4,960,000	$19,400	$165,000	$580,000	$764,000
RF-8a	BI	DCE	700,000	380	93.4	7,967	85	30	$3,350,000	$1,520,000	$8,950,000	$35,000	$297,000	$1,050,000	$1,380,000
RF-9a	BI	DCE	1,200,000	680	168	14,331	85	30	$6,030,000	$2,190,000	$12,900,000	$50,500	$428,000	$1,510,000	$1,990,000
RF-1a/4a	Unbl	NDCE	700,000	450	93.4	9,806	105	30	$4,120,000	$844,000	$4,960,000	$19,400	$165,000	$580,000	$764,000
RF-2a/5a	Unbl	NDCE	1,200,000	820	168	17,638	105	30	$7,430,000	$1,520,000	$8,950,000	$35,000	$297,000	$1,050,000	$1,380,000
RF-3a/6a	Unbl	NDCE	1,800,000	1,200	243	25,512	105	30	$10,700,000	$2,190,000	$12,900,000	$50,500	$428,000	$1,510,000	$1,990,000
RF-7a	Unbl	DCE	400,000	270	56.2	4,794	85	30	$2,010,000	$506,000	$2,520,000	$11,700	$80,400	$359,000	$451,000
RF-8a	Unbl	DCE	700,000	450	93.4	7,967	85	30	$3,350,000	$844,000	$4,190,000	$19,400	$134,000	$597,000	$750,000
RF-9a	Unbl	DCE	1,200,000	820	168	14,331	85	30	$6,030,000	$1,520,000	$7,550,000	$35,000	$241,000	$1,080,000	$1,360,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-2b. Refer to Table 6-2b for footnotes, which include calculations.

TABLE 6-2b (ENGLISH). COSTS OF ESP REPLACEMENT TO CONTROL PM TO 0.044 GR/DSCF FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate--ESP exit, acfm @8% O2	ESP plate area, ft2 (b)	New SCA, ft2/1,000 acfm	Downtime, d	TCI, $ (c)	Pulp production losses, $ (d)	TCI+ production losses, $	Electricity, $/yr (e)	A,I & T, $/yr (f)	Capital recovery, $/yr (g)	ITAC, $/yr (h)
RF-1a/4a	BI	NDCE	1,500,000	420	198,000	105,600	533	30	$4,120,000	$1,190,000	$5,310,000	$19,400	$165,000	$621,000	$805,000
RF-2a/5a	BI	NDCE	2,700,000	750	357,000	190,400	533	30	$7,430,000	$2,130,000	$9,560,000	$35,000	$297,000	$1,120,000	$1,450,000
RF-3a/6a	BI	NDCE	3,900,000	1,100	515,000	274,667	533	30	$10,700,000	$3,120,000	$13,800,000	$50,500	$428,000	$1,610,000	$2,090,000
RF-7a	BI	DCE	900,000	250	119,000	51,567	433	30	$2,010,000	$710,000	$2,720,000	$11,700	$80,400	$387,000	$479,000
RF-8a	BI	DCE	1,500,000	420	198,000	85,800	433	30	$3,350,000	$1,190,000	$4,540,000	$19,400	$134,000	$646,000	$799,000
RF-9a	BI	DCE	2,700,000	750	357,000	154,700	433	30	$6,030,000	$2,130,000	$8,160,000	$35,000	$241,000	$1,160,000	$1,440,000
RF-1a/4a	Unbl	NDCE	1,500,000	500	198,000	105,600	533	30	$4,120,000	$844,000	$4,960,000	$19,400	$165,000	$580,000	$764,000
RF-2a/5a	Unbl	NDCE	2,700,000	900	357,000	190,400	533	30	$7,430,000	$1,520,000	$8,950,000	$35,000	$297,000	$1,050,000	$1,380,000
RF-3a/6a	Unbl	NDCE	3,900,000	1,300	515,000	274,667	533	30	$10,700,000	$2,190,000	$12,900,000	$50,500	$428,000	$1,510,000	$1,990,000
RF-7a	Unbl	DCE	900,000	300	119,000	51,567	433	30	$2,010,000	$506,000	$2,520,000	$11,700	$80,400	$359,000	$451,000
RF-8a	Unbl	DCE	1,500,000	500	198,000	85,800	433	30	$3,350,000	$844,000	$4,190,000	$19,400	$134,000	$597,000	$750,000
RF-9a	Unbl	DCE	2,700,000	900	357,000	154,700	433	30	$6,030,000	$1,520,000	$7,550,000	$35,000	$241,000	$1,080,000	$1,360,000

(a) All costs in $1991
(b) ESP plate area = model gas flowrate x new SCA
(c) TCI = ESP plate area x ($39/ft2 plate area)
(d) Pulp production losses = (25% gross profit margin) x ($646/ton bleached pulp or $384/ton unbleached pulp) x (136.2 $1991/124 $1989) x (30 d downtime-14 d scheduled downtime) x ADTP/d
(e) For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (533 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (433 - 333 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
(f) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI
(g) For NDCE furnaces, capital recovery = 0.1169 CRF x (TCI + production losses) (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x (TCI + production losses) (based on 10-yr ESP life and 7% interest)
(h) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-3. SUMMARY OF ASSUMPTIONS USED IN ESP UPGRADE COSTS[9]

