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(ii) Calculate the half range of the 95 percent confidence interval (CI) for the predicted PM concentration (\hat{y}) at the mean value of x , using Equation 11-8:

$$CI = t_{df, 1-\alpha/2} \cdot S_L \sqrt{\frac{1}{n}} \quad (\text{Eq. 11-8})$$

$$S_L = \sqrt{\frac{1}{n-2} \sum_{i=1}^n (\hat{y}_i - y_i)^2} \quad (\text{Eq. 11-9})$$

Calculate the confidence interval half range at the mean x value as a percentage of the emission limit (CI%) using Equation 11-10:

$$CI\% = \frac{CI}{EL} \cdot 100\% \quad (\text{Eq. 11-10})$$

Where:

CI = the confidence interval half range at the mean x value, and

EL = PM emission limit, as described in section 13.2.

(iii) Calculate the half range of the tolerance interval at the mean x value (TI) using Equation 11-11:

$$TI = k_t \cdot S_L \quad (\text{Eq. 11-11})$$

Where:

TI = the tolerance interval half range at the mean x value,

k_t = as calculated using Equation 11-12, and

S_L = as calculated using Equation 11-9:

$$k_t = u_{n'} \cdot v_{df} \quad (\text{Eq. 11-12})$$

Where:

n' = the number of test runs (n),

$u_{n'}$ = the tolerance factor for 75 percent provided in Table 1, and

v_{df} = the value from Table 1 for $df = n - 2$.

Calculate the tolerance interval half range at the mean x value as a percentage of the emission limit (TI%) using Equation 11-13:

$$TI\% = \frac{TI}{EL} \cdot 100\% \quad (\text{Eq. 11-13})$$

Where:

TI = the tolerance interval half range at the mean value of x , and

Where:

CI = the half range for the 95 percent confidence interval for the mean x value,

$t_{df, 1-\alpha/2}$ = the value for the t statistic provided in Table 1 for $df = n - 2$, and

S_L = the scatter or deviation of values about the correlation curve, which is determined using Equation 11-9:

EL = PM emission limit, as described in section 13.2.

(iv) Calculate the linear correlation coefficient (r) using Equation 11-14:

$$r = \sqrt{1 - \frac{S_L^2}{S_y^2}} \quad (\text{Eq. 11-14})$$

Where:

S_L = as calculated using Equation 11-9, and

S_y = as calculated using Equation 11-15:

$$S_y = \sqrt{\frac{\sum_{i=1}^n (y_i - \bar{y})^2}{n-1}} \quad (\text{Eq. 11-15})$$

(2) How do I evaluate a polynomial correlation for my correlation test data? To evaluate a polynomial correlation, follow the procedures described in paragraphs (2)(i) through (iv) of this section.

(i) Calculate the polynomial correlation equation, which is indicated by Equation 11-16, using Equations 11-17 through 11-22:

$$\hat{y} = b_0 + b_1x + b_2x^2 \quad (\text{Eq. 11-16})$$

Where:

\hat{y} = the PM CEMS concentration predicted by the polynomial correlation equation, and

b_0, b_1, b_2 = the coefficients determined from the solution to the matrix equation $Ab=B$ where:

$$A = \begin{bmatrix} n & S_1 & S_2 \\ S_1 & S_2 & S_3 \\ S_2 & S_3 & S_4 \end{bmatrix}, \quad b = \begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix}, \quad B = \begin{bmatrix} S_5 \\ S_6 \\ S_7 \end{bmatrix}$$

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$$S_1 = \sum_{i=1}^n (x_i), S_2 = \sum_{i=1}^n (x_i^2), S_3 = \sum_{i=1}^n (x_i^3), S_4 = \sum_{i=1}^n (x_i^4), \quad (\text{Eq. 11-17})$$

$$S_5 = \sum_{i=1}^n (y_i), S_6 = \sum_{i=1}^n (x_i y_i), S_7 = \sum_{i=1}^n (x_i^2 y_i). \quad (\text{Eq. 11-18})$$

Where:

 x_i = the PM CEMS response for run i , y_i = the reference method PM concentration for run i , and n = the number of test runs.Calculate the polynomial correlation curve coefficients (b_0 , b_1 , and b_2) using Equations 11-19 to 11-21, respectively:

$$b_0 = \frac{(S_5 \cdot S_2 \cdot S_4 + S_1 \cdot S_3 \cdot S_7 + S_2 \cdot S_6 \cdot S_3 - S_7 \cdot S_2 \cdot S_2 - S_3 \cdot S_3 \cdot S_5 - S_4 \cdot S_6 \cdot S_1)}{\det A} \quad (\text{Eq. 11-19})$$

$$b_1 = \frac{(n \cdot S_6 \cdot S_4 + S_5 \cdot S_3 \cdot S_2 + S_2 \cdot S_1 \cdot S_7 - S_2 \cdot S_6 \cdot S_2 - S_7 \cdot S_3 \cdot n - S_4 \cdot S_1 \cdot S_5)}{\det A} \quad (\text{Eq. 11-20})$$

$$b_2 = \frac{(n \cdot S_2 \cdot S_7 + S_1 \cdot S_6 \cdot S_2 + S_5 \cdot S_1 \cdot S_3 - S_2 \cdot S_2 \cdot S_5 - S_3 \cdot S_6 \cdot n - S_7 \cdot S_1 \cdot S_1)}{\det A} \quad (\text{Eq. 11-21})$$

Where:

$$\det A = n \cdot S_2 \cdot S_4 - S_2 \cdot S_2 + S_1 \cdot S_3 \cdot S_2 - S_3 \cdot S_3 \cdot n + S_2 \cdot S_1 \cdot S_3 - S_4 \cdot S_1 \cdot S_1 \quad (\text{Eq. 11-22})$$

(ii) Calculate the confidence interval half range (CI) by first calculating the C coefficients (C_0 to C_5) using Equations 11-23 and 11-24:

Where:

$$C_0 = \frac{(S_2 \cdot S_4 - S_3^2)}{D}, C_1 = \frac{(S_3 \cdot S_2 - S_1 \cdot S_4)}{D}, C_2 = \frac{(S_1 \cdot S_3 - S_2^2)}{D}, C_3 = \frac{(nS_4 - S_2^2)}{D}, C_4 = \frac{(S_1 \cdot S_2 - nS_3)}{D}, C_5 = \frac{(nS_2 - S_1^2)}{D} \quad (\text{Eq. 11-23})$$

Where:

$$D = n(S_2 \cdot S_4 - S_3^2) + S_1(S_3 \cdot S_2 - S_1 \cdot S_4) + S_2(S_1 \cdot S_3 - S_2^2) \quad (\text{Eq. 11-24})$$

Calculate Δ using Equation 11-25 for each x value:

$$\Delta = C_0 + 2C_1x + (2C_2 + C_3)x^2 + 2C_4x^3 + C_5x^4 \quad (\text{Eq. 11-25})$$

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Determine the x value that corresponds to the minimum value of Δ (Δ_{min}). Determine the scatter or deviation of values about the polynomial correlation curve (S_p) using Equation 11-26:

$$S_p = \sqrt{\frac{1}{n-3} \sum_{i=1}^n (\hat{y}_i - y_i)^2} \quad (\text{Eq. 11-26})$$

Calculate the half range of the 95 percent confidence interval (CI) at the x value that corresponds to Δ_{min} using Equation 11-27:

$$CI = t_{df} \cdot S_p \cdot \sqrt{D_{min}} \quad (\text{Eq. 11-27})$$

Where:

df = n - 3, and

t_{df} = as listed in Table 1 (see section 17).

Calculate the confidence interval half range at the x value for Δ_{min} as a percentage of the emission limit (CI%) using Equation 11-28:

$$CI\% = \frac{CI}{EL} \cdot 100\% \quad (\text{Eq. 11-28})$$

Where:

CI = the confidence interval half range at the x value that corresponds to Δ_{min}, and

EL = PM emission limit, as described in section 13.2.

(iii) Calculate the tolerance interval half range (TI) at the x value for Δ_{min}, as indicated in Equation 11-29 for the polynomial correlation, using Equations 11-30 and 11-31:

$$TI = k_T \cdot S_p \quad (\text{Eq. 11-29})$$

Where:

$$k_T = u_{n'} \cdot v_{df} \quad (\text{Eq. 11-30})$$

$$n' = \frac{1}{\Delta_{min}} \quad (\text{Eq. 11-31})$$

u_{n'} = the value indicated in Table 1, and

v_{df} = the value indicated in Table 1 for df = n - 3.

If the calculated value for n is less than 2, then n = 2.

Calculate the tolerance interval half range at the x value for Δ_{min} as a percentage of the emission limit (TI%) using Equation 11-32:

$$TI\% = \frac{TI}{EL} \cdot 100\% \quad (\text{Eq. 11-32})$$

Where:

TI = the tolerance interval half range at the x value that corresponds to Δ_{min}, and

EL = PM emission limit, as described in section 13.2.

(iv) Calculate the polynomial correlation coefficient (r) using Equation 11-33:

$$r = \sqrt{1 - \frac{S_p^2}{S_y^2}} \quad (\text{Eq. 11-33})$$

Where:

S_p = as calculated using Equation 11-26, and

S_y = as calculated using Equation 11-15.

(3) How do I evaluate a logarithmic correlation for my correlation test data? To evaluate a logarithmic correlation, which has the form indicated by Equation 11-34, follow the procedures described in paragraphs (3)(i) through (iii) of this section.

$$\hat{y} = b_0 + b_1 \ln(x) \quad (\text{Eq. 11-34})$$

(i) Perform a logarithmic transformation of each PM CEMS response value (x values) using Equation 11-35:

$$x_i' = \ln(x_i) \quad (\text{Eq. 11-35})$$

Where:

x_i' = is the transformed value of x_i, and

Ln(x_i) = the natural logarithm of the PM CEMS response for run i.

(ii) Using the values for x_i' in place of the values for x_i, perform the same procedures used to develop the linear correlation equation described in paragraph (1)(i) of this section. The resulting equation has the form indicated by Equation 11-36:

$$\hat{y} = b_0 + b_1 x' \quad (\text{Eq. 11-36})$$

Where:

x' = the natural logarithm of the PM CEMS response, and the variables b₀ and b₁ are as defined in paragraph (1)(i) of this section.

(iii) Using the values for x_i' in place of the values for x_i, calculate the confidence interval half range at the mean x' value as a percentage of the emission limit (CI%), the tolerance interval half range at the mean x' value as a percentage of the emission limit (TI%), and the correlation coefficient (r) using the procedures described in paragraphs (1)(i) through (iv) of this section.

(4) How do I evaluate an exponential correlation for my correlation test data? To evaluate an exponential correlation, which has the form indicated by Equation 11-37, follow the procedures described in paragraphs (4)(i) through (v) of this section:

$$\hat{y} = b_1 e^{b_0 x} \quad (\text{Eq. 11-37})$$

(i) Perform a logarithmic transformation of each PM concentration measurement (y values) using Equation 11-38:

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$$y_i' = \text{Ln}(y_i) \quad (\text{Eq. 11-38})$$

Where:

y_i' = is the transformed value of y_i , and
 $\text{Ln}(y_i)$ = the natural logarithm of the PM concentration measurement for run i .

(ii) Using the values for y_i in place of the values for y_i' perform the same procedures used to develop the linear correlation equation described in paragraph (1)(i) of this section. The resulting equation will have the form indicated by Equation 11-39.

$$\hat{y}' = b_0 + b_1x \quad (\text{Eq. 11-39})$$

Where:

r = the natural logarithm of the predicted PM concentration values, and the variables b_0 , b_1 , and x are as defined in paragraph (1)(i) of this section.

(iii) Using the values for y_i' in place of the values for y_i , calculate the confidence interval half range (CI), as described in paragraph (1)(ii) of this section. However, for the exponential correlation, you must calculate the value for CI at the median x value, instead of the mean x value for linear correlations. Calculate the confidence interval half range at the median x value as a percentage of the emission limit (CI%) using Equation 11-40:

$$\text{CI}\% = \frac{\text{CI}}{\text{Ln}(\text{EL})} \cdot 100\% \quad (\text{Eq. 11-40})$$

Where:

CI = the confidence interval half range at the median x value, and

$\text{Ln}(\text{EL})$ = the natural logarithm of the PM emission limit, as described in section 13.2.

(iv) Using the values for y_i' in place of the values for y_i , calculate the tolerance interval half range (TI), as described in paragraph (1)(iii) of this section. For the exponential correlation, the value for TI also must be calculated at the median x value. Calculate the tolerance interval half range at the median x value as a percentage of the emission limit (TI%) using Equation 11-41:

$$\text{TI}\% = \frac{\text{TI}}{\text{Ln}(\text{EL})} \cdot 100\% \quad (\text{Eq. 11-41})$$

Where:

TI = the tolerance interval half range at the median x value, and

$\text{Ln}(\text{EL})$ = the natural logarithm of the PM emission limit, as described in section 13.2.

(v) Using the values for y_i' in place of the values for y_i , calculate the correlation coefficient (r) using the procedure described in paragraph (1)(iv) of this section.

(5) How do I evaluate a power correlation for my correlation test data? To evaluate a power correlation, which has the form indi-

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cated by Equation 11-42, follow the procedures described in paragraphs (5)(i) through (v) of this section.

$$\hat{y} = b_1x^{b_0} \quad (\text{Eq. 11-42})$$

(i) Perform logarithmic transformations of each PM CEMS response (x values) and each PM concentration measurement (y values) using Equations 11-35 and 11-38, respectively.

(ii) Using the values for x_i' in place of the values for x_i , and the values for y_i' in place of the values for y_i , perform the same procedures used to develop the linear correlation equation described in paragraph (1)(i) of this section. The resulting equation will have the form indicated by Equation 11-43:

$$\hat{y}' = b_0 + b_1x' \quad (\text{Eq. 11-43})$$

Where:

r = the natural logarithm of the predicted PM concentration values, and

x' = the natural logarithm of the PM CEMS response values, and the variables b_0 and b_1 are as defined in paragraph (1)(i) of this section.

(iii) Using the values for y_i' in place of the values for y_i , calculate the confidence interval half range (CI), as described in paragraph (1)(ii) of this section. You must calculate the value for CI at the median x' value, instead of the mean x value for linear correlations. Calculate the confidence interval half range at the median x' value as a percentage of the emission limit (CI%) using Equation 11-40.

(iv) Using the values for y_i' in place of the values for y_i , calculate the tolerance interval half range (TI), as described in paragraph (1)(iii) of this section. The value for TI also must be calculated at the median x' value. Calculate the tolerance interval half range at the median x' value as a percentage of the emission limit (CI%) using Equation 11-41.

(v) Using the values for y_i' in place of the values for y_i , calculate the correlation coefficient (r) using the procedure described in paragraph (1)(iv) of this section.

12.4 Which correlation model should I use? Follow the procedures described in paragraphs (1) through (4) of this section to determine which correlation model you should use.

(1) For each correlation model that you develop using the procedures described in section 12.3 of this specification, compare the confidence interval half range percentage, tolerance interval half range percentage, and correlation coefficient to the performance criteria specified in section 13.2 of this specification. You can use the linear, logarithmic, exponential, or power correlation model if the model satisfies all of the performance criteria specified in section 13.2 of this specification. However, to use the polynomial

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model you first must check that the polynomial correlation curve satisfies the criteria for minimum and maximum values specified in paragraph (3) of this section.

(2) If you develop more than one correlation curve that satisfy the performance criteria specified in section 13.2 of this specification, you should use the correlation curve with the greatest correlation coefficient. If the polynomial model has the greatest correlation coefficient, you first must check that the polynomial correlation curve satisfies the criteria for minimum and maximum values specified in paragraph (3) of this section.

(3) You can use the polynomial model that you develop using the procedures described in section 12.3(2) if the model satisfies the performance criteria specified in section 13.2 of this specification, and the minimum or

maximum value of the polynomial correlation curve does not occur within the expanded data range. The minimum or maximum value of the polynomial correlation curve is the point where the slope of the curve equals zero. To determine if the minimum or maximum value occurs within the expanded data range, follow the procedure described in paragraphs (3)(i) through (iv) of this section.

(i) Determine if your polynomial correlation curve has a minimum or maximum point by comparing the polynomial coefficient b_2 to zero. If b_2 is less than zero, the curve has a maximum value. If b_2 is greater than zero, the curve has a minimum value. (Note: If b_2 equals zero, the correlation curve is linear.)

(ii) Calculate the minimum value using Equation 11-44.

$$\text{maximum or minimum} = -\frac{b_1}{2b_2} \quad (\text{Eq. 11-44})$$

(iii) If your polynomial correlation curve has a minimum point, you must compare the minimum value to the minimum PM CEMS response used to develop the correlation curve. If the correlation curve minimum value is less than or equal to the minimum PM CEMS response value, you can use the polynomial correlation curve, provided the correlation curve also satisfies all of the performance criteria specified in section 13.2 of this specification. If the correlation curve minimum value is greater than the minimum PM CEMS response value, you cannot use the polynomial correlation curve to predict PM concentrations.

