St. Joe Forest Products Co.
Port St. Joe, Florida

TRS CONTROL PROJECT

PROJECT SUMMARY

RUST Contract 21-2982

September 4, 1987

RUST

045 0005

Florida Coast Pipeline

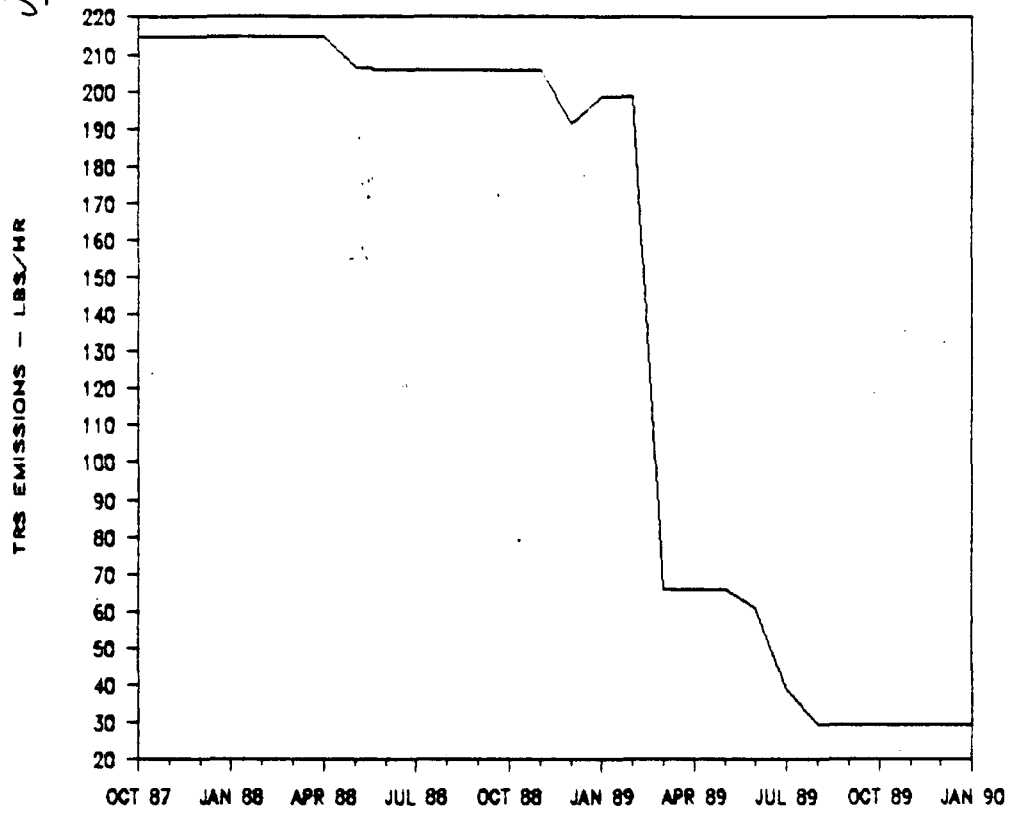
Stone Container

ST. JOE FOREST PRODUCTS COMPANY

PORT ST. JOE, FLORIDA

TRS CONTROL PROJECT

PROJECT SUMMARY



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Rust Contract 21-2982

September 4, 1987

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I. INTRODUCTION

This document briefly describes sources of air pollutant emissions in kraft pulp mills and the various methods selected in St. Joe Forest Products Company's TRS Control Project for controlling TRS emissions.

Reliable, cost-effective control of pulp mill TRS pollutant emissions requires a coordinated effort involving engineers familiar with pulping technology, air pollution control equipment design, boiler and combustion equipment design, and process control engineering. Rust International Corporation in conjunction with St. Joe Forest Products' engineers are carefully coordinating all areas of this project to result in a plant capable of meeting the TRS air quality requirements of the State of Florida while remaining competitive in the manufacturing marketplace. St. Joe Forest Products Company is committed to improving the environment and working in harmony with its coastal resort area neighbors.

