State of California
AIR RESOURCES BOARD

Resolution 82-23

April 22, 1982

Agenda Item No.: 82-10-1

WHEREAS, the California Legislature has declared its intention to encourage the development of cogeneration projects to reduce the waste of energy resources in California, in part by providing relief from emissions offset requirements to cogeneration projects to the extent they reduce demand on existing utility combustion generating facilities in the same air basin;

WHEREAS, the Air Resources Board (the "Board") and local air pollution control districts together are required by Assembly Bill 1862 (Stats. 1981, Ch. 952) to develop by May 1, 1982 a procedure to calculate the incremental emissions benefit derived from the electrical generating portion of a cogeneration project in comparison to the displaced emissions of hydrocarbon combustion utility generating facilities, and also to assure that state and federal ambient air quality standards are achieved and maintained or reasonable further progress achieved toward meeting those standards;

WHEREAS, the Board recognizes the need and desirability of implementing a uniform statewide procedure for calculating displaced electrical generation emissions for the siting of cogeneration projects, pursuant to AB 1862;

WHEREAS, a committee of local district staff representatives and the Board staff developed a recommended procedure following discussions with utilities, cogeneration project proponents, and other interested persons and a public workshop on February 11, 1982;

WHEREAS, the staff prepared a report describing the procedure drafted by the committee, which has been made available for public review and comment; and

WHEREAS, on April 22, 1982, the Board conducted a public meeting to discuss the procedure and consider testimony from industry representatives, interested agencies, and the public.

NOW, THEREFORE, BE IT RESOLVED that the Board concurs with the procedure drafted by the committee and attached hereto as Appendix A and recommends that districts use this procedure as the basis for determining the utility electrical generation emissions offset credit available for siting cogeneration projects.

I hereby certify that this is
a true and correct copy of
Resolution 82-23, as adopted
by the Air Resources Board.

Harold Holmes, Board Secretary

Joint CAPCOA/ARB Recommended Calculation Procedure
for Cogeneration Siting Under AB 1862

A. DEFINITIONS

ACCOUNTING MECHANISM - a procedure required under AB 1862 to periodically track utility and cogeneration emissions, and utility offset credits.

AVERAGE EMISSIONS RATES - the annual averages for the most recent 3 years of complete data. Emission rates for utilities are only calculated for oxides of nitrogen, sulfur oxides, and particulate matter.

AVERAGING PERIOD - most recent 3 years for which complete utility operation data is available.

BACT/LAER - Best Available Control Technology and Lowest Achievable Emissions Rate as defined by the rules of the district.

DISTANCE FACTOR - a fraction equal to or less than 1 which considers the distance between the cogenerator and utility power plants.

IN-BASIN POWER PLANTS - oil and gas fired steam turbines or combined cycle electrical generation units operated by the utility in the same air basin as the cogeneration project. If no purchases occur, in-basin power plants are those of the utility serving the location of the cogenerator.

OWNER/OPERATOR OFFSETS - offsets provided by the project proponent to the extent they are available from facilities the proponent owns or operates in the district and would mitigate the project's impacts.

IN-STATE POWER PLANTS - oil and gas fired steam turbines or combined cycle electrical generation units operated by the purchasing utility in the State of California. If no purchases occur, in-state power plants are those of the utility serving the location of the cogenerator which are in the State of California.

B. STEPS IN CALCULATION PROCEDURE
Figure 1 summarizes these steps.

1. Calculate the UNCONTROLLED PROJECT EMISSIONS.

2. Determine if BACT/LAER is required based on UNCONTROLLED PROJECT EMISSIONS and district rules.

3. Determine, after application of BACT/LAER, the PROJECT OFFSET REQUIREMENTS. This is based on district rules.

4. Determine PROJECT PARAMETERS (see Figures 2 and 3)

   Fp = PRIMARY FUEL (Btu/day)
   Fs = SECONDARY FUEL (Btu/day)
   Pp = PRIMARY POLLUTION (lb/day)
   Ps = SECONDARY POLLUTION (lb/day)
   Pp + Ps = PROJECT OFFSET REQUIREMENTS (lb/day)
   E = USEFUL ELECTRICAL OUTPUT (MWH/day)
   Δ = HEAT ENERGY OF EXHAUST (Btu/day)
   T = USEFUL THERMAL OUTPUT (Btu/day)