NDCE Recovery Furnace ESP Characteristics:	
Existing ESP:	New ESP:
• The existing ESP is assumed to contain 46 lanes on 10-inch centers (weighted wire design).	• The ESP is rebuilt with 42 lanes on 11-inch centers (rigid electrode design).
• The existing ESP is 3 fields long, with each field 10 feet long and 30 feet tall.	• The size will be adequate for 99.4 percent PM removal, yielding an outlet PM residual of 0.044 gr/dscf at 8 percent oxygen.
• The existing ESP has a parallel drag scraper arrangement (dry-bottom).	• The ESP will be 3 fields long, with each field 10 feet long and 30 feet high.
DCE Recovery Furnace ESP Characteristics:	
Existing ESP:	New ESP:
• The existing ESP is assumed to contain 50 lanes on 10-inch centers (weighted wire design).	• The ESP is rebuilt with 46 lanes on 11-inch centers (rigid electrode design).
• The existing ESP is 3 fields long, with each field 10 feet long and 30 feet tall.	• The size will be adequate for 98.8 percent PM removal, yielding an outlet PM residual of 0.044 gr/dscf at 8 percent oxygen.
• The existing ESP has a steel shell design (wet-bottom).	• The ESP will be 3 fields long, with each field 10 feet long and 32 feet high.

Modifications:

- There is single-chamber operation while the other chamber is washed down, the roof removed, and the internals gutted.
- The recovery furnace is taken off line; work continues on rebuild; one chamber is finished.
- The recovery furnace is at partial load through rebuilt chamber; the other chamber is finished.

Other Assumptions:

- The existing casing is in acceptable condition; only minor replating is needed.
- Wet- and dry-bottoms are reused "as is," except for minor repairs. Transformers, controls, and inlet and outlet ductwork are also reused.
- The roof insulation is replaced, but all other insulation is acceptable.
- The site location is in the southeast United States. As such, all field labor is based on merit shop, 1993 wage rates and work rules.
- No removal of asbestos or polychlorinated biphenyls (PCB's) is required.
- The scrap is taken to a site within the plant gates.
- There are no perforated plates.
- The ESP is at grade.
- The ductwork and stack do not obstruct crane mobility.
- There is no low voltage.

TABLE 6-4a (METRIC). COSTS OF SCHEDULE 1 ESP UPGRADE TO CONTROL PM TO 0.10 G/DSCM FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @ 8% O2	Downtime, d	TCI, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-1a/4a	Bl	NDCE	700,000	380	93.4	17	$1,200,000	$19,400	$48,000	$140,000	$207,000
RF-2a/5a	Bl	NDCE	1,200,000	680	168	17	$1,700,000	$35,000	$68,000	$199,000	$302,000
RF-3a/6a	Bl	NDCE	1,800,000	1,000	243	17	$2,120,000	$50,500	$84,800	$248,000	$383,000
RF-7a	Bl	DCE	400,000	230	56.2	17	$811,000	$11,700	$32,400	$115,000	$159,000
RF-8a	Bl	DCE	700,000	380	93.4	17	$1,100,000	$19,400	$44,000	$157,000	$220,000
RF-9a	Bl	DCE	1,200,000	680	168	17	$1,570,000	$35,000	$62,800	$224,000	$322,000
RF-1a/4a	Unbl	NDCE	700,000	450	93.4	17	$1,200,000	$19,400	$48,000	$140,000	$207,000
RF-2a/5a	Unbl	NDCE	1,200,000	820	168	17	$1,700,000	$35,000	$68,000	$199,000	$302,000
RF-3a/6a	Unbl	NDCE	1,800,000	1,200	243	17	$2,120,000	$50,500	$84,800	$248,000	$383,000
RF-7a	Unbl	DCE	400,000	270	56.2	17	$811,000	$11,700	$32,400	$115,000	$159,000
RF-8a	Unbl	DCE	700,000	450	93.4	17	$1,100,000	$19,400	$44,000	$157,000	$220,000
RF-9a	Unbl	DCE	1,200,000	820	168	17	$1,570,000	$35,000	$62,800	$224,000	$322,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-4b. Refer to Table 6-4b for footnotes, which include calculations.

TABLE 6-4b (ENGLISH). COSTS OF SCHEDULE 1 ESP UPGRADE TO CONTROL PM TO 0.044 GR/DSCF FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate-- ESP exit, acfm @ 8% O2	Downtime, d	TCI, $ (b)	Electricity, $/yr (c)	A,I & T, $/yr (d)	Capital recovery, $/yr (e)	ITAC, $/yr (f)
RF-1a/4a	BI	NDCE	1,500,000	420	198,000	17	$1,200,000	$19,400	$48,000	$140,000	$207,000
RF-2a/5a	BI	NDCE	2,700,000	750	357,000	17	$1,700,000	$35,000	$68,000	$199,000	$302,000
RF-3a/6a	BI	NDCE	3,900,000	1,100	515,000	17	$2,120,000	$50,500	$84,800	$248,000	$383,000
RF-7a	BI	DCE	900,000	250	119,000	17	$811,000	$11,700	$32,400	$115,000	$159,000
RF-8a	BI	DCE	1,500,000	420	198,000	17	$1,100,000	$19,400	$44,000	$157,000	$220,000
RF-9a	BI	DCE	2,700,000	750	357,000	17	$1,570,000	$35,000	$62,800	$224,000	$322,000
RF-1a/4a	Unbl	NDCE	1,500,000	500	198,000	17	$1,200,000	$19,400	$48,000	$140,000	$207,000
RF-2a/5a	Unbl	NDCE	2,700,000	900	357,000	17	$1,700,000	$35,000	$68,000	$199,000	$302,000
RF-3a/6a	Unbl	NDCE	3,900,000	1,300	515,000	17	$2,120,000	$50,500	$84,800	$248,000	$383,000
RF-7a	Unbl	DCE	900,000	300	119,000	17	$811,000	$11,700	$32,400	$115,000	$159,000
RF-8a	Unbl	DCE	1,500,000	500	198,000	17	$1,100,000	$19,400	$44,000	$157,000	$220,000
RF-9a	Unbl	DCE	2,700,000	900	357,000	17	$1,570,000	$35,000	$62,800	$224,000	$322,000