The TRS pollution control project adopted by St. Joe Forest Products Company is a costly endeavor, with a projected total installed cost of approximately $40,850,000. The methods of pollution control selected by the owner are not the lowest initial cost alternates, but do represent processes which are accepted industry wide as being the best available control technology. The expenditures associated with this project do

not represent any production increase since the ultimate production of the plant is controlled by process areas which are untouched by this program. There are potential operating cost and maintenance benefits associated with some of the selected control systems which partially offset the additional financial risk associated with installation of the best available control technologies.

New plants can be designed "from the ground up" with air pollution control in mind. Existing plants such as St. Joe Forest Products Company are more difficult and costly to convert to a state-of-the-art design since pollution control measures frequently include revisions or modifications to the pulping process in addition to the proper selection and application of pollution control equipment.

The processes requiring TRS air pollution control measures at St. Joe include the pulping process equipment and the recovery boilers. TRS control measures for these sources incorporate both 1) specific knowledge of the source and its control equipment options, and 2) an understanding of how control measures for that source will affect operation of the overall pulping facility.

Section II of the report addresses the air emission sources and controls in the three recovery boiler areas, the three lime kilns, the recovery smelt tanks, and other miscellaneous sources.

Section III addresses the collection and incineration of noncondensible gasses (NCG) in the batch and continuous digester areas, the turpentine recovery systems, the multiple effect evaporators and steam stripper. This section also addresses the TRS controls to be installed on the recovery boiler smelt dissolving tank vents.

Section IV includes illustrations to emphasize the magnitude of the total project. This section also displays the anticipated air quality improvement resulting from reductions in TRS emissions as the individual control projects reach completion.

II. AIR EMISSION SOURCES AND CONTROLS

A. GENERAL

The primary sources of kraft pulp mill air emissions and available TRS pollution control options, arranged by process area are discussed in this section.

B. STEAM AND POWER AREA

Black Liquor Recovery Boiler

Many existing black liquor recovery boiler designs utilize heat in the flue gas to concentrate the black liquor feed to 60-65 plus percent solids by direct contact evaporation. The three existing recovery units installed at St. Joe Forest Products Company employ this configuration.

An undesirable side effect of direct contact evaporation is that hydrogen sulfide (H_2S) and other TRS compounds will be evolved and appear as TRS emissions in the flue gas.

Compliance with current TRS emission limits can normally be achieved by black liquor oxidation (BLOX), i.e., direct contact oxidation of reduced sulfur compounds in black liquor with air or molecular oxygen prior to introducing black liquor into the furnace. This method is relatively inexpensive to install but has a continuing high operating cost and requires that methods be employed to ensure safe storage and handling of the molecular oxygen.

BLOX is currently being utilized at St. Joe Forest Products Company to control TRS emissions in the recovery boiler flue gasses.

Wet flue gas scrubbing, utilizing caustic soda reagent, air oxidation, and/or activated carbon slurry as a catalyst is sometimes utilized as an alternate to BLOX for retrofit applications. Such scrubber designs normally include a packed bed absorber to provide the large liquid gas contact surface necessary for adequate gas absorption. A recent RUST survey of five operating wet scrubbing systems revealed that some units did not achieve desired performance levels. The inconsistent performance history indicates the importance of a site-specific evaluation prior to retrofitting the scrubbing system for TRS odor control. The scrubbers do not appear to provide assured compliance with the New Source Performance Standard (NSPS). The retrofit scrubber is more likely to succeed in cases where most of the TRS emission is hydrogen sulfide.

The low odor boilers that comply with NSPS limits for TRS require additional indirect contact evaporation stages for black liquor concentration. These boilers, designated low-odor design, have an enlarged boiler heat transfer surface, e.g., extended economizers instead of direct contact black liquor evaporation.