(iv) If your polynomial correlation curve has a maximum, the maximum value must be greater than the allowable extrapolation limit. If your source is not a low-emitting source, as defined in section 3.16 of this specification, the allowable extrapolation limit is 125 percent of the highest PM CEMS response used to develop the correlation curve. If your source is a low-emitting source, the allowable extrapolation limit is 125 percent of the highest PM CEMS response used to develop the correlation curve or the PM CEMS response that corresponds to 50 percent of the emission limit, whichever is greater. If the polynomial correlation curve maximum value is greater than the extrapolation limit, and the correlation curve satisfies all of the performance criteria specified in section 13.2 of this specification, you can use the polynomial correlation curve to predict PM concentrations. If the correlation curve maximum value is less than the extrapolation

limit, you cannot use the polynomial correlation curve to predict PM concentrations.

(4) You may petition the Administrator for alternative solutions or sampling recommendations if the correlation models described in section 12.3 of this specification do not satisfy the performance criteria specified in section 13.2 of this specification.

13.0 What Are the Performance Criteria for My PM CEMS?

You must evaluate your PM CEMS based on the 7-day drift check, the accuracy of the correlation, and the sampling periods and cycle/response time.

13.1 What is the 7-day drift check performance specification? Your daily PM CEMS internal drift checks must demonstrate that the average daily drift of your PM CEMS does not deviate from the value of the reference light, optical filter, Beta attenuation signal, or other technology-suitable reference standard by more than 2 percent of the upscale value. If your CEMS includes diluent and/or auxiliary monitors (for temperature, pressure, and/or moisture) that are employed as a necessary part of this performance specification, you must determine the calibration drift separately for each ancillary monitor in terms of its respective output (see the appropriate performance specification for the diluent CEMS specification). None of the calibration drifts may exceed their individual specification.

13.2 What performance criteria must my PM CEMS correlation satisfy? Your PM CEMS correlation must meet each of the minimum specifications in paragraphs (1),

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(2), and (3) of this section. Before confidence and tolerance interval half range percentage calculations are made, you must convert the emission limit to the appropriate units of your PM CEMS measurement conditions using the average of emissions gas property values (e.g., diluent concentration, temperature, pressure, and moisture) measured during the correlation test.

(1) The correlation coefficient must satisfy the criterion specified in paragraph (1)(i) or (ii), whichever applies.

(i) If your source is not a low-emitting source, as defined in section 3.16 of this specification, the correlation coefficient (r) must be greater than or equal to 0.85.

(ii) If your source is a low-emitting source, as defined in section 3.16 of this specification, the correlation coefficient (r) must be greater than or equal to 0.75.

(2) The confidence interval half range must satisfy the applicable criterion specified in paragraph (2)(i), (ii), or (iii) of this section, based on the type of correlation model.

(i) For linear or logarithmic correlations, the 95 percent confidence interval half range at the mean PM CEMS response value from the correlation test must be within 10 percent of the PM emission limit value specified in the applicable regulation, as calculated using Equation 11-10.

(ii) For polynomial correlations, the 95 percent confidence interval half range at the PM CEMS response value from the correlation test that corresponds to the minimum value for Δ must be within 10 percent of the PM emission limit value specified in the applicable regulation, as calculated using Equation 11-28.

(iii) For exponential or power correlations, the 95 percent confidence interval half range at the median PM CEMS response value from the correlation test must be within 10 percent of the natural logarithm of the PM emission limit value specified in the applicable regulation, as calculated using Equation 11-40.

(3) The tolerance interval half range must satisfy the applicable criterion specified in paragraph (3)(i), (ii), or (iii) of this section, based on the type of correlation model.

(i) For linear or logarithmic correlations, the tolerance interval half range at the mean PM CEMS response value from the correlation test must have 95 percent confidence that 75 percent of all possible values are within 25 percent of the PM emission limit value specified in the applicable regulation, as calculated using Equation 11-13.

(ii) For polynomial correlations, the tolerance interval half range at the PM CEMS response value from the correlation test that corresponds to the minimum value for Δ must have 95 percent confidence that 75 percent of all possible values are within 25 percent of the PM emission limit value specified

in the applicable regulation, as calculated using Equation 11-32.

(iii) For exponential or power correlations, the tolerance interval half range at the median PM CEMS response value from the correlation test must have 95 percent confidence that 75 percent of all possible values are within 25 percent of the natural logarithm of the PM emission limit value specified in the applicable regulation, as calculated using Equation 11-41.

13.3 What are the sampling periods and cycle/response time? You must document and maintain the response time and any changes in the response time following installation.

(1) If you have a batch sampling PM CEMS, you must evaluate the limits presented in paragraphs (1)(i) and (ii) of this section.

(i) The response time of your PM CEMS, which is equivalent to the cycle time, must be no longer than 15 minutes. In addition, the delay between the end of the sampling time and reporting of the sample analysis must be no greater than 3 minutes. You must document any changes in the response time following installation.

(ii) The sampling time of your PM CEMS must be no less than 30 percent of the cycle time. If you have a batch sampling PM CEMS, sampling must be continuous except during pauses when the collected pollutant on the capture media is being analyzed and the next capture medium starts collecting a new sample.

13.4 What PM compliance monitoring must I do? You must report your CEMS measurements in the units of the standard expressed in the regulations (e.g., mg/dscm @ 7 percent oxygen, pounds per million Btu (lb/mmBtu), etc.). You may need to install auxiliary data monitoring equipment to convert the units reported by your PM CEMS into units of the PM emission standard.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Which References Are Relevant to This Performance Specification?

16.1 Technical Guidance Document: Compliance Assurance Monitoring. U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Emission Measurement Center. August 1998.

16.2 40 CFR 60, Appendix B, "Performance Specification 2—Specifications and Test Procedures for SO₂ and NO_x Continuous Emission Monitoring Systems in Stationary Sources."

16.3 40 CFR 60, Appendix B, "Performance Specification 1—Specification and Test Procedures for Opacity Continuous Emission Monitoring Systems in Stationary Sources."

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16.4 40 CFR 60, Appendix A, "Method 1—Sample and Velocity Traverses for Stationary Sources."

16.5 "Current Knowledge of Particulate Matter (PM) Continuous Emission Monitoring." EPA-454/R-00-039. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 2000.

16.6 40 CFR 266, Appendix IX, Section 2, "Performance Specifications for Continuous Emission Monitoring Systems."

16.7 ISO 10155, "Stationary Source Emissions—Automated Monitoring of Mass Con-

centrations of Particles: Performance Characteristics, Test Procedures, and Specifications." American National Standards Institute, New York City. 1995.

17.0 What Reference Tables and Validation Data Are Relevant to PS-11?

Use the information in Table 1 for determining the confidence and tolerance interval half ranges. Use Table 2 to record your 7-day drift test data.

TABLE 1.—FACTORS FOR CALCULATION OF CONFIDENCE AND TOLERANCE INTERVAL HALF RANGES

df or n'	t_{df}	v_{df}	$u_n' (75)$
2	4.303	4.415	1.433
3	3.182	2.920	1.340
4	2.776	2.372	1.295
5	2.571	2.089	1.266
6	2.447	1.915	1.247
7	2.365	1.797	1.233
8	2.306	1.711	1.223
9	2.262	1.645	1.214
10	2.228	1.593	1.208
11	2.201	1.551	1.203
12	2.179	1.515	1.199
13	2.160	1.485	1.195
14	2.145	1.460	1.192
15	2.131	1.437	1.189
16	2.120	1.418	1.187
17	2.110	1.400	1.185
18	2.101	1.385	1.183
19	2.093	1.370	1.181
20	2.086	1.358	1.179
21	2.080	1.346	1.178
22	2.074	1.335	1.177
23	2.069	1.326	1.175
24	2.064	1.317	1.174
25	2.060	1.308	1.173
26	2.056	1.301	1.172
27	2.052	1.294	1.172
28	2.048	1.287	1.171
29	2.045	1.281	1.171
30	2.042	1.274	1.170
31	2.040	1.269	1.169
32	2.037	1.264	1.169
33	2.035	1.258	1.168
34	2.032	1.253	1.168
35	2.030	1.248	1.167
36	2.028	1.244	1.167
37	2.026	1.240	1.166
38	2.025	1.236	1.166
39	2.023	1.232	1.165
40	2.021	1.228	1.165
41	2.020	1.225	1.165
42	2.018	1.222	1.164
43	2.017	1.219	1.164
44	2.015	1.216	1.163
45	2.014	1.213	1.163
46	2.013	1.210	1.163
47	2.012	1.207	1.163
48	2.011	1.205	1.162
49	2.010	1.202	1.162
50	2.009	1.199	1.162
51	2.008	1.197	1.162
52	2.007	1.194	1.162
53	2.006	1.191	1.161
54	2.005	1.189	1.161
55	2.005	1.186	1.161
56	2.004	1.183	1.161
57	2.003	1.181	1.161
58	2.002	1.178	1.160

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TABLE 1.—FACTORS FOR CALCULATION OF CONFIDENCE AND TOLERANCE INTERVAL HALF RANGES—
Continued

df or n'	t_{df}	v_{df}	u_{df} (75)
59	2.001	1.176	1.160
60	2.000	1.173	1.160
61	2.000	1.170	1.160
62	1.999	1.168	1.160
63	1.999	1.165	1.159

TABLE 2.—7-DAY DRIFT TEST DATA

Zero drift day #	Date and time	Zero check value (R _L)	PM CEMS response (R _{CEMS})	Difference (R _{CEMS} - R _L)	Zero drift ((R _{CEMS} - R _L)/R _L) × 100
1					
2					
3					
4					
5					
6					
7					
Upscale drift day #	Date and time	Upscale check value (R _U)	PM CEMS response (R _{CEMS})	Difference (R _{CEMS} - R _U)	Upscale drift ((R _{CEMS} - R _U)/R _U) × 100%
1					
2					
3					
4					
5					
6					
7					

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PERFORMANCE SPECIFICATION 15—PERFORMANCE SPECIFICATION FOR EXTRACTIVE FTIR CONTINUOUS EMISSIONS MONITOR SYSTEMS IN STATIONARY SOURCES

1.0 Scope and Application

1.1 Analytes. This performance specification is applicable for measuring all hazardous air pollutants (HAPs) which absorb in the infrared region and can be quantified using Fourier Transform Infrared Spectroscopy (FTIR), as long as the performance criteria of this performance specification are met. This specification is to be used for evaluating FTIR continuous emission monitoring systems for measuring HAPs regulated under Title III of the 1990 Clean Air Act Amendments. This specification also applies to the use of FTIR CEMs for measuring other volatile organic or inorganic species.

1.2 Applicability. A source which can demonstrate that the extractive FTIR system meets the criteria of this performance specification for each regulated pollutant may use the FTIR system to continuously monitor for the regulated pollutants.

2.0 Summary of Performance Specification

For compound-specific sampling requirements refer to FTIR sampling methods (e.g., reference 1). For data reduction procedures and requirements refer to the EPA FTIR Protocol (reference 2), hereafter referred to as the "FTIR Protocol." This specification describes sampling and analytical procedures for quality assurance. The infrared spectrum of any absorbing compound provides a distinct signature. The infrared spectrum of a mixture contains the superimposed spectra of each mixture component. Thus, an FTIR CEM provides the capability to continuously measure multiple components in a sample using a single analyzer. The number of compounds that can be speciated in a single spectrum depends, in practice, on the specific compounds present and the test conditions.

3.0 Definitions

For a list of definitions related to FTIR spectroscopy refer to Appendix A of the FTIR Protocol. Unless otherwise specified, spectroscopic terms, symbols and equations in this performance specification are taken from the FTIR Protocol or from documents cited in the Protocol. Additional definitions are given below.

3.1 FTIR Continuous Emission Monitoring System (FTIR CEM).

3.1.1 FTIR System. Instrument to measure spectra in the mid-infrared spectral region (500 to 4000 cm^{-1}). It contains an infrared source, interferometer, sample gas containment cell, infrared detector, and computer. The interferometer consists of a beam splitter that divides the beam into two paths, one path a fixed distance and the other a vari-

able distance. The computer is equipped with software to run the interferometer and store the raw digitized signal from the detector (interferogram). The software performs the mathematical conversion (the Fourier transform) of the interferogram into a spectrum showing the frequency dependent sample absorbance. All spectral data can be stored on computer media.

3.1.2 Gas Cell. A gas containment cell that can be evacuated. It contains the sample as the infrared beam passes from the interferometer, through the sample, and to the detector. The gas cell may have multi-pass mirrors depending on the required detection limit(s) for the application.

3.1.3 Sampling System. Equipment used to extract sample from the test location and transport the gas to the FTIR analyzer. Sampling system components include probe, heated line, heated non-reactive pump, gas distribution manifold and valves, flow measurement devices and any sample conditioning systems.

3.2 Reference CEM. An FTIR CEM, with sampling system, that can be used for comparison measurements.

3.3 Infrared Band (also Absorbance Band or Band). Collection of lines arising from rotational transitions superimposed on a vibrational transition. An infrared absorbance band is analyzed to determine the analyte concentration.

3.4 Sample Analysis. Interpreting infrared band shapes, frequencies, and intensities to obtain sample component concentrations. This is usually performed by a software routine using a classical least squares (cls), partial least squares (pls), or K- or P- matrix method.

3.5 (Target) Analyte. A compound whose measurement is required, usually to some established limit of detection and analytical uncertainty.

3.6 Interferant. A compound in the sample matrix whose infrared spectrum overlaps at least part of an analyte spectrum complicating the analyte measurement. The interferant may not prevent the analyte measurement, but could increase the analytical uncertainty in the measured concentration. Reference spectra of interferants are used to distinguish the interferant bands from the analyte bands. An interferant for one analyte may not be an interferant for other analytes.

3.7 Reference Spectrum. Infrared spectra of an analyte, or interferant, prepared under controlled, documented, and reproducible laboratory conditions (see Section 4.6 of the FTIR Protocol). A suitable library of reference spectra can be used to measure target analytes in gas samples.

3.8 Calibration Spectrum. Infrared spectrum of a compound suitable for characterizing the FTIR instrument configuration (Section 4.5 in the FTIR Protocol).

3.9 *One hundred percent line.* A double beam transmittance spectrum obtained by combining two successive background single beam spectra. Ideally, this line is equal to 100 percent transmittance (or zero absorbance) at every point in the spectrum. The zero absorbance line is used to measure the RMS noise of the system.

3.10 *Background Deviation.* Any deviation (from 100 percent) in the one hundred percent line (or from zero absorbance). Deviations greater than ± 5 percent in any analytical region are unacceptable. Such deviations indicate a change in the instrument throughput relative to the single-beam background.

3.11 *Batch Sampling.* A gas cell is alternately filled and evacuated. A Spectrum of each filled cell (one discrete sample) is collected and saved.

3.12 *Continuous Sampling.* Sample is continuously flowing through a gas cell. Spectra of the flowing sample are collected at regular intervals.

3.13 *Continuous Operation.* In continuous operation an FTIR CEM system, without user intervention, samples flue gas, records spectra of samples, saves the spectra to a disk, analyzes the spectra for the target analytes, and prints concentrations of target analytes to a computer file. User intervention is permitted for initial set-up of sampling system, initial calibrations, and periodic maintenance.

3.14 *Sampling Time.* In batch sampling—the time required to fill the cell with flue gas. In continuous sampling—the time required to collect the infrared spectrum of the sample gas.

3.15 *PPM-Meters.* Sample concentration expressed as the concentration-path length product, ppm (molar) concentration multiplied by the path length of the FTIR gas cell. Expressing concentration in these units provides a way to directly compare measurements made using systems with different optical configurations. Another useful expression is (ppm-meters)/K, where K is the absolute temperature of the sample in the gas cell.

3.16 *CEM Measurement Time Constant.* The Time Constant (TC, minutes for one cell volume to flow through the cell) determines the minimum interval for complete removal of an analyte from the FTIR cell. It depends on the sampling rate (R_s in Lpm), the FTIR cell volume (V_{cell} in L) and the chemical and physical properties of an analyte.

$$TC = \frac{V_{cell}}{R_s} \quad \text{Eq. 1}$$

For example, if the sample flow rate (through the FTIR cell) is 5 Lpm and the cell volume is 7 liters, then TC is equal to 1.4 minutes (0.71 cell volumes per minute). This performance specification defines $5 * TC$ as

the minimum interval between independent samples.

