ATTACHMENT 2

CO AND POC COST-EFFECTIVENESS ANALYSIS

The cost and feasibility was assessed to reduce the CO emission limit from 9.0 ppm down to 1.0 ppm with the POC emission limit reduced from 1.0 ppm down to 0.8 ppm. The oxidation catalysts will be provided as part of the HRSGs which, in turn, will be provided as part of GE's Engineered Equipment Package (EEP). GE's guarantee to CCGS is for a CO limit of 2.0 ppm and a POC limit of 1.0 ppm.

The capital cost associated with the installation of additional catalyst includes the catalyst, catalyst housing, HRSG modifications, and balance of plant equipment. Capital costs are based on vendor supplied data as well as scaled estimates from previous budgetary quotations from equipment manufacturers and other engineering estimates. As shown in Table 4, the per combustion turbine total installed capital cost for the oxidation catalyst system is $1,796,748.

The annual operating costs associated with the use of a catalyst to go from a CO concentration of 2.0 ppm down to 1.0 ppm would increase over the base case of 2.0 ppm. The increase in annual operating costs includes catalyst replacement and energy impacts due to increased fuel usage resulting from the increased combustion turbine backpressure. Throughout the life of the facility, the catalyst will require periodic replacement. Catalyst manufacturers typically guarantee a three-year catalyst life. As stated above, both add-on control systems increase the fuel usage of the facility for same net electrical output. This is a result of the increased combustion turbine backpressure resulting from the additional catalyst depth. Maintenance consists of the routine catalyst replacement costs. Labor for the operation and maintenance of the combustion control system is considered a part of the facilities normal operating expenses and were not included in the incremental analysis. The labor costs for the oxidation catalyst system include general maintenance of the system. The estimated additional annual operating cost associated with the oxidation catalyst at 1.0 ppm CO and 0.8 ppm POC is $95,944. Tables 4 through 6 summarize the cost effectiveness analyses for the base case, the existing case, and the incremental case.

The BAAQMD has adopted an economic cost of $17,500 per ton for POC. They have not adopted cost-effectiveness guidelines for CO, but a review of other districts in California found none that consider additional CO controls appropriate as BACT where the total (average) cost-effectiveness will be greater than $400 per ton, or where the incremental cost-effectiveness will be over $1,150 per ton.

Moreover, a review of recent CO BACT determinations in EPA's RACT/BACT/LAER Clearinghouse did not reveal any permits that had imposed CO controls at a cost-per-ton in the range that would be required here. The permits in the Clearinghouse going back through 2005 that included cost-effectiveness information showed a limit of 1.8 ppm being imposed based upon an average cost-effectiveness of $1,750 per ton of CO; a limit of 3.5 ppm based upon an average cost-effectiveness of $2,736 per ton and an incremental cost-effectiveness of $5,472 per ton; and a limit of 2.0 ppm an average cost-effectiveness of $1,161 per ton of CO. The reduction of CO from the base case of 9 ppm down to 1 ppm would result in an overall cost effectiveness of $4,800 per ton. For POC, the reduction from 1.4 ppm down to 0.8 ppm would result in a cost effectiveness of $103,445 per ton removed.

The CO incremental emission reduction from 2.0 ppm (with add-on controls) down to 1.0 ppm (or a 13.2 ton per year reduction) would yield an incremental control cost effectiveness of $5,200 per ton. At this cost, the proposed CO limit of 1.0 ppm would not be considered economical.

The POC emission reduction from 1.0 ppm (with add-on controls) down to 0.8 ppm (or a 1.6 ton per year reduction) would yield an incremental control cost effectiveness of $44,398 per ton. At this cost, the proposed POC limit of 0.8 ppm would not be considered economical.

The average cost-effectiveness value of imposing a 1.0 ppm CO limit for the OGS project would be substantially higher than what was required for any of these other similar facilities. The base cost and incremental costs for POC exceed the BAAQMD cost thresholds.

