San Joaquin Valley
Air Pollution Control District

SSP 1110
Load Following Determinations

Approved By:	_____ David Warner, Director of Permit Services
Date:	April 28, 2008

Purpose

This policy provides a guide for standardized load following determinations.

Scope

This policy applies to all units that intend to qualify as a load following unit per District Rule 4306 (*Boilers, Steam Generators, and Process Heaters*).

Procedure

1. Make a load following determination according to the District's "Load Following State of the Art Report" (attached). The load following determination can be part of a permitting project, emission control plan evaluation, or other. It is not necessary to create a special project for a load following determination for those cases.

    a. Load following determination processing tools are available on the AIRnet in Per/Source Category/Boilers, under the "Load Following" heading. The tools available there are:

        i. The "Load Following State of the Art Report"
        ii. Past letters to applicants requesting load following information
        iii. Past load following determination memos
        iv. Ultra-Low NO_x (ULN) burner manufacturer contact and product information
        v. Achieved-in-Practice (AIP) ULN installations with current PTOs

2. Summarize the load following determination in a memo to file. Use the past load following determination memos on the AIRnet as templates. Submit for manager approval.

3. If new information is obtained for the ULN burner manufacturer table and/or the AIP ULN installations, please forward that information to your supervisor so it can be incorporated into the applicable processing tools.

4. Submit load following determination memos to a permitting supervisor, which will be added to the AIRnet as a sample load following determination memo.

Appendix A: District's "Load Following State of the Art Report"

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District's "Load Following State of the Art Report"

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Load Following State of the Art Report (Draft)

Lead Engineers:
Samir Sheikh, Permit Services Manager
Joven Refuerzo, Supervising Air Quality Engineer
Arnaud Marjollet, Supervising Air Quality Engineer

Processing Engineers:
Brian Clements, Senior Air Quality Engineer
John Ludwick, Senior Air Quality Engineer

June 17, 2005

I. Background

District Rule 4306 (Boilers, Steam Generators, and Process Heaters - Phase 3), which was amended March 17, 2005, limits oxides of nitrogen (NO_x) and carbon monoxide (CO) emissions from any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.

During District Rule 4306 development, the food processing industry raised concerns about the concept of Load Following (LF) units. Load Following units are primarily used in the food processing industry. Unlike base loaded units where the steam demand in the facility is fairly constant, Load Following units encounter frequent fluctuations in the steam demand depending on the variations in the amount of products or materials that need to be processed in a given period of time.

Variations in steam demand may present technical challenges for Ultra-Low NO_x (ULN) burner systems expected to meet 9 ppmvd-NO_x @ 3% O_2. Common challenges for boiler operators include maximizing thermal efficiency at higher loads, minimizing vibrations and noise, and firing multiple fuels. These challenges can be more severe with the use of an ULN burner system, which operates with a cooler, larger, less-stable flame. As a result of these concerns, Load Following units have a less stringent Rule 4306 NO_x emission requirement.

This document provides guidance to ensure uniformity in the interpretation and determinations of Load Following.

II. Definitions

Load Following unit (from Rule 4306, Section 3.11): a unit with normal operational load fluctuations and requirements which exceed the operational response range of an Ultra-Low NO_x burner system(s) operating at 9 ppmv NO_x. The operator shall designate Load Following units on the Permit to Operate.

Response Rate: steam production acceleration or deceleration.

Response Time: the time period that a boiler may take to change load through a specified turndown.

Turndown ratio: the ratio between full boiler output and minimum boiler output.

III. Load Following Determination Guidance

Rule 4306, Section 6.4.2 identifies information that may be used for a Load Following (LF) determination:

6.4.2 ….The APCO shall only designate, as load-following, units for which the following information has been provided to demonstrate that the units qualify as load following:

6.4.2.1 Technical data such as steam demand charts or other information to demonstrate the normal operational load fluctuations and requirements of the unit,

6.4.2.2 Technical data about the operational response range of an Ultra-Low NOx burner system(s) operating at 9 ppmv NOx, and

6.4.2.3 Technical data demonstrated that the unit(s) are designed and operated to optimize the use of base-loaded units in conjunction with the load-following unit(s).

The District considers a "response range" to be either the turndown ratio or the response rate. A unit may be designated as Load Following (LF) if the normal operational load fluctuations and requirements exceed <u>either</u> of the operational response ranges (turndown ratio or response rate) of 9 ppmvd @ 3% O_2 Ultra-Low NO_x (ULN) burner systems, as long as the facility optimizes base load operation.

<u>1 - Base Load Operation</u>

The base load optimization determination is site specific. The permittee or applicant must provide documentation of facility-wide steam demand fluctuations, as well as a detailed explanation of how the facility's boilers accommodate these fluctuations. Case by case determinations or approvals of legitimate facility-wide base loading will be made by the District.