3.17 *Independent Measurement.* Two independent measurements are spectra of two independent samples. Two independent samples are separated by, at least 5 cell volumes. The interval between independent measurements depends on the cell volume and the sample flow rate (through the cell). There is no mixing of gas between two independent samples. Alternatively, estimate the analyte residence time empirically: (1) Fill cell to ambient pressure with a (known analyte concentration) gas standard, (2) measure the spectrum of the gas standard, (3) purge the cell with zero gas at the sampling rate and collect a spectrum every minute until the analyte standard is no longer detected spectroscopically. If the measured time corresponds to less than 5 cell volumes, use $5 * TC$ as the minimum interval between independent measurements. If the measured time is greater than $5 * TC$, then use this time as the minimum interval between independent measurements.

3.18 *Test Condition.* A period of sampling where all process, and sampling conditions, and emissions remain constant and during which a single sampling technique and a single analytical program are used. One Run may include results for more than one test condition. Constant emissions means that the composition of the emissions remains approximately stable so that a single analytical program is suitable for analyzing all of the sample spectra. A greater than two-fold change in analyte or interferant concentrations or the appearance of additional compounds in the emissions, may constitute a new test condition and may require modification of the analytical program.

3.19 *Run.* A single Run consists of spectra (one spectrum each) of at least 10 independent samples over a minimum of one hour. The concentration results from the spectra can be averaged together to give a run average for each analyte measured in the test run.

4.0 Interferences

Several compounds, including water, carbon monoxide, and carbon dioxide, are known interferences in the infrared region in which the FTIR instrument operates. Follow the procedures in the FTIR protocol for subtracting or otherwise dealing with these and other interferences.

5.0 Safety

The procedures required under this performance specification may involve hazardous materials, operations, and equipment. This performance specification may not address all of the safety problems associated with these procedures. It is the responsibility of the user to establish appropriate

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safety and health practices and determine the applicable regulatory limitations prior to performing these procedures. The CEMS users manual and materials recommended by this performance specification should be consulted for specific precautions to be taken.

6.0 Equipment and Supplies

6.1 Installation of sampling equipment should follow requirements of FTIR test Methods such as references 1 and 3 and the EPA FTIR Protocol (reference 2). Select test points where the gas stream composition is representative of the process emissions. If comparing to a reference method, the probe tips for the FTIR CEM and the RM should be positioned close together using the same sample port if possible.

6.2 FTIR Specifications. The FTIR CEM must be equipped with reference spectra bracketing the range of path length-concentrations (absorbance intensities) to be measured for each analyte. The effective concentration range of the analyzer can be adjusted by changing the path length of the gas cell or by diluting the sample. The optical configuration of the FTIR system must be such that maximum absorbance of any target analyte is no greater than 1.0 and the minimum absorbance of any target analyte is at least 10 times the RMSD noise in the analytical region. For example, if the measured RMSD in an analytical region is equal to 10^{-3} , then the peak analyte absorbance is required to be at least 0.01. Adequate measurement of all of the target analytes may require changing path lengths during a run, conducting separate runs for different analytes, diluting the sample, or using more than one gas cell.

6.3 Data Storage Requirements. The system must have sufficient capacity to store all data collected in one week of routine sampling. Data must be stored to a write-protected medium, such as write-once-read-many (WORM) optical storage medium or to a password protected remote storage location. A back-up copy of all data can be temporarily saved to the computer hard drive. The following items must be stored during testing.

- At least one sample interferogram per sampling Run or one interferogram per hour, whichever is greater. This assumes that no sampling or analytical conditions have changed during the run.
- All sample absorbance spectra (about 12 per hr, 288 per day).
- All background spectra and interferograms (variable, but about 5 per day).
- All CTS spectra and interferograms (at least 2 each 24 hour period).
- Documentation showing a record of resolution, path length, apodization, sampling time, sampling conditions, and test condi-

tions for all sample, CTS, calibration, and background spectra.

Using a resolution of 0.5 cm^{-1} , with analytical range of 3500 cm^{-1} , assuming about 65 Kbytes per spectrum and 130 Kb per interferogram, the storage requirement is about 164 Mb for one week of continuous sampling. Lower spectral resolution requires less storage capacity. All of the above data must be stored for at least two weeks. After two weeks, storage requirements include: (1) all analytical results (calculated concentrations), (2) at least 1 sample spectrum with corresponding background and sample interferograms for each test condition, (3) CTS and calibration spectra with at least one interferogram for CTS and all interferograms for calibrations, (4) a record of analytical input used to produce results, and (5) all other documentation. These data must be stored according to the requirements of the applicable regulation.

7.0 Reagents and Standards [Reserved]

8.0 Sample Collection, Preservation, Storage, and Transport [Reserved]

9.0 Quality Control

These procedures shall be used for periodic quarterly or semiannual QA/QC checks on the operation of the FTIR CEM. Some procedures test only the analytical program and are not intended as a test of the sampling system.

9.1 Audit Sample. This can serve as a check on both the sampling system and the analytical program.

9.1.1 Sample Requirements. The audit sample can be a mixture or a single component. It must contain target analyte(s) at approximately the expected flue gas concentration(s). If possible, each mixture component concentration should be NIST traceable (± 2 percent accuracy). If a cylinder mixture standard(s) cannot be obtained, then, alternatively, a gas phase standard can be generated from a condensed phase analyte sample. Audit sample contents and concentrations are not revealed to the FTIR CEM operator until after successful completion of procedures in 5.3.2.

9.1.2 Test Procedure. An audit sample is obtained from the Administrator. Spike the audit sample using the analyte spike procedure in Section 11. The audit sample is measured directly by the FTIR system (undiluted) and then spiked into the effluent at a known dilution ratio. Measure a series of spiked and unspiked samples using the same procedures as those used to analyze the stack gas. Analyze the results using Sections 12.1 and 12.2. The measured concentration of each analyte must be within ± 5 percent of the expected concentration (plus the uncertainty), *i.e.*, the calculated correction factor must be within

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0.93 and 1.07 for an audit with an analyte uncertainty of ± 2 percent.

9.2 Audit Spectra. Audit spectra can be used to test the analytical program of the FTIR CEM, but provide no test of the sampling system.

9.2.1 Definition and Requirements. Audit spectra are absorbance spectra that; (1) have been well characterized, and (2) contain absorbance bands of target analyte(s) and potential interferants at intensities equivalent to what is expected in the source effluent. Audit spectra are provided by the administrator without identifying information. Methods of preparing Audit spectra include; (1) mathematically adding sample spectra or adding reference and interferant spectra, (2) obtaining sample spectra of mixtures prepared in the laboratory, or (3) they may be sample spectra collected previously at a similar source. In the last case it must be demonstrated that the analytical results are correct and reproducible. A record associated with each Audit spectrum documents its method of preparation. The documentation must be sufficient to enable an independent analyst to reproduce the Audit spectra.

9.2.2 Test Procedure. Audit spectra concentrations are measured using the FTIR CEM analytical program. Analytical results must be within ± 5 percent of the certified audit concentration for each analyte (plus the uncertainty in the audit concentration). If the condition is not met, demonstrate how the audit spectra are unrepresentative of the sample spectra. If the audit spectra are representative, modify the FTIR CEM analytical program until the test requirement is met. Use the new analytical program in subsequent FTIR CEM analyses of effluent samples.

9.3 Submit Spectra For Independent Analysis. This procedure tests only the analytical program and not the FTIR CEM sampling system. The analyst can submit FTIR CEM spectra for independent analysis by EPA. Requirements for submission include; (1) three representative absorbance spectra (and stored interferograms) for each test period to be reviewed, (2) corresponding CTS spectra, (3) corresponding background spectra and interferograms, (4) spectra of associated spiked samples if applicable, and (5) analytical results for these sample spectra. The analyst will also submit documentation of process times and conditions, sampling conditions associated with each spectrum, file names and sampling times, method of analysis and reference spectra used, optical configuration of FTIR CEM including cell path length and temperature, spectral resolution and apodization used for every spectrum. Independent analysis can also be performed on site in conjunction with the FTIR CEM sampling and analysis. Sample spectra are stored on the independent analytical system as they are collected by the FTIR CEM sys-

tem. The FTIR CEM and the independent analyses are then performed separately. The two analyses will agree to within ± 120 percent for each analyte using the procedure in Section 12.3. This assumes both analytical routines have properly accounted for differences in optical path length, resolution, and temperature between the sample spectra and the reference spectra.

10.0 Calibration and Standardization

10.1 Calibration Transfer Standards. For CTS requirements see Section 4.5 of the FTIR Protocol. A well characterized absorbance band in the CTS gas is used to measure the path length and line resolution of the instrument. The CTS measurements made at the beginning of every 24 hour period must agree to within ± 5 percent after correction for differences in pressure.

Verify that the frequency response of the instrument and CTS absorbance intensity are correct by comparing to other CTS spectra or by referring to the literature.

10.2 Analyte Calibration. If EPA library reference spectra are not available, use calibration standards to prepare reference spectra according to Section 6 of the FTIR Protocol. A suitable set of analyte reference data includes spectra of at least 2 independent samples at each of at least 2 different concentrations. The concentrations bracket a range that includes the expected analyte absorbance intensities. The linear fit of the reference analyte band areas must have a fractional calibration uncertainty (FCU in Appendix F of the FTIR Protocol) of no greater than 10 percent. For requirements of analyte standards refer to Section 4.6 of the FTIR Protocol.

10.3 System Calibration. The calibration standard is introduced at a point on the sampling probe. The sampling system is purged with the calibration standard to verify that the absorbance measured in this way is equal to the absorbance in the analyte calibration. Note that the system calibration gives no indication of the ability of the sampling system to transport the target analyte(s) under the test conditions.

10.4 Analyte Spike. The target analyte(s) is spiked at the outlet of the sampling probe, upstream of the particulate filter, and combined with effluent at a ratio of about 1 part spike to 9 parts effluent. The measured absorbance of the spike is compared to the expected absorbance of the spike plus the analyte concentration already in the effluent. This measures sampling system bias, if any, as distinguished from analyzer bias. It is important that spiked sample pass through all of the sampling system components before analysis.

10.5 Signal-to-Noise Ratio (S/N). The measure of S/N in this performance specification is the root-mean-square (RMS) noise level as given in Appendix C of the FTIR

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Protocol. The RMS noise level of a contiguous segment of a spectrum is defined as the RMS difference (RMSD) between the n contiguous absorbance values (A_i) which form the segment and the mean value (A_m) of that segment.

$$\text{RMSD} = \sqrt{\left(\frac{1}{n}\right) \sum_{i=1}^n (A_i - A_m)^2} \quad \text{Eq. 2}$$

A decrease in the S/N may indicate a loss in optical throughput, or detector or interferometer malfunction.

10.6 Background Deviation. The 100 percent baseline must be between 95 and 105 percent transmittance (absorbance of 0.02 to -0.02) in every analytical region. When background deviation exceeds this range, a new background spectrum must be collected using nitrogen or other zero gas.

10.7 Detector Linearity. Measure the background and CTS at three instrument aperture settings; one at the aperture setting to be used in the testing, and one each at settings one half and twice the test aperture setting. Compare the three CTS spectra. CTS band areas should agree to within the uncertainty of the cylinder standard. If test aperture is the maximum aperture, collect CTS spectrum at maximum aperture, then close the aperture to reduce the IR throughput by half. Collect a second background and CTS at the smaller aperture setting and compare the spectra as above. Instead of changing the aperture neutral density filters can be used to attenuate the infrared beam. Set up the FTIR system as it will be used in the test measurements. Collect a CTS spectrum. Use a neutral density filter to attenuate the infrared beam (either immediately after the source or the interferometer) to approximately $\frac{1}{2}$ its original intensity. Collect a second CTS spectrum. Use another filter to attenuate the infrared beam to approximately $\frac{1}{4}$ its original intensity. Collect a third background and CTS spectrum. Compare the CTS spectra as above. Another check on linearity is to observe the single beam background in frequency regions where the optical configuration is known to have a zero response. Verify that the detector response is "flat" and equal to zero in these regions. If detector response is not linear, decrease aperture, or attenuate the infrared beam. Repeat the linearity check until system passes the requirement.

11.0 Analytical Procedure

11.1 Initial Certification. First, perform the evaluation procedures in Section 6.0 of the FTIR Protocol. The performance of an FTIR CEM can be certified upon installation using EPA Method 301 type validation (40 CFR, Part 63, Appendix A), or by comparison to a reference Method if one exists for the

target analyte(s). Details of each procedure are given below. Validation testing is used for initial certification upon installation of a new system. Subsequent performance checks can be performed with more limited analyte spiking. Performance of the analytical program is checked initially, and periodically as required by EPA, by analyzing audit spectra or audit gases.

11.1.1 Validation. Use EPA Method 301 type sampling (reference 4, Section 5.3 of Method 301) to validate the FTIR CEM for measuring the target analytes. The analyte spike procedure is as follows: (1) a known concentration of analyte is mixed with a known concentration of a non-reactive tracer gas, (2) the undiluted spike gas is sent directly to the FTIR cell and a spectrum of this sample is collected, (3) pre-heat the spiked gas to at least the sample line temperature, (4) introduce spike gas at the back of the sample probe upstream of the particulate filter, (5) spiked effluent is carried through all sampling components downstream of the probe, (6) spike at a ratio of roughly 1 part spike to 9 parts flue gas (or more dilute), (7) the spike-to-flue gas ratio is estimated by comparing the spike flow to the total sample flow, and (8) the spike ratio is verified by comparing the tracer concentration in spiked flue gas to the tracer concentration in undiluted spike gas. The analyte flue gas concentration is unimportant as long as the spiked component can be measured and the sample matrix (including interferences) is similar to its composition under test conditions. Validation can be performed using a single FTIR CEM analyzing sample spectra collected sequentially. Since flue gas analyte (unspiked) concentrations can vary, it is recommended that two separate sampling lines (and pumps) are used; one line to carry unspiked flue gas and the other line to carry spiked flue gas. Even with two sampling lines the variation in unspiked concentration may be fast compared to the interval between consecutive measurements. Alternatively, two FTIR CEMs can be operated side-by-side, one measuring spiked sample, the other unspiked sample. In this arrangement spiked and unspiked measurements can be synchronized to minimize the affect of temporal variation in the unspiked analyte concentration. In either sampling arrangement, the interval between measured concentrations used in the statistical analysis should be, at least, 5 cell volumes (5 * TC in equation 1). A validation run consists of, at least, 24 independent analytical results, 12 spiked and 12 unspiked samples. See Section 3.17 for definition of an "independent" analytical result. The results are analyzed using Sections 12.1 and 12.2 to determine if the measurements passed the validation requirements. Several analytes can be spiked and measured in the same sampling run, but a separate statistical analysis is

performed for each analyte. In lieu of 24 independent measurements, averaged results can be used in the statistical analysis. In this procedure, a series of consecutive spiked measurements are combined over a sampling period to give a single average result. The related unspiked measurements are averaged in the same way. The minimum 12 spiked and 12 unspiked result averages are obtained by averaging measurements over subsequent sampling periods of equal duration. The averaged results are grouped together and statistically analyzed using Section 12.2.

11.1.1.1 Validation with a Single Analyzer and Sampling Line. If one sampling line is used, connect the sampling system components and purge the entire sampling system and cell with at least 10 cell volumes of sample gas. Begin sampling by collecting spectra of 2 independent unspiked samples. Introduce the spike gas into the back of the probe, upstream of the particulate filter. Allow 10 cell volumes of spiked flue gas to purge the cell and sampling system. Collect spectra of 2 independent spiked samples. Turn off the spike flow and allow 10 cell volumes of unspiked flue gas to purge the FTIR cell and sampling system. Repeat this procedure 6 times until the 24 samples are collected. Spiked and unspiked samples can also be measured in groups of 4 instead of in pairs. Analyze the results using Sections 12.1 and 12.2. If the statistical analysis passes the validation criteria, then the validation is completed. If the results do not pass the validation, the cause may be that temporal variations in the analyte sample gas concentration are fast relative to the interval between measurements. The difficulty may be avoided by: (1) Averaging the measurements over long sampling periods and using the averaged results in the statistical analysis, (2) modifying the sampling system to reduce TC by, for example, using a smaller volume cell or increasing the sample flow rate, (3) using two sample lines (4) use two analyzers to perform synchronized measurements. This performance specification permits modifications in the sampling system to minimize TC if the other requirements of the validation sampling procedure are met.

11.1.1.2 Validation With a Single Analyzer and Two Sampling Lines. An alternative sampling procedure uses two separate sample lines, one carrying spiked flue gas, the other carrying unspiked gas. A valve in the gas distribution manifold allows the operator to choose either sample. A short heated line connects the FTIR cell to the 3-way valve in the manifold. Both sampling lines are continuously purged. Each sample line has a rotameter and a bypass vent line after the rotameter, immediately upstream of the valve, so that the spike and unspiked sample flows can each be continuously monitored. Begin sampling by collecting spectra of 2 independent unspiked samples. Turn the sam-

pling valve to close off the unspiked gas flow and allow the spiked flue gas to enter the FTIR cell. Isolate and evacuate the cell and fill with the spiked sample to ambient pressure. (While the evacuated cell is filling, prevent air leaks into the cell by making sure that the spike sample rotameter always indicates that a portion of the flow is directed out the by-pass vent.) Open the cell outlet valve to allow spiked sample to continuously flow through the cell. Measure spectra of 2 independent spiked samples. Repeat this procedure until at least 24 samples are collected.