Because both the average and incremental costs per ton of CO that would be reduced by imposition of a CO limit below 2.0 ppmvd are significantly higher than the costs that have been or would be required at other similar facilities, OGS is proposing not to require that level of control as BACT taking into account cost/economic impacts.

The use of good combustion control technology and a catalyst to limit CO emissions to 2.0 ppmvd and POC at 1.0 ppmvd (@15% O_2) is proposed as BACT for the CCGS based on the following rational:

- With a base cost of $4,800/ton for CO and $103,445/ton for POC, the application of additional oxidation catalyst down to 1.0 ppm CO and 0.8 ppm POC is not considered BACT based on economic impacts.

- With an incremental cost of $5,200/ton for CO and $44,398/ton for POC, the application of additional oxidation catalyst down to 1.0 ppm CO and 0.8 ppm POC is not considered BACT based on economic impacts.
- Installation of a larger oxidation catalyst system will have negative energy and environmental impacts. This increased control increases the backpressure on the combustion turbine, resulting in decreased efficiency and increased fuel consumption. The increased fuel consumption and decreased efficiency is an energy impact that also results in increases in other pollutant emissions per unit of energy.
- The use of a CO catalyst at 2.0 ppm with POC control at 1.0 ppm has previously been recognized as BACT for CO and POC control by regulatory agencies.

Therefore, the use of an oxidation catalyst to meet CO BACT requirements of 2.0 ppm (1-hour average during the unit steady operation) and POC BACT at 1.0 ppm is at least equal to or more stringent than other BACT determinations for similar power plants.

Table 4

Radback Energy-OGS

CO Oxidation Catalyst Control System (per turbine)

Pollutant Controlled: CO (and VOC, VOC HAPs)