If the permittee/applicant has not provided the necessary information to the District to determine if base load operations are optimized at the facility, the unit in question cannot be deemed LF.

<u>2 - Turndown Ratio</u>

The turndown ratio is the relation between maximum boiler output and minimum boiler output for normal or required operation. Therefore, the turndown ratio of the proposed LF unit, which will be compared to ULN turndowns will be labeled *required turndown ratio*. The following information about the proposed LF unit is necessary for a LF determination based on the turndown ratio:

- Actual historic data (such as steam charts) that indicate the maximum and minimum steam productions of the unit.

From this data, the required turndown of the proposed LF unit can be established, which also sets the performance standard that a theoretical replacement ULN system should meet. Note, the production maximum and minimum requirements of the proposed LF unit may be adjusted by a District approved safety factor to account for operational flexibility.

Compare the turndown ratios of equivalent ULN burner systems to the required turndown of the proposed LF unit (see table below). If the proposed LF unit is required to turndown further or exceeds the turndown ratios of all ULN burner systems, then the unit is LF, provided the facility optimizes base load operations.

The District has compiled the turndown ratios of available ULN burner systems. To summarize this information, any system with a required turndown that exceeds 6:1 qualifies as a LF unit, provided the facility optimizes base load operations.

Example:
The current boiler (proposed LF) has a historic actual maximum and minimum steam production of 200,000 lb-steam/hr and 50,000 lb-steam/hr respectively.

Required Turndown Ratio = Max steam production ÷ Min steam production
= 200,000 lb/hr ÷ 50,000 lb/hr = 4, or 4:1

Since both manufacturer guaranteed and (Achieved in Practice) AIP ULN burner systems exceed the required turndown ratio of the proposed LF unit (see Table below), the proposed LF unit cannot be deemed LF due to its turndown ratio.

3 - Response Rate

A key aspect of the LF determination may be based on consideration to the boiler's acceleration or deceleration, which will be labeled Response Rate (RR). The District has identified the RR in the units of MMBtu/hr/sec.

A comparison of the RR of the current system (proposed LF) to equivalent ULN systems should be made in order to determine if the required RR is achievable based on manufacturer/supplier guarantees, or has been AIP by currently installed ULN systems. The District has compiled data on systems currently operating with ULN burners permitted within the District, as well as ULN burner system manufacturer/supplier information. The table below is a compilation of this data.

Burner system capacities have an impact on the response rate. For example, units that vary in steam capacity by 10 times are not expected to have equivalent RRs. The RR can be considered for units of equivalent steam production capacity, after factoring in the difference in steam production capacities of the units in comparison. Therefore, the response rates of the AIP units under comparison will be adjusted to account for the capacity difference. Note, the adjustment is only necessary for AIP ULN systems. The District has assumed that heat input (MMBtu/hr) is directly proportional to steam production (lb/hr). The column headed Adjusted Response Rate (ARR) in the table below accounts for the difference in steam production capacity and allows for a level comparison by adjusting each AIP ULN burner system capacity to the capacity of the current boiler (proposed LF unit). The adjustment to the AIP RR is made with following calculation:

ARR = [ULN system requirement (MMBtu/hr) × Response Rate AIP unit (MMBtu/hr/sec)]
÷ AIP unit burner rating (MMBtu/hr)

Note: the ULN system rating in the equation above is equivalent to the historical actual requirement of the proposed LF unit.

For LF determinations to be based on the Response Rate, proceed as follows:

1. Acquire the following information about the current boiler (proposed LF unit):

    a. Heat input capacity of the unit (MMBtu/hr).

    b. Boiler type (watertube, firetube, fluid heater, steam generator).

    c. Actual historic data (such as steam charts) that indicate the maximum and minimum steam productions of the unit.

        i. This data establishes the required capacity of the system. Note, the production maximum and minimum requirements of the proposed LF unit may be adjusted by a District approved safety factor to account for operational flexibility.

    d. Actual historic data (such as steam charts) that indicate individual steam production change “episodes” and the response time of each episode. The response rate, to be compared with ULN systems, will be calculated based on these episodes.

2. Insert this acquired data in the applicable fields in the table below.

3. Load Following determinations that are based on the response rate of the system must consider the following:

    a. The *Response Rate* of applicable ULN burner system manufacturer/supplier guarantees that exceed the response rate of the current boiler (proposed Load Following) system; and

    b. The *Adjusted Response Rate* of applicable ULN burner systems permitted within the District that exceed the response rate of the current boiler (proposed Load Following) system.