5. Divide the PROJECT OFFSET REQUIREMENTS into COGENERATION and NON-COGENERATION EMISSIONS PORTIONS

   o COGENERATION EMISSIONS PORTION = Pp (TOPPING CYCLE)

   $$= \left(\frac{\Delta}{Fp}\right) Pp \text{ (BOTTOMING CYCLE)}$$

   o NON-COGENERATION EMISSIONS PORTION = Ps (TOPPING CYCLE)

   $$= \left(\frac{Fp - \Delta}{Fp}\right) Pp + Ps \text{ (BOTTOMING CYCLE)}$$

6. Regardless of the size of the project, the NON-COGENERATION EMISSIONS PORTION must be offset by the project proponent according to the rules of the local district.

7. Calculate the AVERAGE EMISSIONS RATES (lb/MWH) of NOx, SOx Particulate Matter, HC* and CO* for all IN-BASIN POWER PLANTS:

   $$\frac{\text{lb of pollutant emitted by all IN-BASIN POWER PLANTS during averaging period}}{\text{MWH generated by all IN-BASIN POWER PLANTS during averaging period}}$$

8. Calculate the BASIN/SYSTEM FRACTION:

   $$\frac{\text{MWH generated by all IN-BASIN POWER PLANTS during averaging period}}{\text{MWH generated by all IN-STATE POWER PLANTS during averaging period}}$$

* AVERAGE EMISSION RATES (lb/MWH) of carbon monoxide and hydrocarbons for all IN-BASIN POWER PLANTS may be calculated if information satisfactory to the district and the ARB is available from the utility, district, or project proponent.

9. Calculate the IN-BASIN DISPLACED UTILITY EMISSIONS*:

USEFUL ELECTRICAL OUTPUT, E	(MWH/day) x
BASIN/SYSTEM FRACTION	x
AVERAGE EMISSIONS RATE FOR IN-BASIN POWER PLANTS	(lb/MWH) =
IN-BASIN DISPLACED UTILITY EMISSIONS	(lb/day)

10. Multiply IN-BASIN DISPLACED UTILITY EMISSIONS (lb/day) by the DISTANCE FACTOR.

11. Credit the lower of the product calculated in 10 or the COGENERATION EMISSIONS PORTION. This credit is called the UTILITY OFFSET CREDITS.

12. Submit amount of UTILITY OFFSET CREDITS to ACCOUNTING MECHANISM.

13. Calculate REMAINING COGENERATION EMISSIONS =

    COGENERATION EMISSIONS PORTION - UTILITY OFFSET CREDITS

    Note that the REMAINING COGENERATION EMISSIONS will be either zero or a positive quantity.

14. For projects of 50 megawatts or larger the REMAINING COGENERATION EMISSIONS become the responsibility of the project proponent to offset.

15. For projects of less than 50 megawatts REMAINING COGENERATION EMISSIONS are offset in the following order:

    a. available offsets from facilities owned or operated by the project proponent in the same district as the cogeneration project are first procured.

    b. if additional offsets are required after owner/operator offsets are provided, the local district assumes the responsibility for providing these.

16. The offset responsibilities outlined in Steps 14 and 15 are in addition to the responsibility outlined in Step 6.

* If the purchasing utility will demonstrate and certify to the satisfaction of the district and the ARB that displacement would occur in a different manner, then a different method may be used.