(a) All costs in $1991

(b) For NDCE furnaces, TCI = ($1,292,000)/[(230,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)
For DCE furnaces, TCI = ($1,504,750)/[(340,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)

(c) Electricity costs for ESP upgrade assumed to equal electricity costs for ESP replacement.
For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (533 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (433 - 333 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh

(d) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI

(e) For NDCE furnaces, capital recovery = 0.1169 CRF x TCI (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x TCI (based on 10-yr ESP life and 7% interest)

(f) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-5a (METRIC). COSTS OF SCHEDULE 2 ESP UPGRADE TO CONTROL PM TO 0.10 G/DSCM FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @ 8% O2	Downtime, d	TCI, $ (b)	Electricity, $/yr (c)	A,I & T, $/yr (d)	Capital recovery, $/yr (e)	ITAC, $/yr (f)
RF-1a/4a	BI	NDCE	700,000	380	93.4	30	$1,160,000	$19,400	$46,400	$136,000	$202,000
RF-2a/5a	BI	NDCE	1,200,000	680	168	30	$1,660,000	$35,000	$66,400	$194,000	$295,000
RF-3a/6a	BI	NDCE	1,800,000	1,000	243	30	$2,070,000	$50,500	$82,800	$242,000	$375,000
RF-7a	BI	DCE	400,000	230	56.2	30	$791,000	$11,700	$31,600	$113,000	$156,000
RF-8a	BI	DCE	700,000	380	93.4	30	$1,070,000	$19,400	$42,800	$152,000	$214,000
RF-9a	BI	DCE	1,200,000	680	168	30	$1,530,000	$35,000	$61,200	$218,000	$314,000
RF-1a/4a	Unbl	ESP	700,000	450	93.4	30	$1,160,000	$19,400	$46,400	$136,000	$202,000
RF-2a/5a	Unbl	ESP	1,200,000	820	168	30	$1,660,000	$35,000	$66,400	$194,000	$295,000
RF-3a/6a	Unbl	ESP	1,800,000	1,200	243	30	$2,070,000	$50,500	$82,800	$242,000	$375,000
RF-7a	Unbl	DCE	400,000	270	56.2	30	$791,000	$11,700	$31,600	$113,000	$156,000
RF-8a	Unbl	DCE	700,000	450	93.4	30	$1,070,000	$19,400	$42,800	$152,000	$214,000
RF-9a	Unbl	DCE	1,200,000	820	168	30	$1,530,000	$35,000	$61,200	$218,000	$314,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-5b. Refer to Table 6-5b for footnotes, which include calculations.

TABLE 6-5b (ENGLISH). COSTS OF SCHEDULE 2 ESP UPGRADE TO CONTROL PM TO 0.044 GR/DSCF FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate-- ESP exit, acfm @ 8% O2	Downtime, d	TCI, $ (b)	Electricity, $/yr (c)	A,I & T, $/yr (d)	Capital recovery, $/yr (e)	ITAC, $/yr (f)
RF-1a/4a	BI	NDCE	1,500,000	420	198,000	30	$1,160,000	$19,400	$46,400	$136,000	$202,000
RF-2a/5a	BI	NDCE	2,700,000	750	357,000	30	$1,660,000	$35,000	$66,400	$194,000	$295,000
RF-3a/6a	BI	NDCE	3,900,000	1,100	515,000	30	$2,070,000	$50,500	$82,800	$242,000	$375,000
RF-7a	BI	DCE	900,000	250	119,000	30	$791,000	$11,700	$31,600	$113,000	$156,000
RF-8a	BI	DCE	1,500,000	420	198,000	30	$1,070,000	$19,400	$42,800	$152,000	$214,000
RF-9a	BI	DCE	2,700,000	750	357,000	30	$1,530,000	$35,000	$61,200	$218,000	$314,000
RF-1a/4a	Unbl	NDCE	1,500,000	500	198,000	30	$1,160,000	$19,400	$46,400	$136,000	$202,000
RF-2a/5a	Unbl	NDCE	2,700,000	900	357,000	30	$1,660,000	$35,000	$66,400	$194,000	$295,000
RF-3a/6a	Unbl	NDCE	3,900,000	1,300	515,000	30	$2,070,000	$50,500	$82,800	$242,000	$375,000
RF-7a	Unbl	DCE	900,000	300	119,000	30	$791,000	$11,700	$31,600	$113,000	$156,000
RF-8a	Unbl	DCE	1,500,000	500	198,000	30	$1,070,000	$19,400	$42,800	$152,000	$214,000
RF-9a	Unbl	DCE	2,700,000	900	357,000	30	$1,530,000	$35,000	$61,200	$218,000	$314,000

(a) All costs in $1991

(b) For NDCE furnaces, TCI = ($1,259,000)/[(230,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)
For DCE furnaces, TCI = ($1,466,500)/[(340,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)

(c) Electricity costs for ESP upgrade assumed to equal electricity costs for ESP replacement.
For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (533 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (433 - 333 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh

(d) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI

(e) For NDCE furnaces, capital recovery = 0.1169 CRF x TCI (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x TCI (based on 10-yr ESP life and 7% interest)