	CAPITAL COST SUMMARY	
DIRECT CAPITAL COSTS		Explanation of Cost Estimates (2010 $)
1. Purchased Equipment:		**Base Cost - CO 9 ppm to 1 ppm/VOC 1.4 ppm to 0.8 ppm**
A) Purchased Equipment Costs	$958,000	Supplied by project engineering team
B) Other Required Systems	$0	Internal frame cost
C) Instrumentation & Controls	$95,800	EPA OAQPS 10% of A
D) Freight	$47,900	EPA OAQPS 5% of A
E) Taxes	$86,939	8.25% Tax Rate
Total Purchased Equip. Costs (TEC):	$1,188,639	
2. Installation Costs:		
A) Foundation & Supports	$118,900	EPA OAQPS 10% of TEC
B) Erection and Handling	$416,000	EPA OAQPS 35% of TEC
C) Electrical	$11,886	EPA OAQPS 1% of TEC
D) Piping	$23,773	EPA OAQPS 2% of TEC
E) Insulation	$11,886	EPA OAQPS 1% of TEC
F) Painting	$47,546	EPA OAQPS 4% of TEC
G) Site Preparation	$0	estimated by Project engineer
Total Installation Costs (TINC):	$629,991	
Total Direct Capital Costs (TDCC):	$1,818,630	Sum TEC,TINC
INDIRECT CAPITAL COSTS		
1. Engineering & Supervision	$178,300	EPA OAQPS 15% of TEC
2. Construction and Field Exp.	$118,900	EPA OAQPS 10% of TEC
3. Contractor Fees	$59,432	EPA OAQPS 5% of TEC
4. Start-up	$11,900	EPA OAQPS 1% of TEC
5. Performance Testing	$11,900	EPA OAQPS 1% of TEC
Total Indirect Capital Costs (TICC):	$380,432	
Total Direct & Indirect Capital Costs (TDICC):	$2,199,062	Sum TDCC,TICC
Contingency (@ 3%):	$66,000	3% TDICC (EPA OAQPS)
TOTAL CAPITAL COSTS (TCC):	$2,265,062	Sum TDICC,Contingency
	ANNUAL OPERATING COST SUMMARY	
DIRECT OPERATING COSTS		Explanation of Cost Estimates
1. Operating Labor	$19,801	.5 hrs/day, $108.5/hr, 365 days/yr
2. Supervisory Labor	$2,970	15% of Operating Labor
3. Maintenance Labor	$19,801	0.5 hr/day, $108.5/hr, 365 days/yr
4. Maintenance Materials	$19,801	100% of Maintenance Labor
4. Utility Expenses (gas and electricity, plus fuel penalty cost)	$80,724	see Cost Est tab
5. Media replacement and disposal (catalyst, every 5 yrs)	$626,680	see Cost Est tab
6. Process chemicals costs	$0	see Cost Est tab
7. Annual Media Cost	$46,366	Item 5 divided by media life (yrs), x CRF (7%, 15 yrs, = 0.1098)
8. Other Penalties (specify)	$0	Loss power sales $, see Cost Est tab
Total Direct Operating Costs (TDOC):	$189,463	
INDIRECT OPERATING COSTS		
1. Overhead	$13,663	60% Total Labor, EPA OAQPS
Total Indirect Operating Costs (TIOC):	$13,663	
CAPITAL CHARGES & COSTS		
1. Property Tax	$33,500	EPA OAQPS 1.48% TCC
2. Insurance	$22,700	EPA OAQPS 1% TCC
3. General Administrative	$45,300	EPA OAQPS 2% TCC
4. Capital Recovery Cost	$182,600	7% per OMB, 30 yr plant life, CRF=.0806
Total Capital Charges Costs (TCCC):	$284,100	Sum 1,2,3,4
TOTAL ANNUALIZED OPERATING COSTS:	$487,226	Sum TDOC,TIOC,TCCC
	COST EFFECTIVENESS EVALUATION	
Uncontrolled Case Emissions		
Base Concentration-Uncontrolled	9	ppm with DLN and GCPs
Annual Emission Rate	113.3	tpy (steady state emissions only)
Incremental Controlled Emissions Case		
CO Concentration	1.0	ppm with CO Catalyst
Annual Emission Rate:	12.59	tpy
CO Reduction from Uncontrolled Case:	100.7	tpy
Control Cost Effectiveness:	**$4,800**	per ton CO
VOC Base Concentration-Uncontrolled	1.40	ppm (w/o add-on controls)
VOC Annual Emission Rate	11.0	tpy
VOC Concentration	0.80	ppm (BACT w/CO Catalyst)
Annual Emission Rate:	6.24	tpy
VOC Reduction from Uncontrolled Case:	4.7	tpy
Control Cost Effectiveness:	**$103,445**	per ton VOC

References:

1. OAQPS - OAQPS Cost Control Manual, 6th ED., January 2002, EPA
2. EPA1998 - Cost Effectiveness fo Oxidation Catalyst Control of HAP Emissions from Stationary Combustion Turbines, EPA, 1998.
3. NE estimated cost for additional catalyst to achieve 90% control of CO per EPA study.
4. EPA memo dated 12-30-99, ES Division, Docket A-95-51, and May 14, 1999 memo on Stationary CT control cost options.
5. Air Compliance Advisor, Version 7.5, 8-15-2003, EPA-OAQPS. (consulted ref only)
6. SATSOP CT Project, Phase II, SCA Amendment #4, Nov 2001.

References continued:

7. Tesla Power Project, FPL, AFC Section 5.2, October 2001.
8. West County Energy Center, FPL, August 2005.
9. JEA-Greenland Energy Center, B&V, Sept 2008.
10. Vineyard Energy Center, Calpine, Utah DEQ, November 2003.
11. Marsh Landing GS project data scaled to OGS site.

Ammonia system cost:

NH3:	29% aqueous	Unit Totals	Unit Cost, $	
tank cap (gals)	12,000	0	$0	
skids needed:	1 per turbine	0	$0	
unloading system	1 per facility	0	$0	
Est Cost			$0	per turbine>>>>
tank fill capacity at 85%, gals:		0		Standard RMP admin capacity limit.
ammonia density, lbs/gal:		0.00		LaRoche Industries, Inc., Ammonia Technical Data Manual, 1997.