11.1.1.3 Synchronized Measurements With Two Analyzers. Use two FTIR analyzers, each with its own cell, to perform synchronized spiked and unspiked measurements. If possible, use a similar optical configuration for both systems. The optical configurations are compared by measuring the same CTS gas with both analyzers. Each FTIR system uses its own sampling system including a separate sampling probe and sampling line. A common gas distribution manifold can be used if the samples are never mixed. One sampling system and analyzer measures spiked effluent. The other sampling system and analyzer measures unspiked flue gas. The two systems are synchronized so that each measures spectra at approximately the same times. The sample flow rates are also synchronized so that both sampling rates are approximately the same ($TC_1 \sim TC_2$ in equation 1). Start both systems at the same time. Collect spectra of at least 12 independent samples with each (spiked and unspiked) system to obtain the minimum 24 measurements. Analyze the analytical results using Sections 12.1 and 12.2. Run averages can be used in the statistical analysis instead of individual measurements.

11.1.1.4 Compare to a Reference Method (RM). Obtain EPA approval that the method qualifies as an RM for the analyte(s) and the source to be tested. Follow the published procedures for the RM in preparing and setting up equipment and sampling system, performing measurements, and reporting results. Since FTIR CEMS have multicomponent capability, it is possible to perform more than one RM simultaneously, one for each target analyte. Conduct at least 9 runs where the FTIR CEM and the RM are sampling simultaneously. Each Run is at least 30 minutes long and consists of spectra of at least 5 independent FTIR CEM samples and the corresponding RM measurements. If more than 9 runs are conducted, the analyst may eliminate up to 3 runs from the analysis if at least 9 runs are used.

11.1.1.4.1 RMs Using Integrated Sampling. Perform the RM and FTIR CEM sampling simultaneously. The FTIR CEM can measure spectra as frequently as the analyst chooses

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(and should obtain measurements as frequently as possible) provided that the measurements include spectra of at least 5 independent measurements every 30 minutes. Concentration results from all of the FTIR CEM spectra within a run may be averaged for use in the statistical comparison even if all of the measurements are not independent. When averaging the FTIR CEM concentrations within a run, it is permitted to exclude some measurements from the average provided the minimum of 5 independent measurements every 30 minutes are included: The Run average of the FTIR CEM measurements depends on both the sample flow rate and the measurement frequency (MF). The run average of the RM using the integrated sampling method depends primarily on its sampling rate. If the target analyte concentration fluctuates significantly, the contribution to the run average of a large fluctuation depends on the sampling rate and measurement frequency, and on the duration and magnitude of the fluctuation. It is, therefore, important to carefully select the sampling rate for both the FTIR CEM and the RM and the measurement frequency for the FTIR CEM. The minimum of 9 run averages can be compared according to the relative accuracy test procedure in Performance Specification 2 for SO₂ and NO_x CEMs (40 CFR, Part 60, App. B).

11.1.1.4.2 RMs Using a Grab Sampling Technique. Synchronize the RM and FTIR CEM measurements as closely as possible. For a grab sampling RM record the volume collected and the exact sampling period for each sample. Synchronize the FTIR CEM so that the FTIR measures a spectrum of a similar cell volume at the same time as the RM grab sample was collected. Measure at least 5 independent samples with both the FTIR CEM and the RM for each of the minimum 9 Runs. Compare the Run concentration averages by using the relative accuracy analysis procedure in 40 CFR, Part 60, App. B.

11.1.1.4.3 Continuous Emission Monitors (CEMs) as RMs. If the RM is a CEM, synchronize the sampling flow rates of the RM and the FTIR CEM. Each run is at least 1-hour long and consists of at least 10 FTIR CEM measurements and the corresponding 10 RM measurements (or averages). For the sta-

$$CF = \frac{1}{1 + \frac{B}{CS}} \quad \text{Eq. 6}$$

12.2 Statistical Analysis of Validation Measurements. Arrange the independent measurements (or measurement averages) as in Table 1. More than 12 pairs of measure-

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tistical comparison use the relative accuracy analysis procedure in 40 CFR, Part 60, App. B. If the RM time constant is <½ the FTIR CEM time constant, brief fluctuations in analyte concentrations which are not adequately measured with the slower FTIR CEM time constant can be excluded from the run average along with the corresponding RM measurements. However, the FTIR CEM run average must still include at least 10 measurements over a 1-hr period.

12.0 Calculations and Data Analysis

12.1 Spike Dilution Ratio, Expected Concentration. The Method 301 bias is calculated as follows.

$$B = S_m - M_m - CS \quad \text{Eq. 3}$$

Where:

B=Bias at the spike level

S_m=Mean of the observed spiked sample concentrations

M_m=Mean of the observed unspiked sample concentrations

CS=Expected value of the spiked concentration.

The CS is determined by comparing the SF₆ tracer concentration in undiluted spike gas to the SF₆ tracer concentrations in the spiked samples;

$$DF = \frac{[SF_6]_{\text{direct}}}{[SF_6]_{\text{spiked}}} \quad \text{Eq. 4}$$

The expected concentration (CS) is the measured concentration of the analyte in undiluted spike gas divided by the dilution factor

$$CS = \frac{[anal]_{\text{dir}}}{DF} \quad \text{Eq. 5}$$

Where:

[anal]_{dir}=The analyte concentration in undiluted spike gas measured directly by filling the FTIR cell with the spike gas.

If the bias is statistically significant (Section 12.2), Method 301 requires that a correction factor, CF, be multiplied by the analytical results, and that 0.7 ≤ CF ≤ 1.3.

ments can be analyzed. The statistical analysis follows EPA Method 301, Section 6.3. Section 12.1 of this performance specification shows the calculations for the bias, expected

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spike concentration, and correction factor. This Section shows the determination of the statistical significance of the bias. Determine the statistical significance of the bias at the 95 percent confidence level by calculating the t-value for the set of measure-

ments. First, calculate the differences, d_i , for each pair of spiked and each pair of unspiked measurements. Then calculate the standard deviation of the spiked pairs of measurements.

$$SD_s = \sqrt{\frac{\sum d_i^2}{2n}} \quad \text{Eq. 7}$$

Where:

d_i =The differences between pairs of spiked measurements.

SD_s =The standard deviation in the d_i values.

n =The number of spiked pairs, $2n=12$ for the minimum of 12 spiked and 12 unspiked measurements.

Calculate the relative standard deviation, RSD, using SD_s and the mean of the spiked concentrations, S_m . The RSD must be $\leq 50\%$.

$$RSD = \left(\frac{SD_s}{S_m} \right) \quad \text{Eq. 8}$$

Repeat the calculations in equations 7 and 8 to determine SD_u and RSD, respectively, for the unspiked samples. Calculate the stand-

ard deviation of the mean using SD_s and SD_u from equation 7.

$$SD = \sqrt{SD_s^2 + SD_u^2} \quad \text{Eq. 9}$$

The t-statistic is calculated as follows to test the bias for statistical significance;

$$t = \frac{|B|}{SDM} \quad \text{Eq. 10}$$

where the bias, B, and the correction factor, CF, are given in Section 12.1. For 11 degrees of freedom, and a one-tailed distribution, Method 301 requires that $t \leq 2.201$. If the t-statistic indicates the bias is statistically significant, then analytical measurements must be multiplied by the correction factor. There is no limitation on the number of measurements, but there must be at least 12 independent spiked and 12 independent unspiked measurements. Refer to the t-distribution (Table 2) at the 95 percent confidence level and appropriate degrees of freedom for the critical t-value.

16.0 References

1. Method 318, 40 CFR, Part 63, Appendix A (Draft), "Measurement of Gaseous Formaldehyde, Phenol and Methanol Emissions by FTIR Spectroscopy," EPA Contract No. 68D20163, Work Assignment 2-18, February, 1995.
2. "EPA Protocol for the Use of Extractive Fourier Transform Infrared (FTIR) Spectrometry in Analyses of Gaseous Emissions from Stationary Industrial Sources," February, 1995.
3. "Measurement of Gaseous Organic and Inorganic Emissions by Extractive FTIR

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VTA

Pt. 60, App. C

40 CFR Ch. I (7-1-04 Edition)

Spectroscopy," EPA Contract No. 68-D2-0165, Work Assignment 3-08.

17.0 Tables, Diagrams, Flowcharts, and Validation Data

4. "Method 301—Field Validation of Pollutant Measurement Methods from Various Waste Media," 40 CFR 63, App A.

TABLE 1—ARRANGEMENT OF VALIDATION MEASUREMENTS FOR STATISTICAL ANALYSIS

Measurement (or average)	Time	Spiked (ppm)	d, spiked	Unspiked (ppm)	d, unspiked
1		S ₁	S ₂ - S ₁	U ₁	U ₂ - U ₁
2		S ₂		U ₂	
3		S ₃	S ₄ - S ₃	U ₃	U ₄ - U ₃
4		S ₄		U ₄	
5		S ₅	S ₆ - S ₅	U ₅	U ₆ - U ₅
6		S ₆		U ₆	
7		S ₇	S ₈ - S ₇	U ₇	U ₈ - U ₇
8		S ₈		U ₈	
9		S ₉	S ₁₀ - S ₉	U ₉	U ₁₀ - U ₉
10		S ₁₀		U ₁₀	
11		S ₁₁	S ₁₂ - S ₁₁	U ₁₁	U ₁₂ - U ₁₁
12		S ₁₂		U ₁₂	
Average ->		S _m		M _m	

TABLE 2—T=VALUES

n - 1 ^a	t-value	n - 1 ^a	t-value	n - 1 ^a	t-value	n - 1 ^a	t-value
11	2.201	17	2.110	23	2.069	29	2.045
12	2.179	18	2.101	24	2.064	30	2.042
13	2.160	19	2.093	25	2.060	40	2.021
14	2.145	20	2.086	26	2.056	60	2.000
15	2.131	21	2.080	27	2.052	120	1.980
16	2.120	22	2.074	28	2.048	8	1.960

^an is the number of independent pairs of measurements (a pair consists of one spiked and its corresponding unspiked measurement). Either discreet (independent) measurements in a single run, or run averages can be used.

[48 FR 13327, Mar. 30, 1983 and 48 FR 23611, May 25, 1983, as amended at 48 FR 32986, July 20, 1983; 51 FR 31701, Aug. 5, 1985; 52 FR 17556, May 11, 1987; 52 FR 30675, Aug. 18, 1987; 52 FR 34650, Sept. 14, 1987; 53 FR 7515, Mar. 9, 1988; 53 FR 41335, Oct. 21, 1988; 55 FR 18876, May 7, 1990; 55 FR 40178, Oct. 2, 1990; 55 FR 47474, Nov. 14, 1990; 56 FR 5526, Feb. 11, 1991; 59 FR 64593, Dec. 15, 1994; 64 FR 53032, Sept. 30, 1999; 65 FR 62130, 62144, Oct. 17, 2000; 65 FR 48920, Aug. 10, 2000; 69 FR 1802, Jan. 12, 2004]

APPENDIX C TO PART 60—DETERMINATION OF EMISSION RATE CHANGE

1. Introduction.

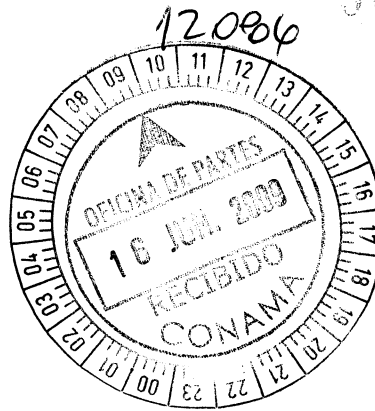
1.1 The following method shall be used to determine whether a physical or operational change to an existing facility resulted in an increase in the emission rate to the atmosphere. The method used is the Student's *t* test, commonly used to make inferences from small samples.

2. Data.

2.1 Each emission test shall consist of *n* runs (usually three) which produce *n* emission rates. Thus two sets of emission rates are generated, one before and one after the change, the two sets being of equal size.

2.2 When using manual emission tests, except as provided in §60.8(b) of this part, the reference methods of appendix A to this part shall be used in accordance with the procedures specified in the applicable subpart both before and after the change to obtain the data.

Nacimiento, junio 15 de 2009
GO-020/2009



Sr.
Hans Willumsen A.
Jefe Departamento Control de la Contaminación
Comisión Nacional de Medio Ambiente
Teatinos 258- Piso 5
Santiago

Ref.: Proceso de revisión del DS 167/99

Estimado Sr. Willumsen,

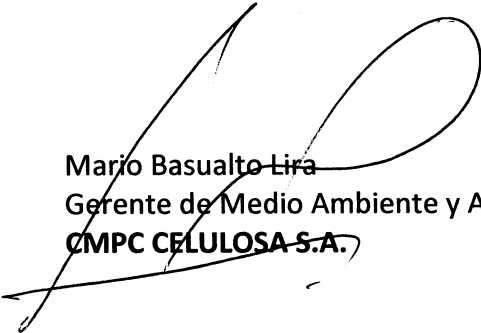
La presente tiene por finalidad dar cumplimiento a los compromisos que asumimos con ocasión de la reunión que sostuvimos con usted el pasado 6 de mayo en relación con el proceso de revisión del DS 167/99.

Al respecto, le informamos:

1. El pasado 2 de Junio nos reunimos con don Andrés López A., Gerente General de la empresa DSS, que asesora a Conama en esta gestión regulatoria con la finalidad de clarificar el contenido de las Fichas que se nos hicieran llegar para completar o corregir los datos de nuestras plantas Laja, Pacífico y Santa Fe.
2. El pasado 10 de Junio invitamos a la Srta. Caimanque para que recorriera nuestras 3 plantas junto con el Sr. López con la finalidad de fortalecer su conocimiento de nuestra industria sector y, al mismo tiempo, resolver en terreno las interrogantes técnicas. En dicha ocasión se hizo entrega de versiones avanzadas de las Fichas antes aludidas.
3. Con esta fecha, dentro del plazo comprometido, le hacemos llegar las Fichas, en su versión definitiva. Junto a ellas adjuntamos las presentaciones que, con ocasión de la visita de la Srta. Caimanque le fueron ofrecidas en las plantas Laja, Pacífico y Santa Fe.

Cualquier duda que surja con relación a la documentación adjunta como asimismo en relación con otras materias asociadas a la gestión de revisión del DS 167/99, le solicitamos disponer se contacte directamente a Pedro Navarrete, celular 98370564, oficina 043-403930, email pnavarrete@celulosa.cmpc.cl.

Sin otro particular, le saluda atentamente,



Mario Basualto Lira
Gerente de Medio Ambiente y Asuntos Públicos
CMPC CELULOSA S.A.

INCL: Lo indicado



CMPC Celulosa S.A. Planta Laja

Tabla Nº 1: Caracterización de las fuentes emisoras

Nombre de Planta	CMPC Celulosa S.A., Planta Laja
Año que entra en operación	Línea 1, 1959 y línea 2, 1965
Ubicación	VIII Región; Comuna de Laja; Balmaceda 30, Laja.
Localidades más cercanas	Laja, San Rosendo y Los Ángeles
Producto	Celulosa fibra larga Blanqueada, no blanqueada y papeles.
Producción	360.000 ton/año
Tecnología	ECF

Tabla Nº2: Caracterización de las fuentes emisoras de Planta Laja.

Fuentes de emisión	CR 4	CR 5	H. Cal 1 y 2	Estanque Disolvedor 4	Estanque Disolvedor 5
Monitoreo	Si	Si	Si	Si	Si
Tipo de monitoreo.	Discreto	Continuo	Discreto	Discreto	Discreto
Método de monitoreo	Epa 16-A	Epa 16-B	Epa 16-A	Epa 16-A	Epa 16-A
Validado método de monitoreo (Por algún laboratorio o que lo reconozca la norma)	1. Equipo de Medición Discreta, según EPA 16-A (referencia de norma). 2. Empresa Proterm (*)	1. Luz UV pulsante, Método USEPA designado: EQSA-0486-060. 2. Lab. Serpram (*)	1. Equipo de Medición Discreta, según EPA 16-A (referencia de norma) 2. Empresa Proterm (*)	1. Equipo de Medición Discreta, según EPA 16-A (referencia de norma) 2. Empresa Proterm (*)	1. Equipo de Medición Discreta, según EPA 16-A (referencia de norma). 2. Empresa Proterm (*)
Cumple DS Nº 167/99 art 3º	Si (**)	Si	Si	Si	Si
Equipos de mitigación	Sistema CNCG (2006) e incinerador (2006)				
Otras fuentes fijas	No				
Fuente fugitivas	Venteos de Estanques de filtrados en área de lavado y de Licor Negro, Blanco y Verde.				