(f) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-6a (METRIC). COSTS OF SCHEDULE 1 ESP UPGRADE TO CONTROL PM TO 0.10 G/DSCM FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @8% O2	Downtime, d	TCI, $	Pulp production losses, $	TCI+ production losses, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-1a/4a	BI	NDCE	700,000	380	93.4	17	$1,200,000	$224,000	$1,420,000	$19,400	$48,000	$166,000	$233,000
RF-2a/5a	BI	NDCE	1,200,000	680	168	17	$1,700,000	$399,000	$2,100,000	$35,000	$68,000	$245,000	$348,000
RF-3a/6a	BI	NDCE	1,800,000	1,000	243	17	$2,120,000	$585,000	$2,710,000	$50,500	$84,800	$317,000	$452,000
RF-7a	BI	DCE	400,000	230	56.2	17	$811,000	$133,000	$944,000	$11,700	$32,400	$134,000	$178,000
RF-8a	BI	DCE	700,000	380	93.4	17	$1,100,000	$224,000	$1,320,000	$19,400	$44,000	$188,000	$251,000
RF-9a	BI	DCE	1,200,000	680	168	17	$1,570,000	$399,000	$1,970,000	$35,000	$62,800	$281,000	$379,000
RF-1a/4a	Unbl	NDCE	700,000	450	93.4	17	$1,200,000	$158,000	$1,360,000	$19,400	$48,000	$159,000	$226,000
RF-2a/5a	Unbl	NDCE	1,200,000	820	168	17	$1,700,000	$285,000	$1,990,000	$35,000	$68,000	$233,000	$336,000
RF-3a/6a	Unbl	NDCE	1,800,000	1,200	243	17	$2,120,000	$411,000	$2,530,000	$50,500	$84,800	$296,000	$431,000
RF-7a	Unbl	DCE	400,000	270	56.2	17	$811,000	$94,900	$906,000	$11,700	$32,400	$129,000	$173,000
RF-8a	Unbl	DCE	700,000	450	93.4	17	$1,100,000	$158,000	$1,260,000	$19,400	$44,000	$179,000	$242,000
RF-9a	Unbl	DCE	1,200,000	820	168	17	$1,570,000	$285,000	$1,860,000	$35,000	$62,800	$265,000	$363,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-6b. Refer to Table 6-6b for footnotes, which include calculations.

TABLE 6-6b (ENGLISH). COSTS OF SCHEDULE 1 ESP UPGRADE TO CONTROL PM TO 0.044 GR/DSCF FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate-- ESP exit, acfm @8% O2	Downtime, d	TCI, $ (b)	Pulp production losses, $ (c)	TCI+ production losses, $	Electricity, $/yr (d)	A,I & T, $/yr (e)	Capital recovery, $/yr (f)	ITAC, $/yr (g)
RF-1a/4a	BI	NDCE	1,500,000	420	198,000	17	$1,200,000	$224,000	$1,420,000	$19,400	$48,000	$166,000	$233,000
RF-2a/5a	BI	NDCE	2,700,000	750	357,000	17	$1,700,000	$399,000	$2,100,000	$35,000	$68,000	$245,000	$348,000
RF-3a/6a	BI	NDCE	3,900,000	1,100	515,000	17	$2,120,000	$585,000	$2,710,000	$50,500	$84,800	$317,000	$452,000
RF-7a	BI	DCE	900,000	250	119,000	17	$811,000	$133,000	$944,000	$11,700	$32,400	$134,000	$178,000
RF-8a	BI	DCE	1,500,000	420	198,000	17	$1,100,000	$224,000	$1,320,000	$19,400	$44,000	$188,000	$251,000
RF-9a	BI	DCE	2,700,000	750	357,000	17	$1,570,000	$399,000	$1,970,000	$35,000	$62,800	$281,000	$379,000
RF-1a/4a	Unbl	NDCE	1,500,000	500	198,000	17	$1,200,000	$158,000	$1,360,000	$19,400	$48,000	$159,000	$226,000
RF-2a/5a	Unbl	NDCE	2,700,000	900	357,000	17	$1,700,000	$285,000	$1,990,000	$35,000	$68,000	$233,000	$336,000
RF-3a/6a	Unbl	NDCE	3,900,000	1,300	515,000	17	$2,120,000	$411,000	$2,530,000	$50,500	$84,800	$296,000	$431,000
RF-7a	Unbl	DCE	900,000	300	119,000	17	$811,000	$94,900	$906,000	$11,700	$32,400	$129,000	$173,000
RF-8a	Unbl	DCE	1,500,000	500	198,000	17	$1,100,000	$158,000	$1,260,000	$19,400	$44,000	$179,000	$242,000
RF-9a	Unbl	DCE	2,700,000	900	357,000	17	$1,570,000	$285,000	$1,860,000	$35,000	$62,800	$265,000	$363,000

(a) All costs in $1991

(b) For NDCE furnaces, TCI = ($1,292,000)/[(230,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)
For DCE furnaces, TCI = ($1,504,750)/[(340,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)

(c) Pulp production losses = (25% gross profit margin) x ($646/ton bleached pulp or $384/ton unbleached pulp) x (136.2 $1991/124 $1989) x (17 d downtime-14 d scheduled downtime) x ADTP/d

(d) Electricity costs for ESP upgrade assumed to equal electricity costs for ESP replacement.
For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (533 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (433 - 333 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh

(e) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI

(f) For NDCE furnaces, capital recovery = 0.1169 CRF x (TCI + production losses) (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x (TCI + production losses) (based on 10-yr ESP life and 7% interest)