IV. Permit Identification

Upon a Load Following determination according to the guidance above, a unit shall be identified on their respective District permit according to the sample description below:

C-XXXX-X-X:
XXX MMBTU/HR MAKE MODEL NATURAL GAS FIRED BOILER WITH A MAKE MODEL BURNER (LOAD FOLLOWING UNIT)

ULTRA LOW NOX BURNER SYSTEM COMPARISONS

Boiler Type #: 2

1. Firetube
2. Watertube
3. Fluid Heater
4. Steam Generator

Historic Actual Data of Proposed Load Following Boiler:

Maximum Rated Heat Input Capacity: 187.5 MMBtu/hr
Historic Actual Max Steam Demand: 150,000 lb-steam/hr *
Historical Actual Min Steam Demand: 32,000 lb-steam/hr *
Historic Actual Required Heat Input: 187.5 MMBtu/hr

Conversion Factor: 800 lb-steam/MMBtu

Data from a Historic Actual "Load Following" Episode of Proposed Load Following Boiler:

High end steam production: 150,000 lb/hr
Low end steam production: 32,000 lb/hr
Response time of episode: 220 sec

Required turndown ratio: **4.7** to 1
Heat input change: **147.5** MMBtu/hr
Response Rate: **0.670** MMBtu/hr/sec

Is boiler a load following unit? **NO.**

ULN System**	Make	Model	Boiler Type	Heat Input Capacity (MMBtu/hr)	Turndown Ratio (X to 1)	Response Time (sec)	Response Rate (MMBtu/hr/sec)	Adjusted Response Rate (MMBtu/hr/sec)
Mfg/Supplier	Johnston Boiler Co.	FIR	1,3	20 - 100	6.0	20		
Mfg/Supplier	Johnston Boiler Co.	FIR	1,3	2 - 20	4.0	20		
Mfg/Supplier	Ind. Comb./Profire NT	Profire NT	1,2,3,4	5 - 30	5.0	30		
Mfg/Supplier	Power Flame Inc.	NOVA Plus	1,2,3	2 - 14.7	2.0	30		
Mfg/Supplier	Power Flame Inc.	NOVA Premix	1,3	0.85 - 2.2	2.0	30		
Mfg/Supplier	Coen Company	Delta ULN	2	20 - 440	5.0	60	2.500	**2.500**
Mfg/Supplier	Coen Company	Micro ULN	1	10 - 60	5.0	60		
Mfg/Supplier	ALZETA Corporation	CSB	1,2,3	2 - 14.7	4.0	60		
Mfg/Supplier	NAT-COM	NAT-COM	1,2,3,4	10 - 400	6.0	90	1.736	**1.736**
Mfg/Supplier	Ind. Comb./Profire NT	Profire NT	1,2,3,4	30 - 60	6.0	90		
Mfg/Supplier	ALZETA Corporation	CSB	1,2,3	14.7 - 130	5.0	120		
Mfg/Supplier	John Zink Company	Gordon Piatt	1,2,3	5.2 - 50	4.0	120		
Mfg/Supplier	John Zink Company	TODD	1,2,3	30 - 600	6.0	180	0.868	**0.868**
AIP (N-4201)	ALZETA Corporation	CSB		39.0	4.0	45		
AIP (N-1363)	ALZETA Corporation	CSB		63.0	5.0	60	0.840	**2.500**
AIP (S-1346)	ALZETA Corporation	CSB		31.5	5.0	60	0.420	**2.500**
AIP (C-402)	NAT-COM	NAT-COM	2	57.0	5.0	60	0.760	**2.500**
AIP (C-402)	John Zink Company	TODD	2	67.0	5.0	90	0.596	**1.667**
AIP (C-628)	ALZETA Corporation	CSB		43.4	5.0	90	0.386	**1.667**
AIP (N-1399)	John Zink Company	TODD	2	220.0	5.5	120	1.500	**1.278**
AIP (S-416)	John Zink Company	TODD	2	60.4	5.0	120	0.403	**1.250**
AIP (N-1968)	John Zink Company	TODD		99.8	5.0	180	0.444	**0.833**
AIP (C-787)	John Zink Company	TODD		182.2	4.0	180		
AIP (N-1680)	John Zink Company	TODD		94.0	5.0	195	0.386	**0.769**
AIP (N-1276)	John Zink Company	TODD		182.5	5.0	210	0.695	**0.714**
AIP (N-1277)	John Zink Company	TODD		182.5	5.0	210	0.695	**0.714**
AIP (C-1163)	John Zink Company	TODD		89.1	7.0	225	0.339	**0.714**

*These values may be adjusted by a District approved safety factor to account for operational flexibility.

**Each of these represents an ULN burner system. AIP = Achieved in Practice installation located within the San Joaquin Valley APCD. Mfg/Supplier = Guarantees given to District by either the burner manufacturer or supplier.