(*): Los Laboratorios Proterm y Serpram que validaron el CEM para asegurar el cumplimiento normativo son Laboratorios acreditados ante la Seremi de Salud.

(**): Equipo anterior a 1975. Norma establece gradualidad hasta el año 2012.

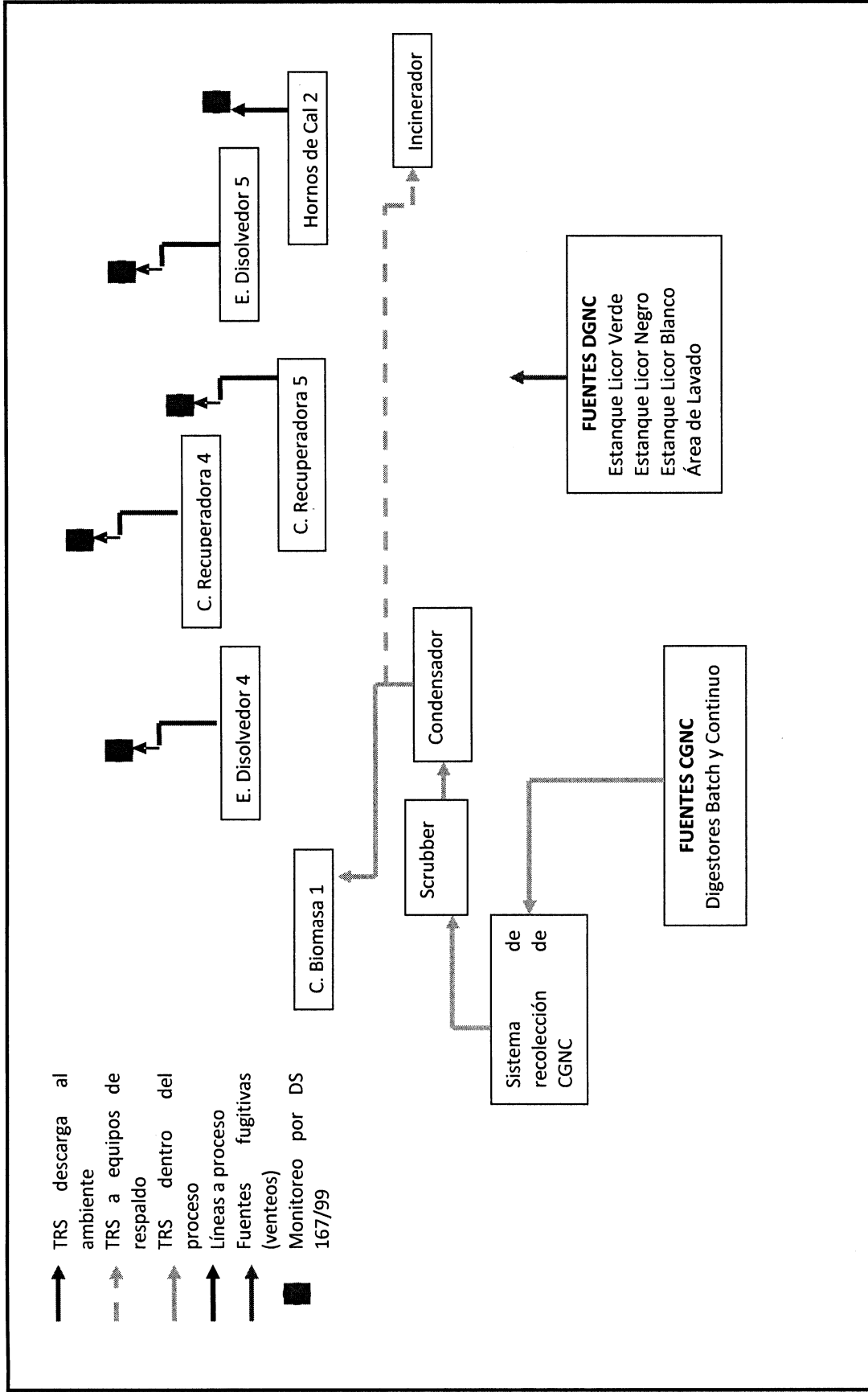


Figura 1: Esquema de las emisiones de TRS en Planta Laja.

Observaciones del diagrama de flujo

El incinerador no es fuente emisora ya que la dinámica de su operación (puntual) no sigue la del proceso (continua)

Las Calderas de Poder 1 y 2 tampoco son fuentes de TRS.

La C1 es el equipo de incineración de los gases CNCG y opera con Biomasa.

La C2 opera con Biomasa.

CMPC Celulosa S.A. - Planta Pacífico

Tabla N°1: Caracterización Planta

Nombre de Planta	CMPC Celulosa S.A - Planta Pacifico
Año que entra en operación	1992
Ubicación	IX Región, Comuna de Collipulli, Localidad de Mininco, Av. Alessandri 001.
Localidades más cercanas	Mininco, Angol, Mulchén, Renaico, Collipulli
Producto	Celulosa Blanqueada de Fibra Larga.
Producción	520.000 ton/año
Tecnología	ECF

Tabla N°2: Caracterización de las fuentes emisoras de Planta Pacífico

Fuentes de emisión	Caldera Recuperadora	Horno de Cal	Estanque Disolvedor
Monitoreo	Si	Si	Si
Tipo de monitoreo.	Continuo	Continuo	Discreto
Método de monitoreo	Luz UV pulsante, Método USEPA designado: EQSA-0486-060	Luz UV pulsante, Método USEPA designado: EQSA-0486-060	Método EPA 16 A
Validado método de monitoreo (Por algún laboratorio o que lo reconozca la norma)	Equipo de Medición Discreta, según EPA 16B, aprobado por Resolución N° 721 de 31 de agosto de 2004 del Servicio de Salud Araucanía	Equipo de Medición Discreta, según EPA 16B, aprobado por Resolución N° 721 de 31 de agosto de 2004 del Servicio de Salud Araucanía	Aprobado por Resolución N° 721 de 31 de agosto de 2004 del Servicio de Salud Araucanía
Cumple DS N° 167/99 art 3º	Si	Si	Si
Equipos de mitigación	Quemado de CGNC en Horno de Cal, con Incinerador de respaldo.		
Otras fuentes fijas	No hay.		
Fuente fugitivas	Estanques y equipos de áreas de Pulpa, Evaporadores y Caustificación.		

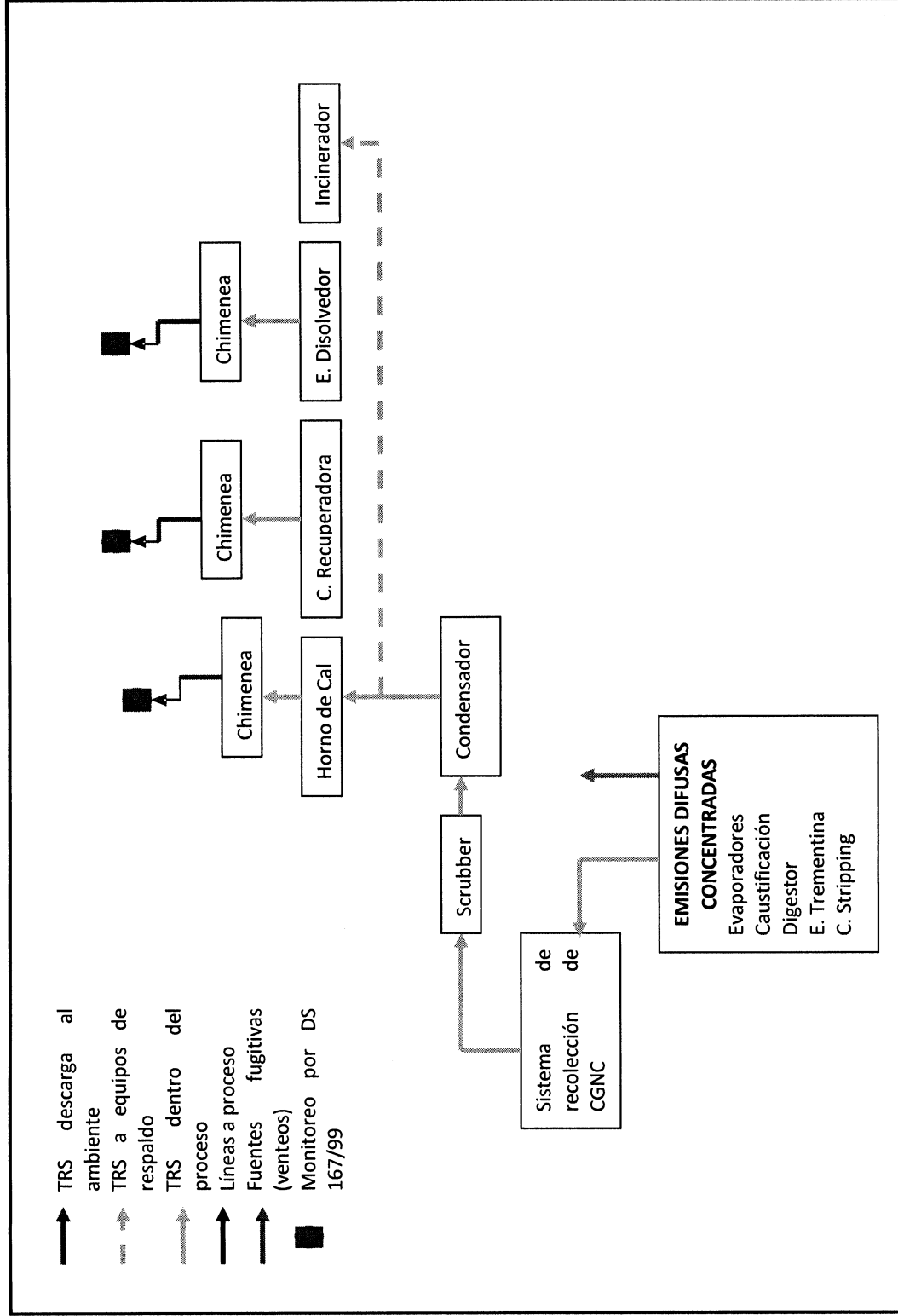


Figura 1: Esquema de emisiones de TRS en Planta Pacifico

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Revisión DS 167
Información a CONAMA
10/6/09

000442

Observaciones del diagrama de flujo

- No se incluyen equipos que no corresponden a fuentes fijas de emisión de TRS
- Se agrega flecha en área Fibras, representando sus fuentes difusas
- Se elimina venteo Tk Trementina.
- Se elimina venteo desde Incinerador de respaldo.

CMPC Celulosa S.A. - Planta Celulosa Santa Fe Línea 1

Tabla N°1: Caracterización Planta

Nombre	CMPC Celulosa S.A. - Planta Santa Fe Línea 1
Año que entra en operación	1991
Ubicación	VIII Región, Nacimiento, Av. Julio Hemmelmann N° 670
Localidades más cercanas	Nacimiento y Los Ángeles
Producto	Celulosa Blanqueada de fibra corta en base a eucalipto.
Producción	370.000 ton/año
Tecnología	ECF

Tabla N°2: Caracterización de las fuentes emisoras (DS 167/99)

Fuentes de emisión TRS	Caldera Recuperadora N°1	Horno de Cal	Estanque Disolvedor
Monitoreo	Si	Si	Si
Tipo de monitoreo.	Continuo	Continuo	Discreto
Método de monitoreo	Luz UV pulsante, Método USEPA designado: EQSA-0486-060 CEMS	Luz UV pulsante, Método USEPA designado: EQSA-0486-060 CEMS	EPA 16 B
Validado método de monitoreo (Por algún laboratorio o que lo reconozca la norma)	Equipo de Medición Discreta, según EPA 16A, mencionado como método de referencia en el DS 167/99	Equipo de Medición Discreta, según EPA 16A, mencionado como método de referencia en el DS 167/99	1. Equipo de Medición Discreta, según EPA 16 A (método de referencia en el DS 167/99) 2.Laboratorio Planta Santa Fe
Cumple DS N° 167/99 art 3º	Si	Si	Si
Equipos de mitigación	No ¹	Scrubber	Scrubber
Otras fuentes fijas	No hay		
Fuente fugitivas	Estanques área Caustificación L1 ²		

¹ La combustión de los gases en la Caldera Recuperadora posibilita el cumplimiento normativo.

² Según la definición entregada en el Manual de aplicación de la Norma (D.S. 167), este tipo de emisión, corresponde a las del tipo continuas misceláneas, emisiones que se liberan a la atmósfera a baja altura, temperatura y velocidad.

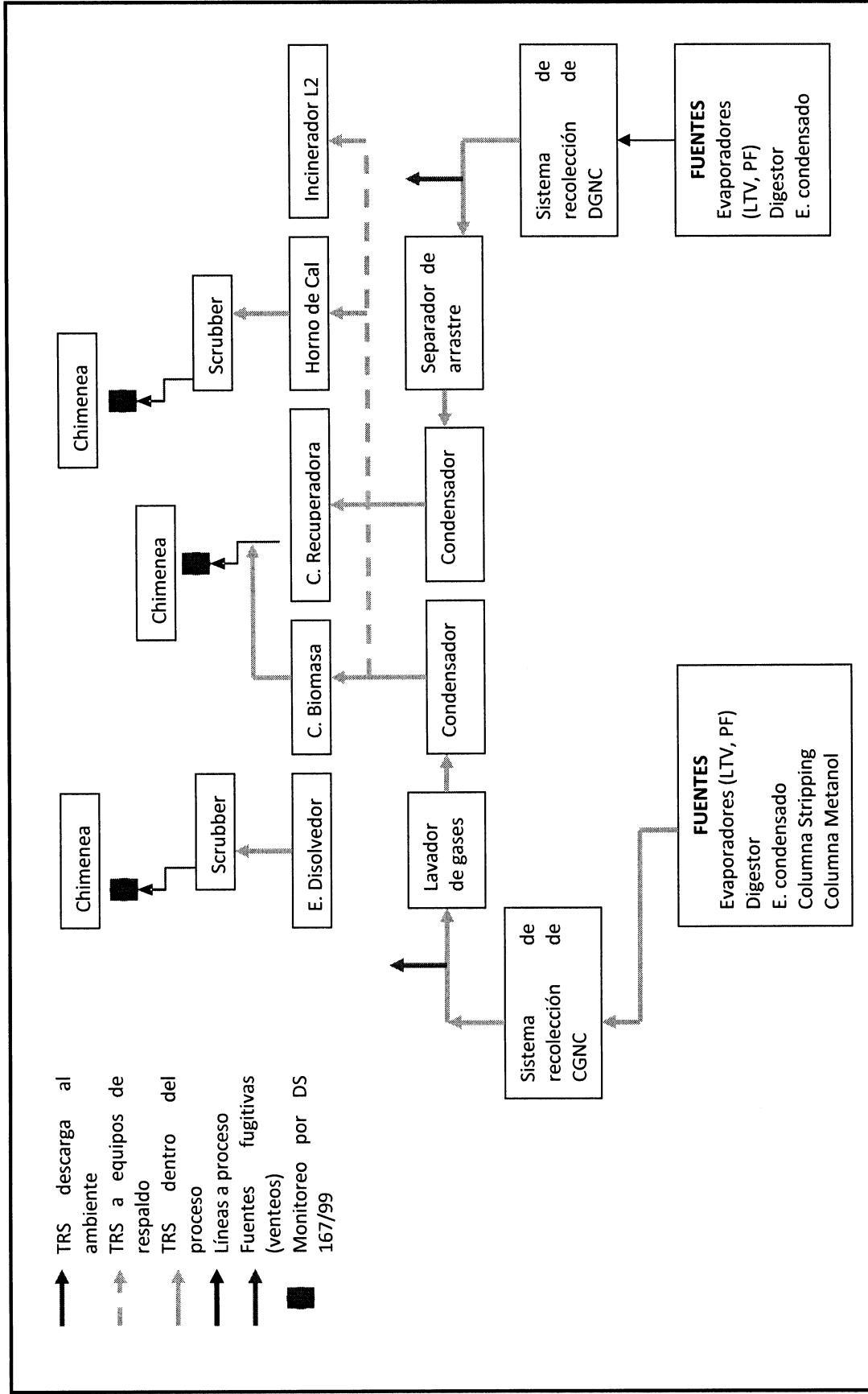


Figura 1: Esquema de emisiones de TRS en la Línea 1 de Planta Santa Fe

000441

Observaciones del diagrama de flujo

1. Cumplimiento normativo

La Figura 1 muestra el sistema de recolección e incineración de gases concentrados (CGNC), regulados en el DS 167/99, de la Línea 1 de Planta Santa Fe.