This method has the highest initial cost of all of the currently accepted methods of TRS control but is also

considered to be the best available control technology. All of the St. Joe Forest Products' recovery boilers will be converted to low odor design.

Particulate emissions consisting primarily of salt cake (sodium sulfate) are controlled by electrostatic precipitators. A means of returning the salt cake to the black liquor feed stream is provided. Wet bottom precipitators allow collected salt cake to fall directly into a stirred liquid pool of black liquor, which is then pumped directly to the boiler. TRS can be picked up by the flue gas in conventional wet bottom electrostatic precipitators. To minimize flue gas contact with black liquor, the precipitators at St. Joe Forest Products will employ uniquely designed agitators, gas passages and other devices to minimize TRS emissions. Information furnished to the Department by NCASI and Radian Corporation show that wet bottom precipitators on low odor boilers are successful in achieving compliance with existing source TRS standards.

C. CAUSTICIZING AREA

Lime Kiln

Particulates are normally controlled by a high-energy (pressure drop of 20 to 30 inches water gauge) venturi scrubber; the aqueous bleed-off slurry is returned to the caustic plant.

The energy requirement for fine particulate removal may be met by using high water pressure eductor scrubbers,

which require substantially lower gas pressure drop. However, the horsepower requirement for the pump is higher. Some vendors claim that the overall energy consumption in these scrubbers is less than for a conventional venturi scrubber. The particular scrubber to be installed on the St. Joe Forest Products' lime kilns will be selected based on technological evaluation and an economic comparison of the aspects of the high energy type versus the low energy type srubbers.

Control of TRS emissions in the causticizing area is discussed in Section III.

D. SMELT DISSOLVING TANK

Smelt from the mills' three recovery boilers is dissolved with weak wash (weak caustic solution) in the four existing smelt dissolving tanks. Sulfur in the smelt is in the form of sodium sulfide. Steam and noncondensable gasses formed in the tanks are vented from the tanks to the atmosphere via the smelt dissolving tank vent scrubbers. The scrubbing solution for the scrubbers is weak wash. Two scrubbers will be installed to control the emissions from the three recovery boilers. One scrubber will process the vent gasses from single dissolving tanks on the No. 5 and No. 6 recovery and one scrubber will process the vent gasses from the dual dissolving tanks on the No. 7 recovery. The scrubbers also achieve the required particulate removal.

E. MISCELLANEOUS SOURCES

Other kraft pulp mill TRS emission sources include the digesters, blow heat tanks, turpentine recovery systems, and evaporator hot wells. These sources of noncondensable gasses (NCG) are discussed in Section III.

III. NONCONDENSABLE GAS (NCG) SYSTEM

A. GENERAL

Noncondensable gasses (NCG) include methanol, turpentine, acetone, and the odorous Total Reduced Sulfur (TRS) compounds such as hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH), dimethyl sulfide [$(CH_3)_2S$], and dimethyl disulfide [$(CH_3)_2S_2$].

Although TRS gasses are rarely present in the absence of other NCG, most TRS gasses are odorous and regulated by pollution control agencies. Thus, a NCG collection and destruction system is commonly called a TRS system or odor control system. Throughout most of this discussion, the broad term NCG will be used, except where specifically referring to regulated TRS gasses.

B. NCG SOURCES

Figures 3-1 and 3-2 at the end of this section show the typical noncondensable gas and emission sources and controls for a kraft pulp mill. The major sources of noncondensable gasses to be collected and incinerated in a kraft pulp mill such as St. Joe Forest Products Company are listed below:

- Digester Area
  1. Blow Heat Condensing System
  2. Turpentine Recovery System

- o Evaporator Area

  Evaporator Hot Well

- o ~~Lime Kiln Stack~~

- o Steam Stripper Column

Several NCG emission control options are available for each source. The control options have been selected on a site-specific basis, and are dependent on the type of pulpwood used, cooking cycle, and type of digester. The available options are shown in Figure 3-1 at the end of this section.