Labor costs: $/hr $108.50 burdened labor costs

Electricity Cost:

Req'd kw/hr	0	per turbine	Supplied by project team, ammonia forwarding, vaporization, etc.
cents/kw-hr	10.22		EIA-DOE Retail Electricity price listing, 9-15-10, Industrial sector, California.
Ops hrs/yr	8,400		Supplied by project team-AFC
Cost $/hr	$0.00		
Cost $/OP-Yr	$0		

Gas Cost:

Req'd 1000scf/hr	0	per turbine	Supplied by project team
$/1000scf	$4.35		EIA-DOE NG Price listing, 2009, as of 10-5-10, Electric Power Price, California.
Ops hrs/yr	8,400		Supplied by project team-AFC
Cost $/hr	$0		
Cost $/OP-yr	$0		

Fuel/Efficiency Penalties:

system backpressure, inH2O:	1.00	per turbine	Supplied by project team
fuel penalty per inH2O:	0.00105	0.00105	GRI General Fuel penalty value, EPA Memo 12-30-99,R. Sims-ESD, Docket A-95-51
max hourly fuel rate, 1000scf/hr:	2,104.0		Supplied by project team-AFC
Ops hrs/yr	8,400		Supplied by project team-AFC
$/1000scf	$4.35		EIA-DOE NG Price listing, 2009, as of 10-5-10, Electric Power Price, California.
fuel penalty/hr, 1000scf	2.2092		
fuel penalty/yr, 1000scf	18,557		
fuel penalty cost, $/hr	$9.61		
fuel penalty cost, $/yr	$80,724		

Annual Ammonia supply costs: per turbine

ammonia injection rate, lbs/hr:	0.00	Supplied by project team-AFC
ammonia injection Ops, hrs/yr	8,400	Supplied by project team-AFC
total ammonia used, lbs/yr	0	
total ammonia used, gals/yr	#DIV/0!	
total ammonia used, tons/yr	0.00	
ammonia cost, $/ton	$350	Materials + freight, ICIS.com, August 2010, and USDA-ERS, Bulletin WRS-0702, 8/07.
annual ammonia cost, $	$0	
annual tank turnovers at 85% cap:	#DIV/0!	

Lost Power Sales Revenue

avg baseload day power sales, $	$0	per turbine	Supplied by project engineering team
# days/yr downtime due to system inspection and maintenance issues	2		Supplied by project engineering team
total lost power sales revenue, $/yr	$0		

CO catalyst replacement cost per turbine

replacement cost, $	$626,680	Supplied by project engineering team

Cost Multiplier Values Per OAQPS*

Cost Parameter	OAQPS Value Range, %	Value Used in Analysis,%	Comment
Instrumentation/Controls	10%	10%	
Freight	5%	5%	
Taxes	3%	8.25%	local area tax rate
Foundations/Supports	4-12%	10%	
Erection/Handling	14-50%	35%	per project developer
Electrical	1-8%	1%	per project developer
Piping	1-30%	2%	per project developer
Insulation	1-7%	2%	per project developer
Painting	1-4%	4%	per project developer
Site Preparation	as Req'd	0%	
Engineering/Supervision	10-20%	15%	per project developer
Construction	5-20%	10%	per project developer
Contractor Fees	0-10%	5%	per project developer
Startup Costs	1-2%	1%	
Performance Testing	1%	1%	
Contingency	3%	3%	
Supervisory Labor	15%	15%	15% of OP labor
Maintenance Materials	100%	100%	100% of maintenance labor costs
Overhead	60%	60%	BAAQMD value is 80%
Administrative Charges	2%	2%	
Property Taxes	1%	1.48%	
Insurance	1%	1%	
Capital Recovery Factor	calculated	calculated	OMB interest rate 7%

* OAQPS - OAQPS Cost Control Manual, 6th ED., January 2002, EPA.