Los gases concentrados (CNCG) provenientes de la cocción (digestor), evaporadores PF, evaporadores LTV, columna stripping y columna de metanol son capturados en una sola corriente e ingresan a una etapa de lavado (scrubber). Los CGNC extraídos de la etapa de lavado pasan por un eyector y son impulsados hacia un condensador. Una vez que han sido acondicionados, son quemados en la Caldera Biomasa. Los equipos de respaldo son el incinerador L2 y el Horno de Cal L1.

2. Desarrollos voluntarios

La Figura incluye, como información adicional, los mejoramientos voluntarios que CMPC ha desarrollado fuera del alcance de la norma (gases diluidos, DNCG). Estos gases, provenientes de las áreas de fibra y recuperación, ingresan al separador donde se eliminan las gotas presentes en la corriente de gas. Luego son enviados hacia una etapa de enfriamiento, cuya función es condensar parte del vapor de agua presente en los gases. Una vez acondicionados, son transportados hacia la Caldera Recuperadora L1 para ser quemados.

CMPC Celulosa S.A. - Planta Celulosa Santa Fe Línea 2

Tabla N°1: Caracterización Planta

Nombre	CMPC Celulosa S.A. - Planta Santa Fe Línea 2
Año que entra en operación	2006
Ubicación	VIII Región, Nacimiento, Av. Julio Hemmelmann N° 670
Localidades más cercanas	Nacimiento y Los Ángeles
Producto	Celulosa Blanqueada de fibra corta en base a eucalipto.
Producción	780.000 ton/año
Tecnología	ECF

Tabla N°2: Caracterización de las fuentes emisoras (DS 167/99)

Fuentes de emisión TRS	Caldera Recuperadora 2 ¹	Horno de Cal 2
Monitoreo	Si	Si
Tipo de monitoreo.	Continuo	Continuo
Método de monitoreo	Luz UV pulsante, Método USEPA designado: EQSA-0486-060 CEMS	Luz UV pulsante, Método USEPA designado: EQSA-0486-060 CEMS
Validado método de monitoreo (Por algún laboratorio o que lo reconozca la norma)	EPA 16A, mencionado como método de referencia en el DS 167/99	EPA 16A, mencionado como método de referencia en el DS 167/99
Cumple DS N° 167/99 art 3º	Si	Si
Equipos de mitigación	No ²	Scrubber
Otras fuentes fijas	No hay	
Fuente fugitivas	Estanques área Caustificación L2	

¹ Los gases de la chimenea del Estanque Disolvedor se inyectan al hogar de la Caldera Recuperadora, por lo que el ED se elimina como Fuente Fija.

² La combustión de los gases en la Caldera Recuperadora posibilita el cumplimiento normativo.

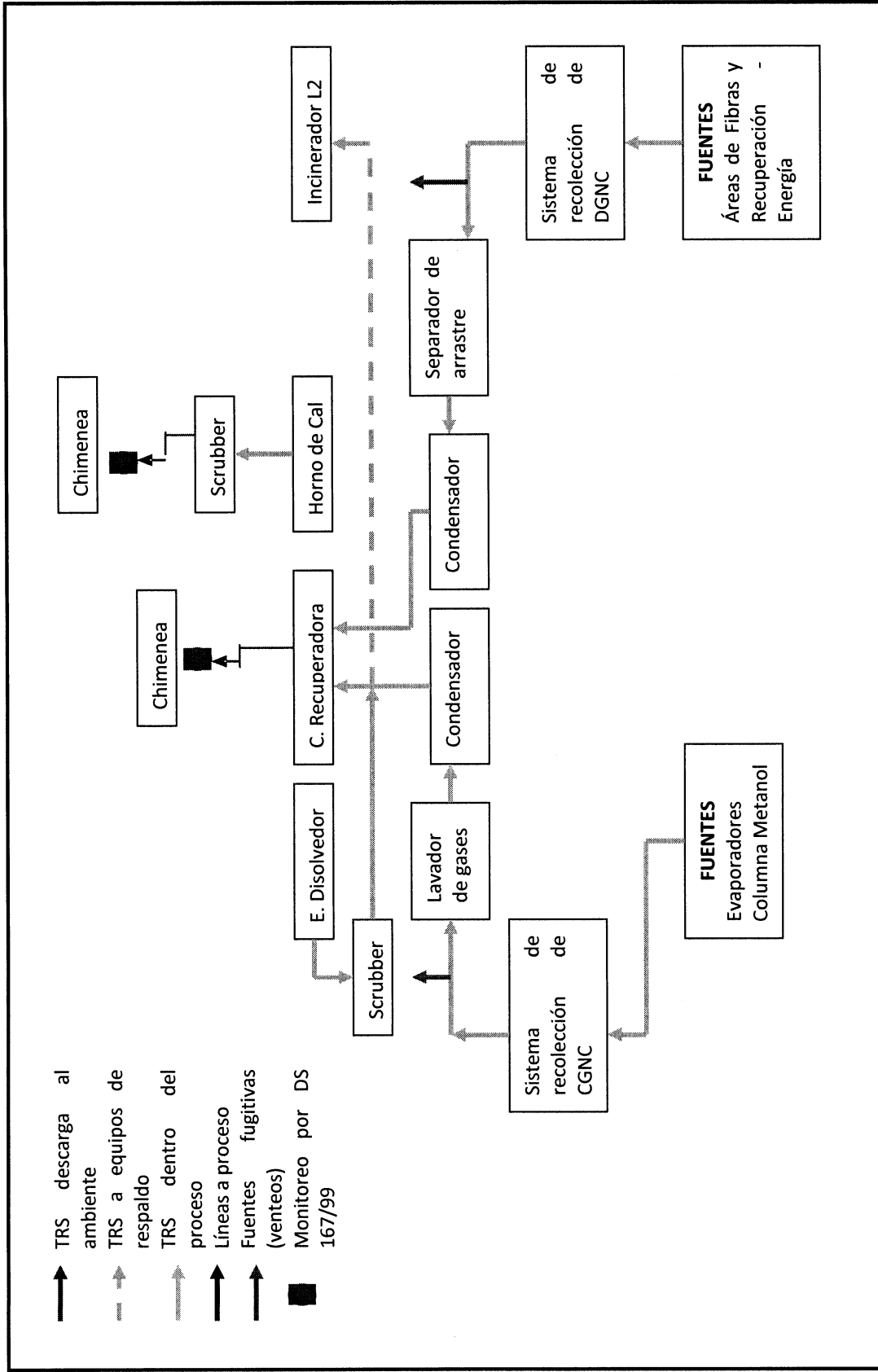


Figura 1: Esquema de emisiones de TRS en la Línea 2 de Planta Santa Fe

Observaciones del diagrama de flujo

1. Cumplimiento normativo

La Figura 1 muestra el sistema de recolección e incineración de gases concentrados (CGNC), regulados en el DS 167/99, de la Línea 2 de Planta Santa Fe.

Los gases concentrados son capturados desde sus fuentes de generación (sistema de vacío en área evaporadores, sistema de metanol, Digestor y Columna de Stripping). Una vez acondicionados, son quemados en la Caldera Recuperadora L2. El equipo de respaldo es el incinerador L2

2. Desarrollos voluntarios

La Figura 1 incluye, como información adicional, los mejoramientos voluntarios que CMPC ha desarrollado fuera del alcance de la norma (gases diluidos, DNCG). Estos gases son capturados desde las áreas de Recuperación y Energía y Fibra (cocción: pre y post lavado) y acondicionados retirándoles humedad. Luego de ello se queman en la Caldera Recuperadora L2 junto al aire secundario.

Presentación



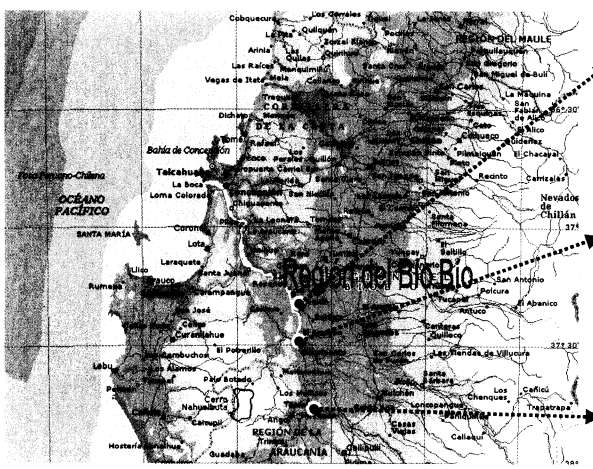
CMPC CELULOSA S.A., Planta Laja da la más cordial bienvenida a los miembros de la comisión de estudio de la modificación del DS MINSAL 167.

Nuestra Misión

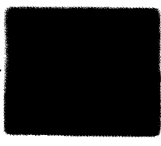


Garantizar y fortalecer nuestro liderazgo como productor de celulosa y papel en el mundo, haciendo de Planta Laja el mejor lugar para las personas que trabajamos en ella, nuestras familias y la comunidad, comprometidos con el medio ambiente, potenciando las capacidades de nuestro personal y de los proveedores de bienes y servicios, logrando con ello la satisfacción de nuestros Clientes y Accionistas.

Ubicación



Laja Mill

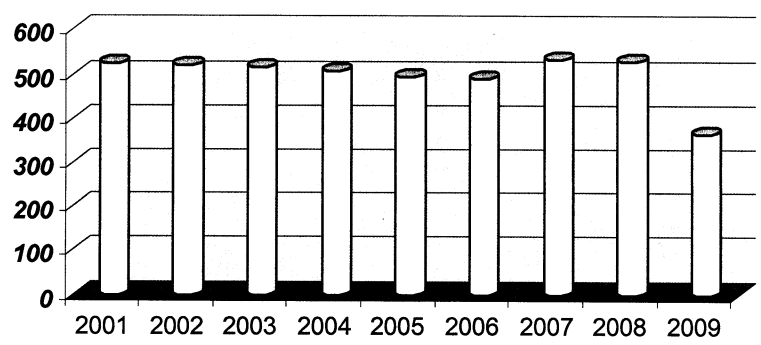


Santa Fe Mill



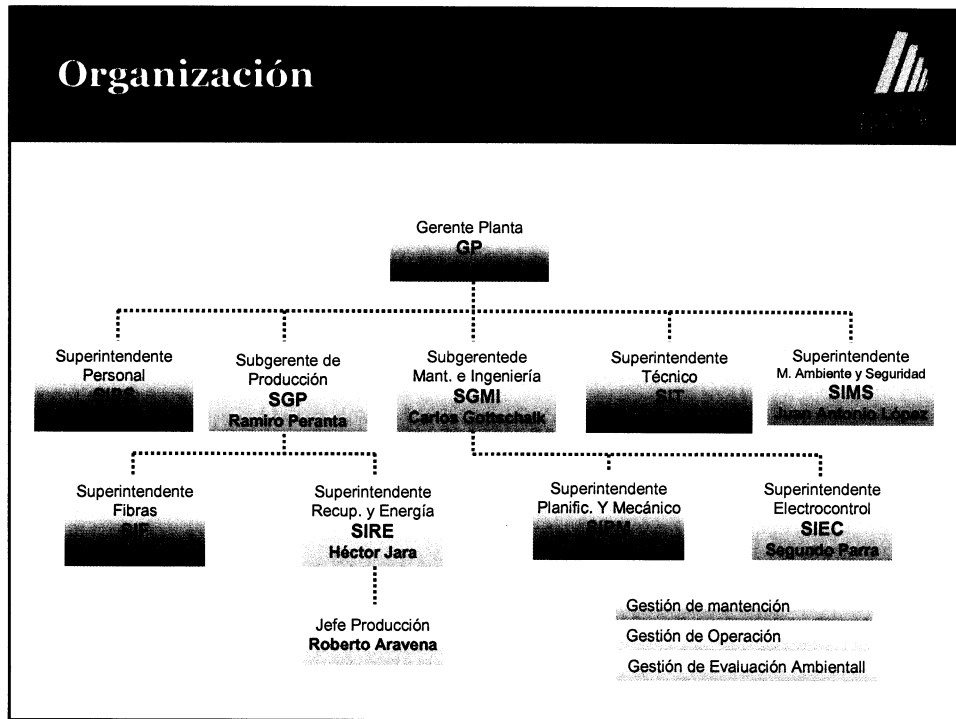
Pacifico Mill

Trabajadores Personal Propio



365 personas

500 personas



Productos de Planta Laja

Celulosa

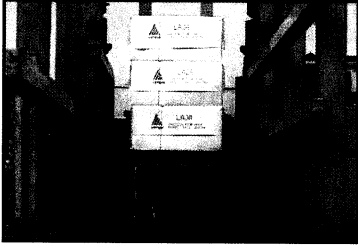
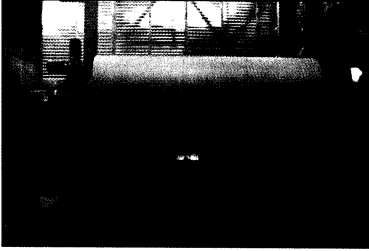
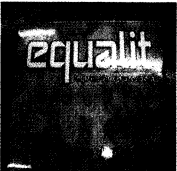
- Celulosa No Blanqueada
- Celulosa Blanqueada
- Celulosa Fluff

• **Papeles**

- Impresión y Escritura
- Sackraft
- Kraftliner

Conversión Resmas

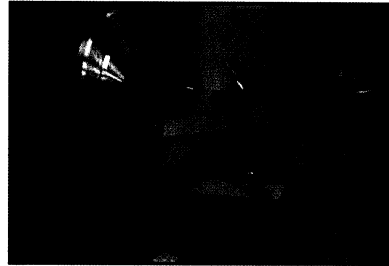
- Papel Fotocopia

SIG y Certificaciones



- Planta Laja está certificada bajo los estándares ISO 9001: 2000 (Gestión de calidad), ISO 14001: 2004 (Gestión Ambiental) y OHSAS18001:2007 (Gestión de seguridad industrial y salud ocupacional)
- En febrero 2005 certifica el sello CERTFOR - Cadena de Custodia (homologado PEFC)
- Certifica su laboratorio de riles con ISO17025 ante el INN.



Proceso de Planta Laja Estadísticas de Producción



Proceso de Planta Laja

Descripción del Proceso



Planta Laja, produce hasta 2008 anualmente 360.000 ADton/año de celulosa y papeles. Actualmente produce a un nivel de 260.000 ADt/año.

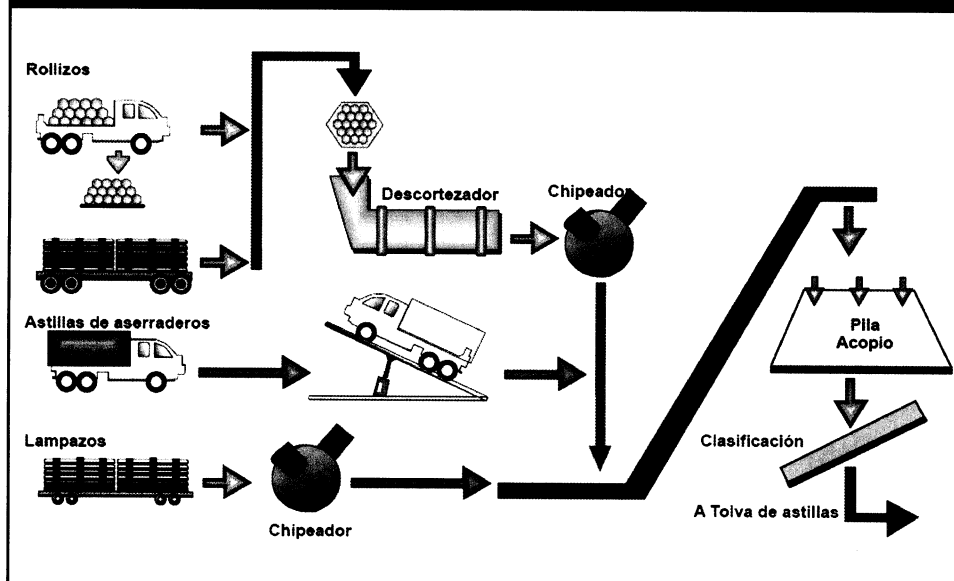
Posee dos líneas de producción de pulpa de fibra larga de Pino Radiata. Ambas líneas con el proceso Kraft convencional.

La primera (1959) con tecnología Batch, produce la celulosa sin blanquear para la Secadora N°1 y la Máquina Papelera 12. Posee un potencial de producción de 320 Adt/d.