(g) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-7a (METRIC). COSTS OF SCHEDULE 2 ESP UPGRADE TO CONTROL PM TO 0.10 G/DSCM FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @8% O2	Downtime, d	TCI, $	Pulp production losses, $	TCI+ production losses, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-1a/4a	BI	NDCE	700,000	380	93.4	30	$1,160,000	$1,190,000	$2,350,000	$19,400	$46,400	$275,000	$341,000
RF-2a/5a	BI	NDCE	1,200,000	680	168	30	$1,660,000	$2,130,000	$3,790,000	$35,000	$66,400	$443,000	$544,000
RF-3a/6a	BI	NDCE	1,800,000	1,000	243	30	$2,070,000	$3,120,000	$5,190,000	$50,500	$82,800	$607,000	$740,000
RF-7a	BI	DCE	400,000	230	56.2	30	$791,000	$710,000	$1,500,000	$11,700	$31,600	$214,000	$257,000
RF-8a	BI	DCE	700,000	380	93.4	30	$1,070,000	$1,190,000	$2,260,000	$19,400	$42,800	$322,000	$384,000
RF-9a	BI	DCE	1,200,000	680	168	30	$1,530,000	$2,130,000	$3,660,000	$35,000	$61,200	$521,000	$617,000
RF-1a/4a	Unbl	NDCE	700,000	450	93.4	30	$1,160,000	$844,000	$2,000,000	$19,400	$46,400	$234,000	$300,000
RF-2a/5a	Unbl	NDCE	1,200,000	820	168	30	$1,660,000	$1,520,000	$3,180,000	$35,000	$66,400	$372,000	$473,000
RF-3a/6a	Unbl	NDCE	1,800,000	1,200	243	30	$2,070,000	$2,190,000	$4,260,000	$50,500	$82,800	$498,000	$631,000
RF-7a	Unbl	DCE	400,000	270	56.2	30	$791,000	$506,000	$1,300,000	$11,700	$31,600	$185,000	$228,000
RF-8a	Unbl	DCE	700,000	450	93.4	30	$1,070,000	$844,000	$1,910,000	$19,400	$42,800	$272,000	$334,000
RF-9a	Unbl	DCE	1,200,000	820	168	30	$1,530,000	$1,520,000	$3,050,000	$35,000	$61,200	$434,000	$530,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-7b. Refer to Table 6-7b for footnotes, which include calculations.

TABLE 6-7b (ENGLISH). COSTS OF SCHEDULE 2 ESP UPGRADE TO CONTROL PM TO 0.044 GR/DSCF FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate--ESP exit, acfm @8% O2	Downtime, d	TCI, $ (b)	Pulp production losses, $ (c)	TCI+ production losses, $	Electricity, $/yr (d)	A,I & T, $/yr (e)	Capital recovery, $/yr (f)	ITAC, $/yr (g)
RF-1a/4a	BI	NDCE	1,500,000	420	198,000	30	$1,160,000	$1,190,000	$2,350,000	$19,400	$46,400	$275,000	$341,000
RF-2a/5a	BI	NDCE	2,700,000	750	357,000	30	$1,660,000	$2,130,000	$3,790,000	$35,000	$66,400	$443,000	$544,000
RF-3a/6a	BI	NDCE	3,900,000	1,100	515,000	30	$2,070,000	$3,120,000	$5,190,000	$50,500	$82,800	$607,000	$740,000
RF-7a	BI	DCE	900,000	250	119,000	30	$791,000	$710,000	$1,500,000	$11,700	$31,600	$214,000	$257,000
RF-8a	BI	DCE	1,500,000	420	198,000	30	$1,070,000	$1,190,000	$2,260,000	$19,400	$42,800	$322,000	$384,000
RF-9a	BI	DCE	2,700,000	750	357,000	30	$1,530,000	$2,130,000	$3,660,000	$35,000	$61,200	$521,000	$617,000
RF-1a/4a	Unbl	NDCE	1,500,000	500	198,000	30	$1,160,000	$844,000	$2,000,000	$19,400	$46,400	$234,000	$300,000
RF-2a/5a	Unbl	NDCE	2,700,000	900	357,000	30	$1,660,000	$1,520,000	$3,180,000	$35,000	$66,400	$372,000	$473,000
RF-3a/6a	Unbl	NDCE	3,900,000	1,300	515,000	30	$2,070,000	$2,190,000	$4,260,000	$50,500	$82,800	$498,000	$631,000
RF-7a	Unbl	DCE	900,000	300	119,000	30	$791,000	$506,000	$1,300,000	$11,700	$31,600	$185,000	$228,000
RF-8a	Unbl	DCE	1,500,000	500	198,000	30	$1,070,000	$844,000	$1,910,000	$19,400	$42,800	$272,000	$334,000
RF-9a	Unbl	DCE	2,700,000	900	357,000	30	$1,530,000	$1,520,000	$3,050,000	$35,000	$61,200	$434,000	$530,000

(a) All costs in $1991

(b) For NDCE furnaces, TCI = ($1,259,000)/[(230,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)
For DCE furnaces, TCI = ($1,466,500)/[(340,000 acfm/model gas flowrate) ^ 0.6] x (361.3 $1991/357 $May 1993)

(c) Pulp production losses = (25% gross profit margin) x ($646/ton bleached pulp or $384/ton unbleached pulp) x (136.2 $1991/124 $1989) x (30 d downtime-14 d scheduled downtime) x ADTP/d

(d) Electricity costs for ESP upgrade assumed to equal electricity costs for ESP replacement.
For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (533 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (433 - 333 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh

(e) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI

(f) For NDCE furnaces, capital recovery = 0.1169 CRF x (TCI + production losses) (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x (TCI + production losses) (based on 10-yr ESP life and 7% interest)

(g) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-8a (METRIC). COSTS OF ESP UPGRADE TO CONTROL PM FROM 0.10 G/DSCM TO 0.034 G/DSCM FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @8% O2	Increase in ESP plate area, m2	Increase in SCA, m2/(m3/sec)	Downtime, d	TCI, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-1b/4b	BI	NDCE	700,000	380	93.4	1,532	16	17	$644,000	$16,200	$25,800	$75,300	$117,000
RF-2b/5b	BI	NDCE	1,200,000	680	168	2,756	16	17	$1,160,000	$29,200	$46,400	$136,000	$212,000
RF-3b/6b	BI	NDCE	1,800,000	1,000	243	3,986	16	17	$1,670,000	$42,100	$66,800	$195,000	$304,000
RF-7b	BI	DCE	400,000	230	56.2	922	16	17	$387,000	$9,720	$15,500	$55,100	$80,300
RF-8b	BI	DCE	700,000	380	93.4	1,532	16	17	$644,000	$16,200	$25,800	$91,700	$134,000
RF-9b	BI	DCE	1,200,000	700	168	2,756	16	17	$1,160,000	$29,200	$46,400	$165,000	$241,000
RF-1b/4b	Unbl	NDCE	700,000	450	93.4	1,532	16	17	$644,000	$16,200	$25,800	$75,300	$117,000
RF-2b/5b	Unbl	NDCE	1,200,000	820	168	2,756	16	17	$1,160,000	$29,200	$46,400	$136,000	$212,000
RF-3b/6b	Unbl	NDCE	1,800,000	1,200	243	3,986	16	17	$1,670,000	$42,100	$66,800	$195,000	$304,000
RF-7b	Unbl	DCE	400,000	270	56.2	922	16	17	$387,000	$9,720	$15,500	$55,100	$80,300
RF-8b	Unbl	DCE	700,000	450	93.4	1,532	16	17	$644,000	$16,200	$25,800	$91,700	$134,000
RF-9b	Unbl	DCE	1,200,000	820	168	2,756	16	17	$1,160,000	$29,200	$46,400	$165,000	$241,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-8b. Refer to Table 6-8b for footnotes, which include calculations.

TABLE 6-8b (ENGLISH). COSTS OF ESP UPGRADE TO CONTROL PM FROM 0.044 GR/DSCF TO 0.015 GR/DSCF FOR MODEL RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate--ESP exit, acfm @8% O2	Increase in ESP plate area, ft2 (b)	Increase in SCA, ft2/1,000 acfm	Downtime, d	TCI, $ (c)	Electricity, $/yr (d)	A,I & T, $/yr (e)	Capital recovery, $/yr (f)	ITAC, $/yr (g)
RF-1b/4b	BI	NDCE	1,500,000	420	198,000	16,500	83	17	$644,000	$16,200	$25,800	$75,300	$117,000
RF-2b/5b	BI	NDCE	2,700,000	750	357,000	29,750	83	17	$1,160,000	$29,200	$46,400	$136,000	$212,000
RF-3b/6b	BI	NDCE	3,900,000	1,100	515,000	42,917	83	17	$1,670,000	$42,100	$66,800	$195,000	$304,000
RF-7b	BI	DCE	900,000	250	119,000	9,917	83	17	$387,000	$9,720	$15,500	$55,100	$80,300
RF-8b	BI	DCE	1,500,000	420	198,000	16,500	83	17	$644,000	$16,200	$25,800	$91,700	$134,000
RF-9b	BI	DCE	2,700,000	750	357,000	29,750	83	17	$1,160,000	$29,200	$46,400	$165,000	$241,000
RF-1b/4b	Unbl	NDCE	1,500,000	500	198,000	16,500	83	17	$644,000	$16,200	$25,800	$75,300	$117,000
RF-2b/5b	Unbl	NDCE	2,700,000	900	357,000	29,750	83	17	$1,160,000	$29,200	$46,400	$136,000	$212,000
RF-3b/6b	Unbl	NDCE	3,900,000	1,300	515,000	42,917	83	17	$1,670,000	$42,100	$66,800	$195,000	$304,000
RF-7b	Unbl	DCE	900,000	300	119,000	9,917	83	17	$387,000	$9,720	$15,500	$55,100	$80,300
RF-8b	Unbl	DCE	1,500,000	500	198,000	16,500	83	17	$644,000	$16,200	$25,800	$91,700	$134,000
RF-9b	Unbl	DCE	2,700,000	900	357,000	29,750	83	17	$1,160,000	$29,200	$46,400	$165,000	$241,000