Table 5

Radback Energy-OGS

CO Oxidation Catalyst Control System (per turbine)

Pollutant Controlled: CO (and VOC, VOC HAPs)

CAPITAL COST SUMMARY		
DIRECT CAPITAL COSTS		Explanation of Cost Estimates (2010 $)
1. Purchased Equipment:		**Base Cost - CO 9 ppm to 2 ppm/VOC 1.4 ppm to 1.0 ppm**
A) Purchased Equipment Costs	$829,000	Supplied by project engineering team
B) Other Required Systems	$0	
C) Instrumentation & Controls	$82,900	EPA OAQPS 10% of A
D) Freight	$41,450	EPA OAQPS 5% of A
E) Taxes	$75,232	8.25% Tax Rate
Total Purchased Equip. Costs (TEC):	$1,028,582	
2. Installation Costs:		
A) Foundation & Supports	$102,900	EPA OAQPS 10% of TEC
B) Erection and Handling	$360,000	EPA OAQPS 35% of TEC
C) Electrical	$10,300	EPA OAQPS 1% of TEC
D) Piping	$20,600	EPA OAQPS 2% of TEC
E) Insulation	$10,300	EPA OAQPS 1% of TEC
F) Painting	$41,100	EPA OAQPS 4% of TEC
G) Site Preparation	$0	estimated by Project engineer
Total Installation Costs (TINC):	$545,200	
Total Direct Capital Costs (TDCC):	$1,573,782	Sum TEC,TINC
INDIRECT CAPITAL COSTS		
1. Engineering & Supervision	$154,300	EPA OAQPS 15% of TEC
2. Construction and Field Exp.	$102,900	EPA OAQPS 10% of TEC
3. Contractor Fees	$51,400	EPA OAQPS 5% of TEC
4. Start-up	$10,300	EPA OAQPS 1% of TEC
5. Performance Testing	$10,300	EPA OAQPS 1% of TEC
Total Indirect Capital Costs (TICC):	$329,200	
Total Direct & Indirect Capital Costs (TDICC):	$1,902,982	Sum TDCC,TICC
Contingency (@ 3%):	$57,100	3% TDICC (EPA OAQPS)
TOTAL CAPITAL COSTS (TCC):	$1,960,082	Sum TDICC,Contingency
ANNUAL OPERATING COST SUMMARY		
DIRECT OPERATING COSTS		Explanation of Cost Estimates
1. Operating Labor	$19,801	.5 hrs/day, $108.5/hr, 365 days/yr
2. Supervisory Labor	$2,970	15% of Operating Labor
3. Maintenance Labor	$19,801	0.5 hr/day, $108.5/hr, 365 days/yr
4. Maintenance Materials	$19,801	100% of Maintenance Labor
4. Utility Expenses (gas and electricity, plus fuel penalty cost)	$56,507	see Cost Est tab
5. Media replacement and disposal (catalyst, every 5 yrs)	$497,680	see Cost Est tab
6. Process chemicals costs	$0	see Cost Est tab
7. Annual Media Cost	$36,822	Item 5 divided by media life (yrs), x CRF (7%, 15 yrs, = 0.1098)
8. Other Penalties (specify)	$0	Loss power sales $, see Cost Est tab
Total Direct Operating Costs (TDOC):	$155,702	
INDIRECT OPERATING COSTS		
1. Overhead	$13,663	60% Total Labor, EPA OAQPS
Total Indirect Operating Costs (TIOC):	$13,663	
CAPITAL CHARGES & COSTS		
1. Property Tax	$29,000	EPA OAQPS 1.48% TCC
2. Insurance	$19,600	EPA OAQPS 1% TCC
3. General Administrative	$39,200	EPA OAQPS 2% TCC
4. Capital Recovery Cost	$158,000	7% per OMB, 30 yr plant life, CRF=.0806
Total Capital Charges Costs (TCCC):	$245,800	Sum 1,2,3,4
TOTAL ANNUALIZED OPERATING COSTS:	$415,165	Sum TDOC,TIOC,TCCC
COST EFFECTIVENESS EVALUATION		
Uncontrolled Case Emissions		
Base Concentration-Uncontrolled	9	ppm with DLN and GCPs
Annual Emission Rate	113.3	tpy (steady state emissions only)
Incremental Controlled Emissions Case		
CO Concentration	2.0	ppm with CO Catalyst
Annual Emission Rate:	25.18	tpy
CO Reduction from Uncontrolled Case:	88.1	tpy
Control Cost Effectiveness:	**$4,700**	per ton CO
VOC Base Concentration-Uncontrolled	1.40	ppm (w/o add-on controls)
VOC Annual Emission Rate	11.0	tpy
VOC Concentration	1.00	ppm (w/CO Catalyst)
Annual Emission Rate:	7.80	tpy
VOC Reduction from Uncontrolled Case:	3.2	tpy
Control Cost Effectiveness:	**$131,798**	per ton VOC