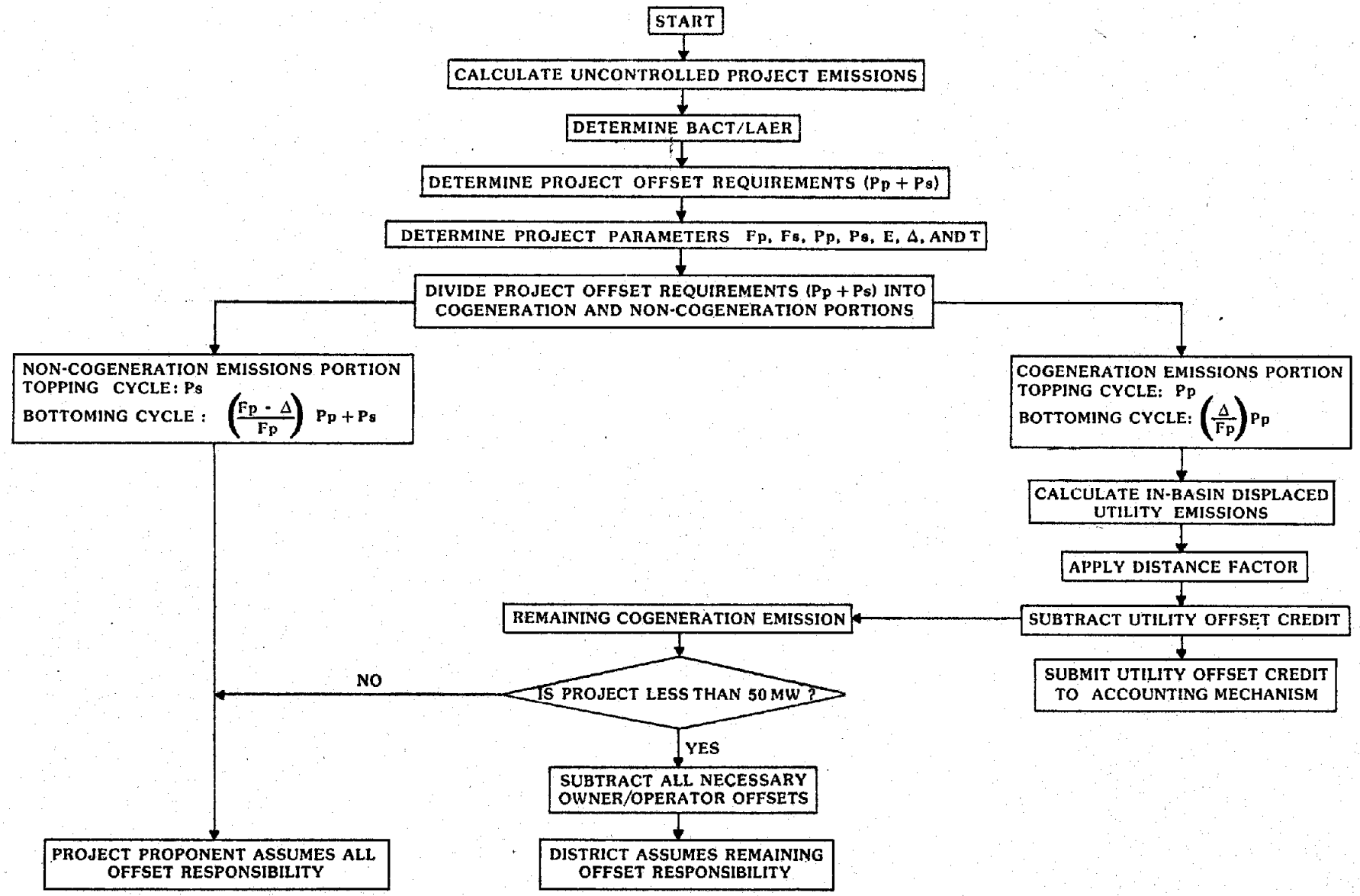
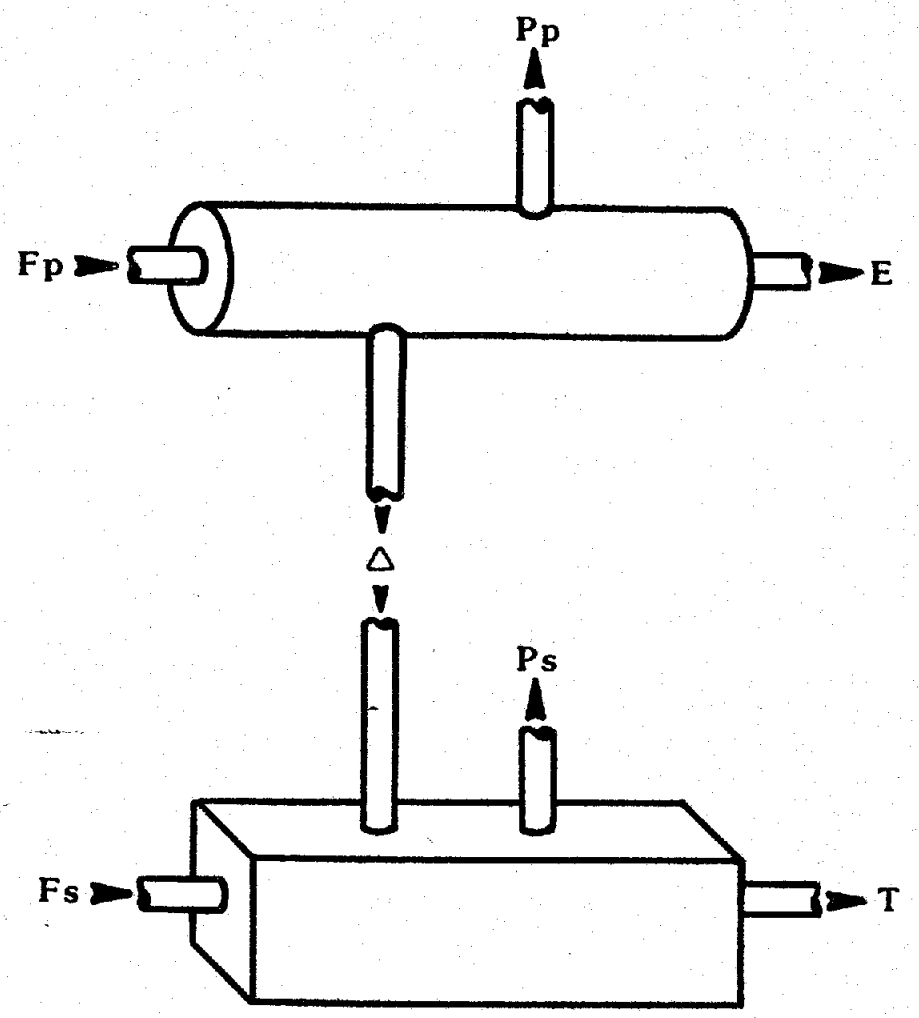