(a) All costs in $1991
(b) Increase in ESP plate area = model gas flowrate x increase in SCA
(c) TCI = Increase in ESP plate area x ($39/ft2 plate area)
(d) For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (617 - 533 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (517 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
(e) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI
(f) For NDCE furnaces, capital recovery = 0.1169 CRF x TCI (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x TCI (based on 10-yr ESP life and 7% interest)
(g) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-9a (METRIC). COSTS OF ESP UPGRADE TO CONTROL PM FROM 0.10 G/DSCM TO 0.034 G/DSCM FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @8% O2	Increase in ESP plate area, m2	Increase in SCA, m2/(m3/sec)	Downtime, d	TCI, $	Pulp production losses, $	TCI+ production losses, $	Electricity, $/yr	A,I & T, $/yr	Capital recovery, $/yr	iTAC, $/yr
RF-1b/4b	BI	NDCE	700,000	380	93.4	1,532	16	17	$644,000	$224,000	$868,000	$16,200	$25,800	$101,000	$143,000
RF-2b/5b	BI	NDCE	1,200,000	680	168	2,756	16	17	$1,160,000	$399,000	$1,560,000	$29,200	$46,400	$182,000	$258,000
RF-3b/6b	BI	NDCE	1,800,000	1,000	243	3,986	16	17	$1,670,000	$585,000	$2,260,000	$42,100	$66,800	$264,000	$373,000
RF-7b	BI	DCE	400,000	230	56.2	922	16	17	$387,000	$133,000	$520,000	$9,700	$15,500	$74,000	$99,000
RF-8b	BI	DCE	700,000	380	93.4	1,532	16	17	$644,000	$224,000	$868,000	$16,200	$25,800	$124,000	$166,000
RF-9b	BI	DCE	1,200,000	680	168	2,756	16	17	$1,160,000	$399,000	$1,560,000	$29,200	$46,400	$222,000	$298,000
RF-1b/4b	Unbl	NDCE	700,000	230	93.4	1,532	16	17	$644,000	$158,000	$802,000	$16,200	$25,800	$93,800	$136,000
RF-2b/5b	Unbl	NDCE	1,200,000	820	168	2,756	16	17	$1,160,000	$285,000	$1,450,000	$29,200	$46,400	$170,000	$246,000
RF-3b/6b	Unbl	NDCE	1,800,000	1,200	243	3,986	16	17	$1,670,000	$411,000	$2,080,000	$42,100	$66,800	$243,000	$352,000
RF-7b	Unbl	DCE	400,000	270	56.2	922	16	17	$387,000	$94,900	$482,000	$9,700	$15,500	$68,600	$94,000
RF-8b	Unbl	DCE	700,000	450	93.4	1,532	16	17	$644,000	$158,000	$802,000	$16,200	$25,800	$114,000	$156,000
RF-9b	Unbl	DCE	1,200,000	820	168	2,756	16	17	$1,160,000	$285,000	$1,450,000	$29,200	$46,400	$206,000	$282,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-9b. Refer to Table 6-9b for footnotes, which include calculations.

TABLE 6-9b (ENGLISH). COSTS OF ESP UPGRADE TO CONTROL PM FROM 0.044 GR/DSCF TO 0.015 GR/DSCF FOR MODEL RECOVERY FURNACES (INCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Furnace type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Gas flowrate-- ESP exit, acfm @8% O2	Increase in ESP plate area, ft2 (b)	Increase in SCA, ft2/1,000 acfm	Downtime, d	TCI, $ (c)	Pulp production losses, $ (d)	TCI+ production losses, $	Electricity, $/yr (e)	A,I & T, $/yr (f)	Capital recovery, $/yr (g)	ITAC, $/yr (h)
RF-1b/4b	BI	NDCE	1,500,000	420	198,000	16,500	83	17	$644,000	$224,000	$868,000	$16,200	$25,800	$101,000	$143,000
RF-2b/5b	BI	NDCE	2,700,000	750	357,000	29,750	83	17	$1,160,000	$399,000	$1,560,000	$29,200	$46,400	$182,000	$258,000
RF-3b/6b	BI	NDCE	3,900,000	1,100	515,000	42,917	83	17	$1,670,000	$585,000	$2,260,000	$42,100	$66,800	$264,000	$373,000
RF-7b	BI	DCE	900,000	250	119,000	9,917	83	17	$387,000	$133,000	$520,000	$9,700	$15,500	$74,000	$99,000
RF-8b	BI	DCE	1,500,000	420	198,000	16,500	83	17	$644,000	$224,000	$868,000	$16,200	$25,800	$124,000	$166,000
RF-9b	BI	DCE	2,700,000	750	357,000	29,750	83	17	$1,160,000	$399,000	$1,560,000	$29,200	$46,400	$222,000	$298,000
RF-1b/4b	Unbl	NDCE	1,500,000	500	198,000	16,500	83	17	$644,000	$158,000	$802,000	$16,200	$25,800	$93,800	$136,000
RF-2b/5b	Unbl	NDCE	2,700,000	900	357,000	29,750	83	17	$1,160,000	$285,000	$1,450,000	$29,200	$46,400	$170,000	$246,000
RF-3b/6b	Unbl	NDCE	3,900,000	1,300	515,000	42,917	83	17	$1,670,000	$411,000	$2,080,000	$42,100	$66,800	$243,000	$352,000
RF-7b	Unbl	DCE	900,000	300	119,000	9,917	83	17	$387,000	$94,900	$482,000	$9,700	$15,500	$68,600	$94,000
RF-8b	Unbl	DCE	1,500,000	500	198,000	16,500	83	17	$644,000	$158,000	$802,000	$16,200	$25,800	$114,000	$156,000
RF-9b	Unbl	DCE	2,700,000	900	357,000	29,750	83	17	$1,160,000	$285,000	$1,450,000	$29,200	$46,400	$206,000	$282,000

(a) All costs in $1991

(b) Increase in ESP plate area = model gas flowrate x increase in SCA

(c) TCI = Increase in ESP plate area x ($39/ft2 plate area)

(d) Pulp production losses = (25% gross profit margin) x ($646/ton bleached pulp or $384/ton unbleached pulp) x (136.2 $1991/124 $1989)x (17 d downtime-14 d scheduled downtime) x ADTP/d

(d) For NDCE furnaces, electricity = 0.00194 x model gas flowrate x (617 - 533 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh
For DCE furnaces, electricity = 0.00194 x model gas flowrate x (517 - 433 ft2)/1,000 acfm x 8,424 hr/yr x $0.06/kWh