References:

1. OAQPS - OAQPS Cost Control Manual, 6th ED., January 2002, EPA
2. EPA1998 - Cost Effectiveness fo Oxidation Catalyst Control of HAP Emissions from Stationary Combustion Turbines, EPA, 1998.
3. NE estimated cost for additional catalyst to achieve 90% control of CO per EPA study.
4. EPA memo dated 12-30-99, ES Division, Docket A-95-51, and May 14, 1999 memo on Stationary CT control cost options.
5. Air Compliance Advisor, Version 7.5, 8-15-2003, EPA-OAQPS. (consulted ref only)
6. SATSOP CT Project, Phase II, SCA Amendment #4, Nov 2001.

References continued:

7. Tesla Power Project, FPL, AFC Section 5.2, October 2001.
8. West County Energy Center, FPL, August 2005.
9. JEA-Greenland Energy Center, B&V, Sept 2008.
10. Vineyard Energy Center, Calpine, Utah DEQ, November 2003.
11. Marsh Landing GS project data scaled to OGS site.

Ammonia system cost:					
NH3:	29% aqueous	Unit Totals	Unit Cost, $		
tank cap (gals)	12,000	0	$0		
skids needed:	1 per turbine	0	$0		
unloading system	1 per facility	0	$0		
Est Cost			$0		per turbine>>>>
tank fill capacity at 85%, gals:		0		Standard RMP admin capacity limit.	
ammonia density, lbs/gal:		0.00		LaRoche Industries, Inc., Ammonia Technical Data Manual, 1997.	
Labor costs: $/hr	$108.50	burdened labor costs			
Electricity Cost:					
Req'd kw/hr	0		per turbine	Supplied by project team, ammonia forwarding, vaporization, etc.	
cents/kw-hr	10.22			EIA-DOE Retail Electricity price listing, 9-15-10, Industrial sector, California.	
Ops hrs/yr	8,400			Supplied by project team-AFC	
Cost $/hr	$0.00				
Cost $/OP-Yr	$0				
Gas Cost:					
Req'd 1000scf/hr	0		per turbine	Supplied by project team	
$/1000scf	$4.35			EIA-DOE NG Price listing, 2009, as of 10-5-10, Electric Power Price, California.	
Ops hrs/yr	8,400			Supplied by project team-AFC	
Cost $/hr	$0				
Cost $/OP-yr	$0				
Fuel/Efficiency Penalties:					
system backpressure, inH2O:		0.70	per turbine	BASF, 1/2010	
fuel penalty per inH2O:		0.00105	0.00074	GRI General Fuel penalty value, EPA Memo 12-30-99,R. Sims-ESD, Docket A-95-51	
max hourly fuel rate, 1000scf/hr:		2,104.0		Supplied by project team-AFC	
Ops hrs/yr		8,400		Supplied by project team-AFC	
$/1000scf		$4.35		EIA-DOE NG Price listing, 2009, as of 10-5-10, Electric Power Price, California.	
fuel penalty/hr, 1000scf		1.5464			
fuel penalty/yr, 1000scf		12,990			
fuel penalty cost, $/hr		$6.73			
fuel penalty cost, $/yr		$56,507			
Annual Ammonia supply costs:			per turbine		
ammonia injection rate, lbs/hr:		0.00		Supplied by project team-AFC	
ammonia injection Ops, hrs/yr		8,400		Supplied by project team-AFC	
total ammonia used, lbs/yr		0			
total ammonia used, gals/yr		#DIV/0!			
total ammonia used, tons/yr		0.00			
ammonia cost, $/ton		$350		Materials + freight, ICIS.com, August 2010, and USDA-ERS, Bulletin WRS-0702, 8/07.	
annual ammonia cost, $		$0			
annual tank turnovers at 85% cap:		#DIV/0!			
Lost Power Sales Revenue					
avg baseload day power sales, $		$0	per turbine	Supplied by project engineering team	
# days/yr downtime due to system					
inspection and maintenance issues		2		Supplied by project engineering team	
total lost power sales revenue, $/yr		$0			
CO catalyst replacement cost			per turbine		
replacement cost, $		$497,680	replace and disposal (take back), freight both ways, taxes, etc.		