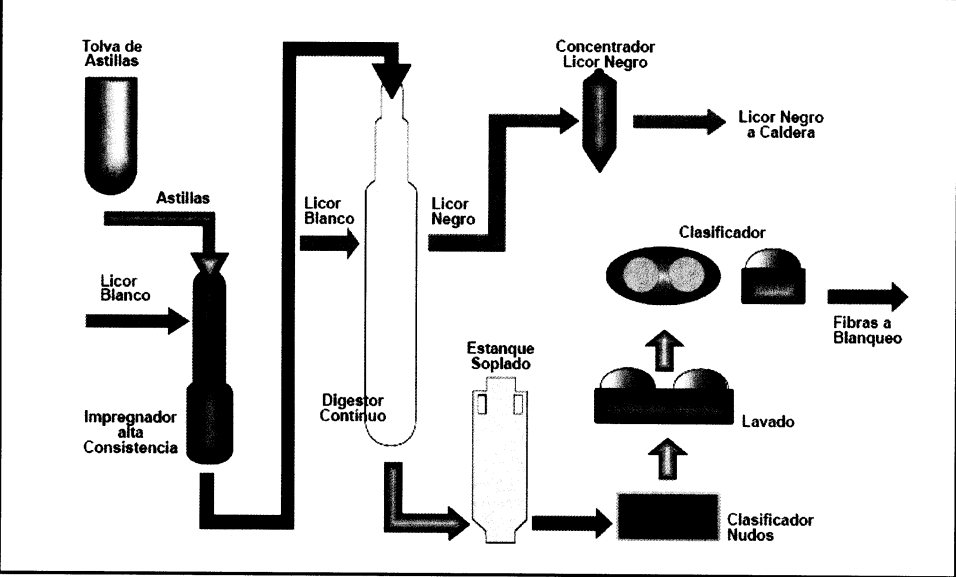
La segunda línea (1965) con tecnología continua, alimenta a la Secadora N°2 y la Máquina Papelera N°15. Actualmente opera a un ritmo de producción de 760 Adt/d.

Proceso Planta Laja

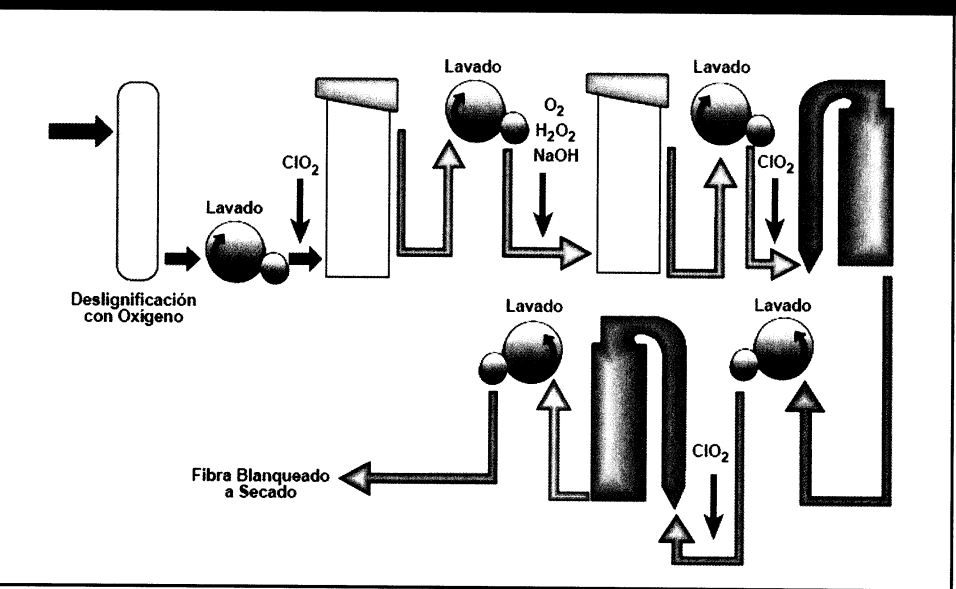
Diagrama de Flujos



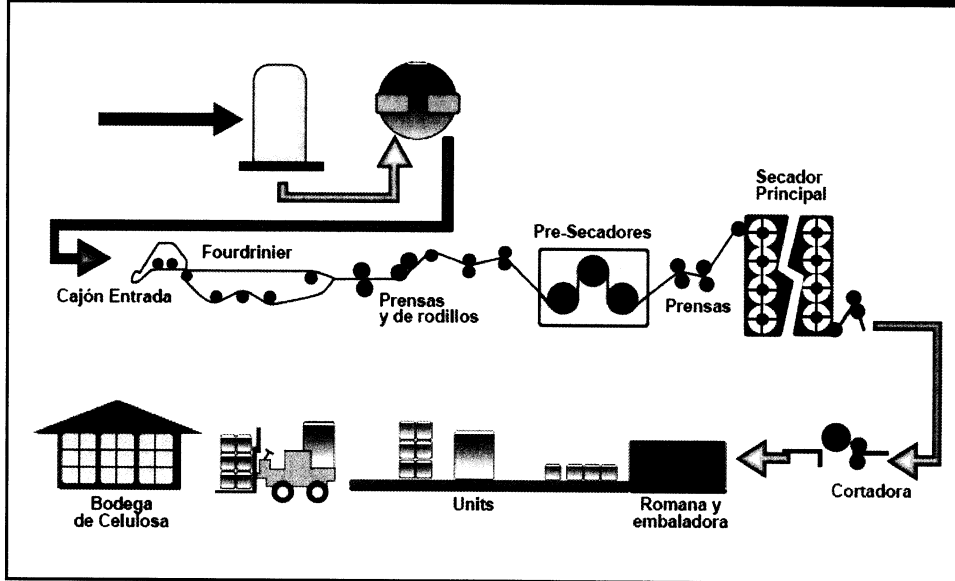
Proceso Planta Laja Diagrama de Flujos



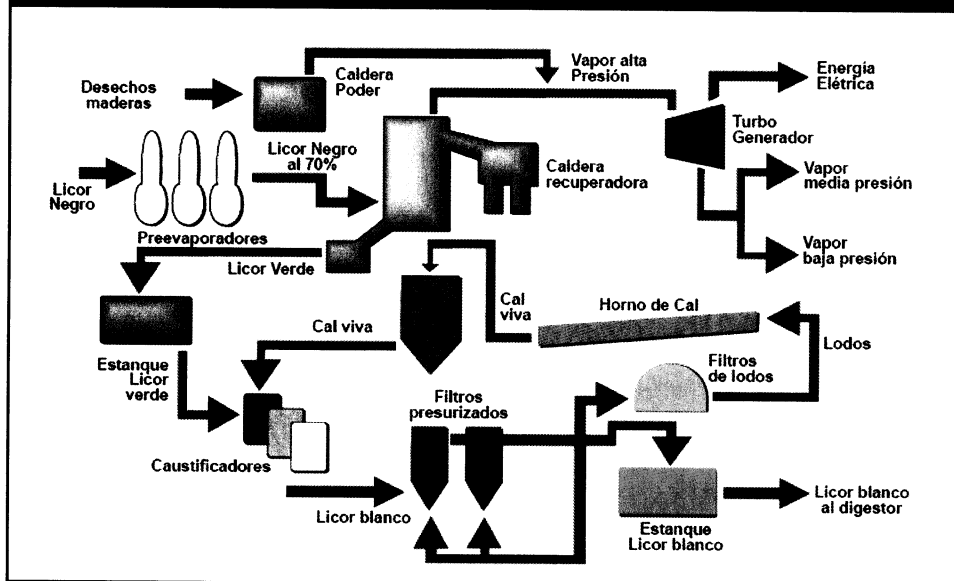
Proceso Planta Laja Diagrama de Flujos



Proceso Planta Laja Diagrama de Flujos



Proceso Planta Laja Diagrama de Flujos



Gestión Ambiental de TRS

Los 6 ejes de la Gestión Ambiental



- 1.- Gestión de Emisiones Áreas
- 2.- Gestión de Emisiones Líquidas
- 3.- Gestión de Residuos Sólidos
- 4.- Gestión de Recursos Naturales
- 5.- Gestión de Monitoreo de Impactos
- 6.- Gestión de Reportes Públicos

Gestión Ambiental de TRS

Los 6 ejes de la Gestión Ambiental



- ◆ Precipitadores Electrostáticos y Scrubbers
- ◆ Mediciones Gases (TRS, PM-10, etc.)
- ◆ Quemado de gases TRS
- ◆ Cámara de Neutralización
- ◆ Clarificador Primario
- ◆ Torres de enfriamiento
- ◆ Bio Reactores
- ◆ Clarificador secundario (DAF)
- ◆ Laguna de regulación
- ◆ Prensa Desaguadora
- ◆ Separación de Residuos Peligrosos
- ◆ Despacho controlado a disposición
- ◆ Disposición controlada de RIS
- ◆ ADCs (Vertedero) Autorizado

Gestión Ambiental de TRS

Los 6 ejes de la Gestión Ambiental

- ◆ Monitoreo de calidad de aire
- ◆ Monitoreo de aguas superficiales
- ◆ Monitoreo de aguas subterráneas
- ◆ Monitoreo de agua potable
- ◆ Monitoreos de ruido

- ◆ Madera, Energía Eléctrica, Agua
- ◆ Combustibles Fósiles

- ◆ Reporte trimestral a CONAMA
- ◆ Reportes mensual a SISS
- ◆ Reporte mensual a SEREMI Salud

Gestión Ambiental de TRS

Resumen ambiental en Planta Laja

Medio Ambiente Planta Laja "Efluente General"

pH (Escala)	T(°C) (Amb.)	S.S.(mg/l)	DBO (mg/l)	DQO (mg/l)	Clorof. (mg/l)	Color (mg/l)	Res.Sólidos (mg/l)	Res.Sólidos (mg/l)	Res.Sólidos (mg/l)
7,0 - 7,0	25,0	95	202	739	497	197	9,5	9,0	15,6

Planta de Tratamiento de Efluentes

Efluentes Parciales

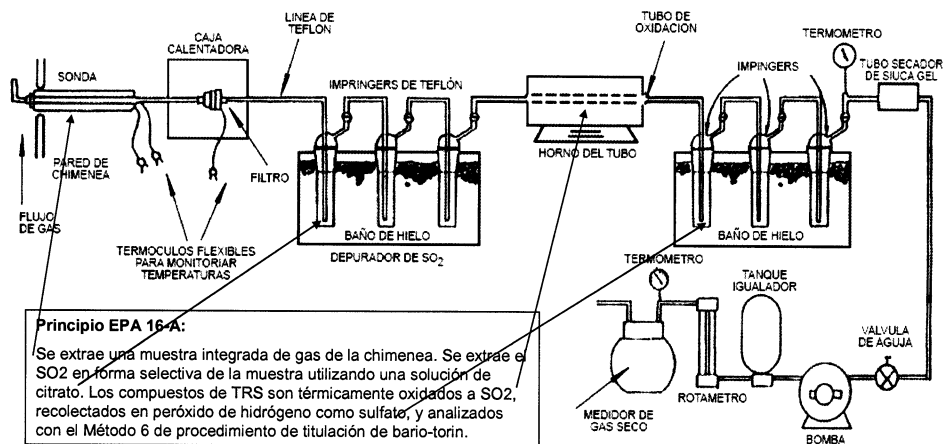
Parámetro	MP-002	MP-017	Est. I	Est. II	Est. III	Diferencia	W.Comb. Control	Clor. Fluor.	Clor.	Color	Res. Sólidos	DBO-2
P.Floro (V/L)	0,20	0,00	0,00	0,04	0,08	0,08	0,04	2,91	---	---	---	---
P.Fósforo (V/L)	---	---	---	---	1,13	-0,08	0,34	---	0,21	0,05	---	---
pH	---	---	---	---	0,44	18,57	7,70	---	0,20	0,05	0,08	---
Conduct.(mg/l)	---	---	---	---	---	---	---	---	345,4	0,000,0	0,00,0	---

Sistema de CNCG

Estadio de CNCG	Diferencia (°C)	Diferencia (°C)	Diferencia (°C)	Temp. (°C)	Temp. (°C)	Temp. (°C)	Temp. (°C)	Temp. (°C)	Temp. (°C)
1	15,0	11,4	10,0	---	---	---	---	---	---
2	---	---	---	---	---	---	---	---	---

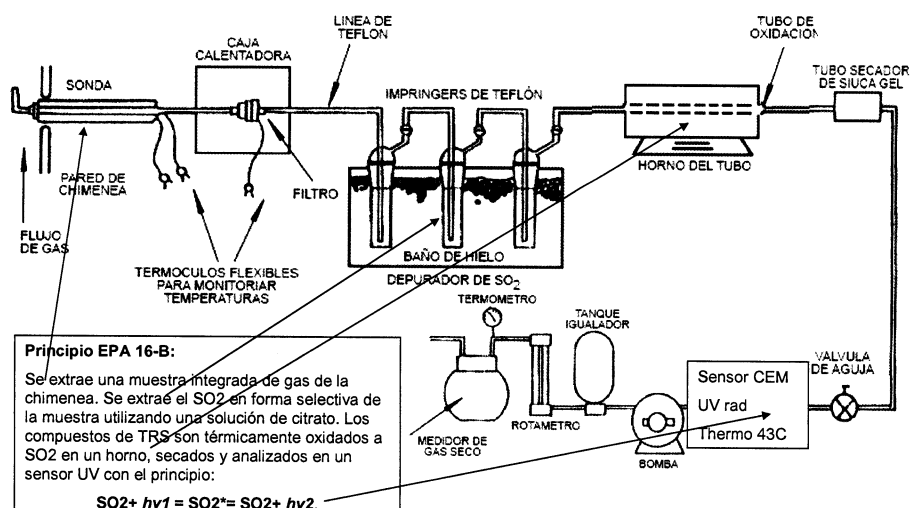
Gestión Ambiental de TRS

La medición de TRS discreta en Planta Laja



Gestión Ambiental de TRS

La medición de TRS discreta en Planta Laja



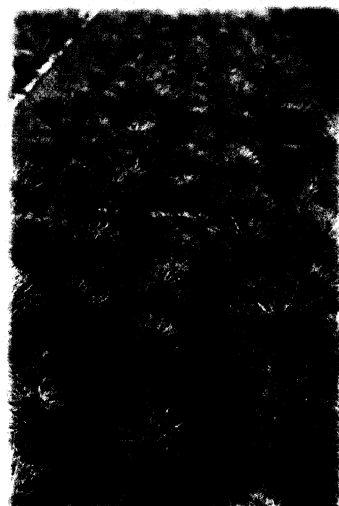


Antecedentes Planta Pacífico



- **Ubicación** : Mininco, Prov. Malleco, IX Región
- **Inicio operación** : Febrero 1992
- **Producción** : 498.000 t/año (ppto. 2009)
- **Producto** : Celulosa blanca fibra larga
- **Materia prima** : Pino radiata
- **Empleo directo** : 304 personas
- **Empleo indirecto** : 500 personas

Materias Primas



- Pacífico utiliza pino Radiata.

El pino Radiata es una especie de rápido crecimiento que proviene de bosques plantados en la Octava y Novena Regiones.