START
CALCULATE UNCONTROLLED PROJECT EMISSIONS
DETERMINE BACT/LAER
DETERMINE PROJECT OFFSET REQUIREMENTS (Pp + Ps)
DETERMINE PROJECT PARAMETERS Fp, Fs, Pp, Ps, E, Δ, AND T
DIVIDE PROJECT OFFSET REQUIREMENTS (Pp + Ps) INTO COGENERATION AND NON-COGENERATION PORTIONS
NON-COGENERATION EMISSIONS PORTION
TOPPING CYCLE: Ps
BOTTOMING CYCLE : (Fp - Δ / Fp) Pp + Ps
COGENERATION EMISSIONS PORTION
TOPPING CYCLE: Pp
BOTTOMING CYCLE: (Δ / Fp) Pp
CALCULATE IN-BASIN DISPLACED UTILITY EMISSIONS
APPLY DISTANCE FACTOR
SUBTRACT UTILITY OFFSET CREDIT
SUBMIT UTILITY OFFSET CREDIT TO ACCOUNTING MECHANISM
REMAINING COGENERATION EMISSION
IS PROJECT LESS THAN 50 MW ?
NO
YES
SUBTRACT ALL NECESSARY OWNER/OPERATOR OFFSETS
DISTRICT ASSUMES REMAINING OFFSET RESPONSIBILITY
PROJECT PROPONENT ASSUMES ALL OFFSET RESPONSIBILITY