Cost Multiplier Values Per OAQPS*

Cost Parameter	OAQPS Value Range, %	Value Used in Analysis,%	Comment
Instrumentation/Controls	10%	10%	
Freight	5%	5%	
Taxes	3%	8.25%	local area tax rate
Foundations/Supports	4-12%	10%	
Erection/Handling	14-50%	35%	per project developer
Electrical	1-8%	1%	per project developer
Piping	1-30%	2%	per project developer
Insulation	1-7%	2%	per project developer
Painting	1-4%	4%	per project developer
Site Preparation	as Req'd	0%	
Engineering/Supervision	10-20%	15%	per project developer
Construction	5-20%	10%	per project developer
Contractor Fees	0-10%	5%	per project developer
Startup Costs	1-2%	1%	
Performance Testing	1%	1%	
Contingency	3%	3%	
Supervisory Labor	15%	15%	15% of OP labor
Maintenance Materials	100%	100%	100% of maintenance labor costs
Overhead	60%	60%	BAAQMD value is 80%
Administrative Charges	2%	2%	
Property Taxes	1%	1.48%	
Insurance	1%	1%	
Capital Recovery Factor	calculated	calculated	OMB interest rate 7%

* OAQPS - OAQPS Cost Control Manual, 6th ED., January 2002, EPA.

Table 6

Radback Energy-OGS
CO Catalyst Control System (per turbine)
Pollutant Controlled: CO (VOC, VOC HAPs)