	Consumo Anual, m ³ ssc	%	Densidad, kg/m ³ ssc
Rollizos	2.052.000	73	383
Astillas	759.000	27	424

Proceso Kraft

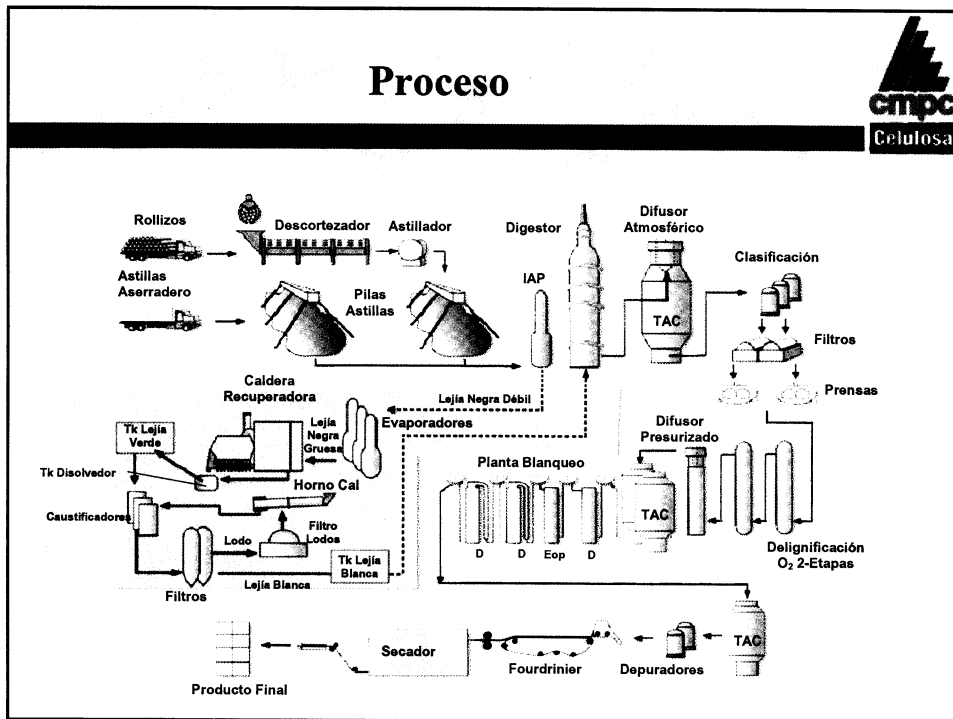


Materia Prima:
MADERA = FIBRA + LIGNINA

Cocción:
MADERA + L.BLANCA = FIBRA + L.NEGRA

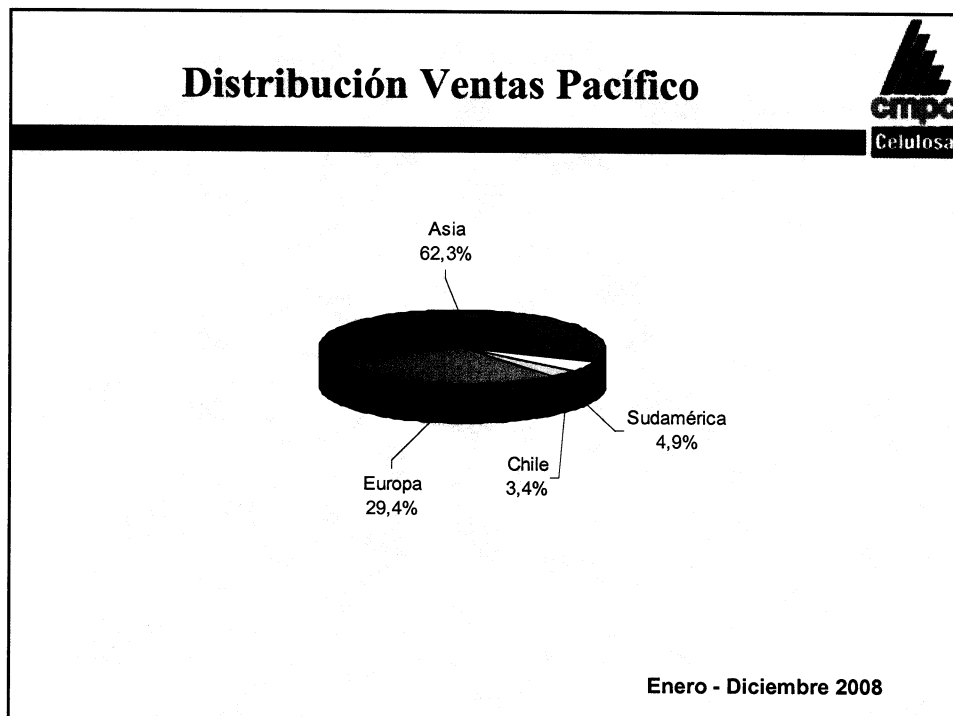
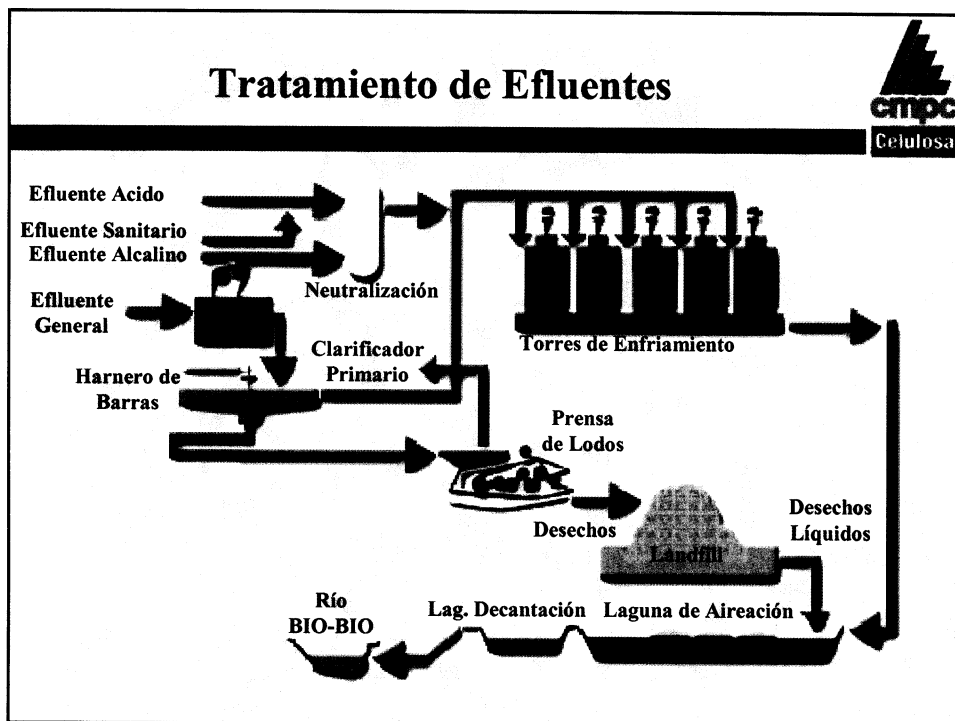
Recuperación:
L.NEGRA = ENERGÍA + L.BLANCA

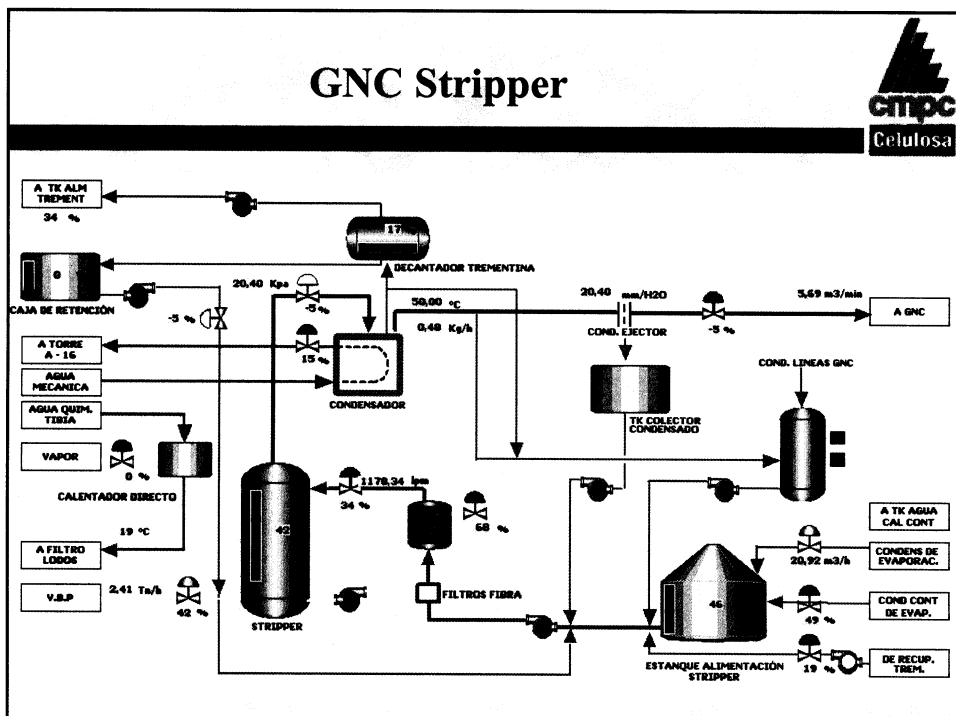
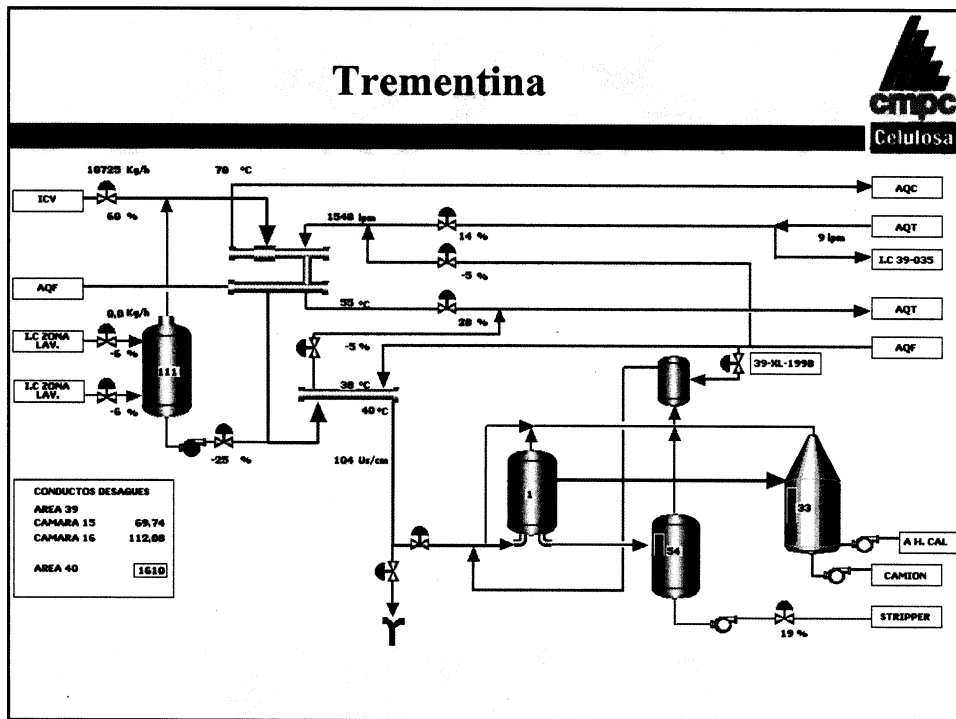
Energía:
ENERGÍA = VAPOR + E.ELÉCTRICA

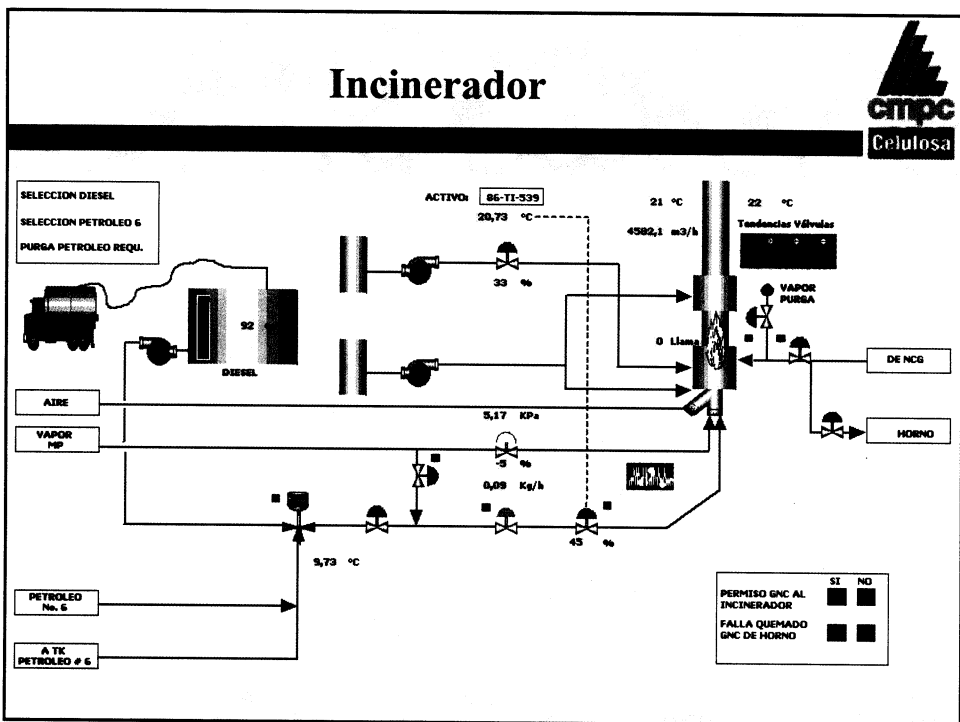
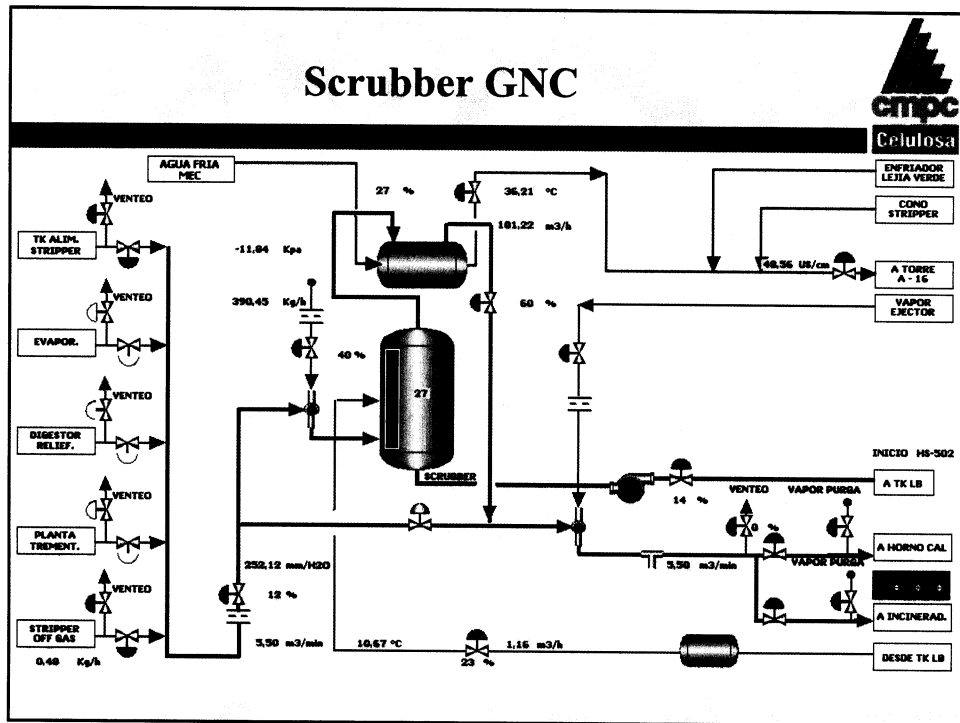


Caldera de Biomasa

- **Inversión** : US\$ 57 Millones
- **Inicio Oper.** : Octubre 2006
- **Producción** : 150 ton/h VAP





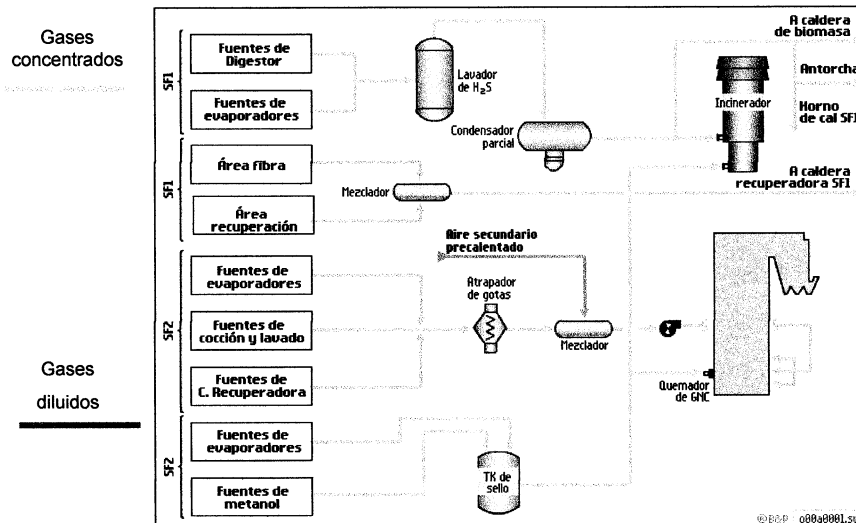




SISTEMA DE CAPTURA Y CONTROL DE GASES CONCENTRADOS EN CMPC CELULOSA PLANTA SANTA FE

Junio 2009

DESCRIPCIÓN GENERAL DEL SISTEMA DE GASES EN CMPC CELULOSA – PLANTA SANTA FE



SISTEMA DE GASES CONCENTRADOS



El sistema comienza con la recolección de los GNC (gases no condensables) de las distintas fuentes y termina cuando son quemados en la caldera recuperadora y/o quemador incinerador stand-by.

Su función es recolectar los GNC generados en las distintas áreas de SF2, acondicionarlos y posteriormente quemarlos en la caldera recuperadora y/o quemador incinerador stand-by.

Las fuentes de generación de GNC en SF2 son evaporadores (Sistema vacío) y sistema metanol.

SISTEMA DE GASES CONCENTRADOS