(f) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI

(g) For NDCE furnaces, capital recovery = 0.1169 CRF x (TCI + production losses) (based on 13.5-yr ESP life and 7% interest)
For DCE furnaces, capital recovery = 0.1424 CRF x (TCI + production losses) (based on 10-yr ESP life and 7% interest)

(h) Incremental total annual cost (ITAC) = Electricity + A,I & T + capital recovery

TABLE 6-10a (METRIC). WET- TO DRY-BOTTOM ESP CONVERSION COSTS FOR MODEL NDCE RECOVERY FURNACES[a]

Model recovery furnaces	Pulp type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Baseline ESP type	Control option ESP type	Gas flowrate-- ESP exit, m3/sec @8% O2	TCI, $	A,I & T, $/yr	Capital recovery, $/yr	ITAC, $/yr
RF-4a/4b	BI	700,000	380	wet-bottom	dry-bottom	93.4	$596,000	$23,800	$69,700	$93,500
RF-5a/5b	BI	1,200,000	680	wet-bottom	dry-bottom	168	$849,000	$34,000	$99,200	$133,000
RF-6a/6b	BI	1,800,000	1,000	wet-bottom	dry-bottom	243	$1,060,000	$42,400	$124,000	$166,000
RF-4a/4b	Unbl	700,000	450	wet-bottom	dry-bottom	93.4	$596,000	$23,800	$69,700	$93,500
RF-5a/5b	Unbl	1,200,000	820	wet-bottom	dry-bottom	168	$849,000	$34,000	$99,200	$133,000
RF-6a/6b	Unbl	1,800,000	1,200	wet-bottom	dry-bottom	243	$1,060,000	$42,400	$124,000	$166,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-10b. Refer to Table 6-10 for footnotes, which include calculations.

TABLE 6-10b (ENGLISH). WET- TO DRY-BOTTOM ESP CONVERSION COSTS FOR MODEL NDCE RECOVERY FURNACES[a]

Model recovery furnaces	Pulp type	Black liquor firing rate, lb BLS/d	Equivalent ADTP/d	Baseline ESP type	Control option ESP type	Gas flowrate--ESP exit, acfm @8% O2	TCI, $ (b)	A,I & T, $/yr (c)	Capital recovery, $/yr (d)	ITAC, $/yr (e)
RF-4a/4b	Bl	1,500,000	420	wet-bottom	dry-bottom	198,000	$596,000	$23,800	$69,700	$93,500
RF-5a/5b	Bl	2,700,000	750	wet-bottom	dry-bottom	357,000	$849,000	$34,000	$99,200	$133,000
RF-6a/6b	Bl	3,900,000	1,100	wet-bottom	dry-bottom	515,000	$1,060,000	$42,400	$124,000	$166,000
RF-4a/4b	Unbl	1,500,000	500	wet-bottom	dry-bottom	198,000	$596,000	$23,800	$69,700	$93,500
RF-5a/5b	Unbl	2,700,000	900	wet-bottom	dry-bottom	357,000	$849,000	$34,000	$99,200	$133,000
RF-6a/6b	Unbl	3,900,000	1,300	wet-bottom	dry-bottom	515,000	$1,060,000	$42,400	$124,000	$166,000

(a) All costs in $1991
(b) TCI = $845,000/(357,000 acfm/model gas flowrate) ^ 0.6 x (361.3 $1991/359.4 $July 1993)
(c) Administrative, insurance, and taxes (A,I & T) = 0.04 x TCI
(d) Capital recovery = 0.1169 CRF x TCI (based on 13.5-yr ESP life and 7% interest)
(e) Incremental total annual cost (ITAC) = A,I & T + capital recovery

TABLE 6-11a (METRIC). CAPITAL COSTS OF LOW-ODOR CONVERSION (INCLUDING ESP UPGRADE TO CONTROL PM TO 0.10 G/DSCM) FOR MODEL DCE RECOVERY FURNACES (EXCLUDING PULP PRODUCTION LOSSES)[a]

Model recovery furnaces	Pulp type	Black liquor firing rate, kg BLS/d	Equivalent ADMP/d	Gas flowrate-- ESP exit, m3/sec @ 8% O2	Downtime, d	Economizer expansion, demolition, $	Concentrator, $	Low-odor conversion, $	ESP upgrade, $	Wet- to dry-bottom ESP conversion, $	TCI, $
RF-7a/7b	BI	400,000	230	56.2	25	$4,780,000	$3,310,000	$8,090,000	$881,000	$439,000	$9,410,000
RF-8a/8b	BI	700,000	380	93.4	25	$6,500,000	$4,500,000	$11,000,000	$1,200,000	$596,000	$12,800,000
RF-9a/9b	BI	1,200,000	680	168	25	$9,250,000	$6,400,000	$15,700,000	$1,700,000	$849,000	$18,200,000
RF-7a/7b	Unbl	400,000	270	56.2	25	$4,780,000	$3,310,000	$8,090,000	$881,000	$439,000	$9,410,000
RF-8a/8b	Unbl	700,000	450	93.4	25	$6,500,000	$4,500,000	$11,000,000	$1,200,000	$596,000	$12,800,000
RF-9a/9b	Unbl	1,200,000	820	168	25	$9,250,000	$6,400,000	$15,700,000	$1,700,000	$849,000	$18,200,000

(a) Metric equivalents in this table were converted from the calculated English unit values given in Table 6-11b. Refer to Table 6-11b for footnotes, which include calculations.