Figure 1

Figure 2

TOPPING CYCLE COGENERATION SCHEMATICS



Fp ≡ PRIMARY FUEL

Pp ≡ PRIMARY POLLUTION

E ≡ USEFUL ELECTRICAL OUTPUT

Δ ≡ HEAT ENERGY OF EXHAUST

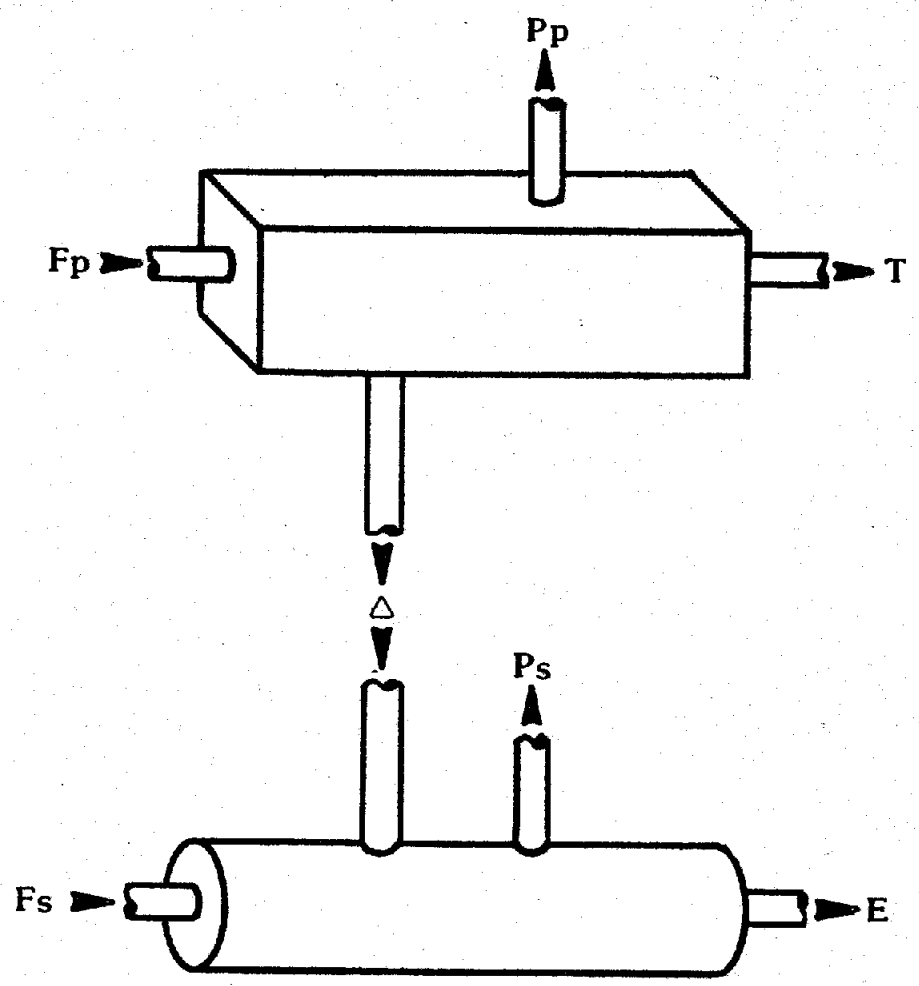
Fs ≡ SECONDARY FUEL

Ps ≡ SECONDARY POLLUTION

T ≡ USEFUL THERMAL OUTPUT

Figure 3

BOTTOMING CYCLE COGENERATION SCHEMATICS



Fp = PRIMARY FUEL

Pp = PRIMARY POLLUTION

E = USEFUL ELECTRICAL OUTPUT

Δ = HEAT ENERGY OF EXHAUST

Fs = SECONDARY FUEL

Ps = SECONDARY POLLUTION

T = USEFUL THERMAL OUTPUT

C. EXAMPLE OF CALCULATION PROCEDURE

In the following example, a hypothetical cogeneration project is sited in Oakland, California. The project consists of a 33 MW turbine and a supplementary-fired waste heat recovery boiler.

This example follows the procedure and illustrates the calculation of the utility offset credits. For the sake of simplicity, only NOx is considered in this example. Calculations for SOx and TSP can be done in a similar manner.

To qualify under AB 1862 a project must meet the following standards:

(a) At least 5 percent of the facility's total annual energy output shall be in the form of useful thermal energy.

(b) Where useful thermal energy follows power production, the useful annual power output plus one-half the useful annual thermal energy output equals not less than 42.5 percent of any natural gas and oil energy input.