	CAPITAL COST SUMMARY	
DIRECT CAPITAL COSTS		Explanation of Cost Estimates (2010 $)
1. Purchased Equipment:		**INCREMENTAL Cost - 2 ppm to 1 ppm**
A) Purchased Equipment Costs	$129,000	**Cost differential from 9-2 versus 9-1 ppm**
B) Other Required Systems (racking)	$0	
C) Instrumentation & Controls	$12,900	
D) Freight	$6,450	
E) Taxes	$12,239	
Total Purchased Equip. Costs (TEC):	$148,350	
2. Installation Costs:		
A) Foundation & Supports	$14,800	EPA OAQPS 10% of TEC
B) Erection and Handling	$51,900	EPA OAQPS 35% of TEC
C) Electrical	$1,484	EPA OAQPS 1% of TEC
D) Piping	$2,967	EPA OAQPS 2% of TEC
E) Insulation	$1,484	EPA OAQPS 1% of TEC
F) Painting	$5,934	EPA OAQPS 4% of TEC
G) Site Preparation	$0	estimated by Project engineer
Total Installation Costs (TINC):	$78,568	
Total Direct Capital Costs (TDCC):	$226,918	Sum TEC,TINC
INDIRECT CAPITAL COSTS		
1. Engineering & Supervision	$22,300	EPA OAQPS 15% of TEC
2. Construction and Field Exp.	$14,800	EPA OAQPS 10% of TEC
3. Contractor Fees	$7,418	EPA OAQPS 5% of TEC
4. Start-up	$1,500	EPA OAQPS 1% of TEC
5. Performance Testing	$1,500	EPA OAQPS 1% of TEC
Total Indirect Capital Costs (TICC):	$47,518	
Total Direct & Indirect Capital Costs (TDICC):	$274,436	Sum TDCC,TICC
Contingency (@ 3%):	$8,700	
TOTAL CAPITAL COSTS (TCC):	$283,136	Sum TDICC,Contingency
	ANNUAL OPERATING COST SUMMARY	
DIRECT OPERATING COSTS		Explanation of Cost Estimates
1. Operating Labor	$0	.5 hrs/day, $108.5/hr, 365 days/yr
2. Supervisory Labor	$0	15% of Operating Labor
3. Maintenance Labor	$0	0.5 hr/day, $108.5/hr, 365 days/yr
4. Maintenance Materials	$0	100% of Maintenance Labor
4. Utility Expenses (gas and electricity, plus fuel penalty cost)	$24,217	see Cost Est tab
5. Media replacement and disposal (catalyst, every 15 yrs)	$129,000	see Cost Est tab
6. Process chemicals costs (ammonia)	$0	see Cost Est tab
7. Annual Media Cost	$9,544	Item 5 divided by media life (yrs), x CRF (7%, 15 yrs, = 0.1098)
8. Other Penalties (specify)	$0	Loss power sales $, see Cost Est tab
Total Direct Operating Costs (TDOC):	$33,761	
INDIRECT OPERATING COSTS		
1. Overhead	$0	
Total Indirect Operating Costs (TIOC):	$0	
CAPITAL CHARGES & COSTS		
1. Property Tax	$4,200	EPA OAQPS 1.48% TCC
2. Insurance	$2,800	EPA OAQPS 1% TCC
3. General Administrative	$5,700	EPA OAQPS 2% TCC
4. Capital Recovery Cost	$22,800	7% per OMB, 30 yr plant life, CRF=.0806
Total Capital Charges Costs (TCCC):	$35,500	Sum 1,2,3,4
TOTAL ANNUALIZED OPERATING COSTS:	$69,261	Sum TDOC,TIOC,TCCC
	COST EFFECTIVENESS EVALUATION	
Controlled Case Emissions		
Base Concentration-Controlled	2	ppm with DLN Combustors and CO Catalyst
Annual Emission Rate	25.8	tpy (steady state emissions only)
Incremental Controlled Emissions Case		
CO Concentration	1.0	ppm with added CO Catalyst
Annual Emission Rate:	12.59	tpy
CO Reduction from Controlled Case:	13.2	tpy
Control Cost Effectiveness:	**$5,200**	per ton CO
VOC Base Concentration-controlled	1.00	ppm (w add-on controls)
VOC Annual Emission Rate	7.8	tpy
VOC Concentration	0.80	ppm (BACT w/CO Catalyst)
Annual Emission Rate:	6.24	tpy
VOC Reduction from Uncontrolled Case:	1.6	tpy
Control Cost Effectiveness:	**$44,398**	per ton VOC

6. SATSOP CT Project, Phase II, SCA Amendment #4, Nov 2001.

References:

1. OAQPS - OAQPS Cost Control Manual, 6th ED., January 2002, EPA
2. EPA1998 - Cost Effectiveness fo Oxidation Catalyst Control of HAP Emissions from Stationary Combustion Turbines, EPA, 1998.
3. NE estimated cost for additional catalyst to achieve 90% control of CO per EPA study.
4. EPA memo dated 12-30-99, ES Division, Docket A-95-51, and May 14, 1999 memo on Stationary CT control cost options.
5. Air Compliance Advisor, Version 7.5, 8-15-2003, EPA-OAQPS. (consulted ref only)

References continued:

7. Tesla Power Project, FPL, AFC Section 5.2, October 2001.
8. West County Energy Center, FPL, August 2005.
9. JEA-Greenland Energy Center, B&V, Sept 2008.
10. Vineyard Energy Center, Calpine, Utah DEQ, November 2003.
11. Marsh Landing GS project data scaled to OGS site.
12. Optimization of Ammonia Source for SCR Applications, Paper #46, R.Salib, et.al., Washington Group Int'l., no date.