Annual project parameters are listed below*:

Fp = PRIMARY FUEL (natural gas) = 3.89×10^{12} Btu/yr

Fs = SECONDARY FUEL (natural gas) = 3.96×10^{11} Btu/yr

E = USEFUL ELECTRICAL OUTPUT = 9.72×10^{11} Btu/yr

T = USEFUL THERMAL OUTPUT = 2.02×10^{12} Btu/yr

* (360 days of operation per year, 24 hours per day)

(1) $$\frac{T}{T+E} = \frac{2.02 \times 10^{12} \text{ Btu/yr}}{2.02 \times 10^{12} \text{ Btu/yr} + 9.72 \times 10^{11} \text{ Btu/yr}} = 67.5\%$$

(2) Applicable only to topping cycles:

$$\frac{E + 1/2\ T}{Fp + Fs} \geq 42.5\%$$

$$\frac{9.72 \times 10^{11} \text{ Btu/yr} + 1/2\ (2.02 \times 10^{12} \text{ Btu/yr})}{3.89 \times 10^{12} \text{ Btu/yr} + 3.96 \times 10^{11} \text{ Btu/yr}} = 46.2\%$$

Conditions (a) and (b) are met. Facility qualifies as cogenerator for the purposes of AB 1862.

1. UNCONTROLLED PROJECT EMISSIONS: from turbine = 4,950 lb/day; from supplemental burners = 165 lb/day (Ps).
2. BACT/LAER required: water injection with 80% NOx reduction, controlled emissions = 990 lb/day (Pp).
3. PROJECT OFFSET REQUIREMENTS: (Pp + Ps) = 1,155 lb/day.
4. PROJECT PARAMETERS:

   Fp = PRIMARY FUEL (natural gas) = 1.08×10^{10} Btu/day

   Fs = SECONDARY FUEL (natural gas) = 1.1×10^{9} Btu/day

   Pp = PRIMARY POLLUTION, NOx = 990 lb/day

   Ps = SECONDARY POLLUTION, NOx = 165 lb/day

   E = USEFUL ELECTRICAL OUTPUT = 792 MWH/day = 2.7×10^{9} Btu/day

   Δ = HEAT ENERGY OF EXHAUST = 7.0×10^{9} Btu/day

   T = USEFUL THERMAL OUTPUT = 5.6×10^{9} Btu/day
5. COGENERATION EMISSIONS PORTION = Pp = 990 lb/day, NOx

   NON-COGENERATION EMISSIONS PORTION = Ps = 165 lb/day, NOx
6. NON-COGENERATION EMISSIONS PORTION (165 lb/day, NOx) must be offset by the project proponent according to the rules of the local district.

7. AVERAGE EMISSIONS RATE*
OF IN-BASIN POWER PLANTS

PLANT	CAPACITY (MW)	NOx EMISSION (TONS/YR)	ENERGY PRODUCED (MWH/YEAR)
Contra Costa	1260	11,463	6,679,407
Hunters Point	377	7,735	2,037,702
Pittsburgh	2002	16,400	8,053,915
Potrero	323	1,988	1,066,138
BASIN TOTAL		37,586	17,837,162

Electricity produced by PG&E's IN-STATE POWER PLANTS = 34,238,520 MWH/yr

AVERAGE EMISSION RATE FOR NOx FOR ALL IN-BASIN POWER PLANTS:

$$\frac{(37{,}586 \text{ tons/yr})\ (2000 \text{ lb/ton})}{17{,}837{,}162 \text{ MWH/yr}} = 4.214 \text{ lb/MWH}$$

* Based on PG&E's data for 1979 and 1980

8. BASIN/SYSTEM FRACTION:

$$\frac{17{,}837{,}162 \text{ MWH/year}}{34{,}238{,}520 \text{ MWH/year}} = 0.521$$

9. IN-BASIN DISPLACED UTILITY EMISSIONS:

792 MWH/day (E) x 0.521 x 4.214 lb/MWH (AVERAGE EMISSION RATE)

= 1,739 lb/day

10. Multiply IN-BASIN DISPLACED UTILITY EMISSIONS (lb/day) by the DISTANCE FACTOR.

1,739 lb/day x 1.0 (distance factor for Bay Area) = 1,739 lb/day