Figure 3-2 at the end of this section shows the various TRS/NCG control options. The following paragraphs, organized by process area, explain the applicable NCG collection and transport options for each process.

1. Blow Heat Recovery System

Digester systems in kraft pulp mills consist of either batch processes or continuous processes to cook the raw wood chips and separate the wood fibers and make paper pulp. St. Joe utilizes a combination of batch digesters for their unbleached pulp production, and a Kamyr continuous digester for their bleached pulp production.

Noncondensable gasses are relatively easy to collect from the continuous digester due to the constancy of its process. Collection of gasses from the batch digester system, however, is more complicated and expensive due to the variability of the "blow" cycles and the wide differences of average and peak steam flows from each batch digester.

Pulp mills typically install blow heat accumulators which condense a portion of the blow steam from the digesters to reclaim the heat for use in heating process water. The economics often do not support a blow heat accumulator system large enough to condense 100 percent of the blow steam and thus most of the steam and all of the odorous NCG was exhausted to the atmosphere. The new blow heat recovery system at St. Joe Forest Products is being designed to condense 100 percent of the peak blow steam and segregate the NCG for transportation to the incineration device.

The type of digester, batch or continuous, is of particular importance because of the large and variable quantity of unavoidable air infiltration which occurs when charging a batch digester. On the other hand, air infiltration into the continuous digester is small. The introduction of air (oxygen) makes the NCG mixture potentially explosive and care must be exercized in designing the transport system.

The NCG transport systems designed for the blow heat recovery are; 1) the "as is" (potentially flammable) system, and 2) the UEL (Upper Explosive Limit) system. The small quantity of air infiltration into the continuous digesters makes it possible to maintain high NCG concentrations, i.e., above the UEL. NCG gasses exiting the batch digesters will be collected as is, but the collection/transport system must be designed for safe explosion containment

and relief. Since the St. Joe Forest Products' mill has both continuous and batch digesters, both of these transport methods will be incorporated. Steam jet ejectors, located at the point of incineration, will be used for NCG transportation.

2. Turpentine Recovery System

Turpentine vapor is explosive over a wide range of concentrations in the air, and turpentine droplets readily attain static electric charges. For these reasons, turpentine is implicated in a majority of NCG system explosions. A reliable, adequately sized turpentine recovery system is an essential safety element in the design of digester gas collection systems. The turpentine recovery systems at St. Joe Forest Products are being evaluated and will be modified to conform to the best available design criteria.

For the turpentine recovery processes applied to the existing batch digesters, the NCG collection/transport system is similar to that for the blow heat recovery process. Substantial air infiltration will normally preclude the UEL collection/transport option.

The "as is" concentrated system will operate slightly under vacuum; with the motivating device being a steam jet ejector located near the point of incineration. The NCG mixture during transport is potentially flammable because of significant air infiltration into the batch digesters.

3. Black Liquor Evaporator Hot Wells

When black liquor is evaporated from approximately 14 to 68 percent solids, water and volatile organic compounds are vaporized. These compounds are then partially condensed in surface or barometric condenser. The resultant foul condensate and uncondensed NCG accumulate in the evaporator hot wells. The hot well vents will be collected and transported to the lime kilns for incineration.

4. Lime Kiln

Sodium sulfide (Na_2S) carry-over from the causticizing equipment and the mud filter is responsible for most of the NCG emissions from the lime kiln. The following control strategies will be used, either singly or in combination to reduce the TRS/NCG emissions from the three St. Joe Forest Products lime kilns:

a. Substitute a clean process water stream to be used on the kiln scrubbers.

b. Increase excess oxygen in lime kiln flue gas (minimum 2 percent O_2 by volume or greater).

c. Modify the filtering system as required to reduce sulfur compounds in the lime mud kiln feed.

d. Add the capability to scrub flue gas with caustic soda. Since both SO_2 and NCG will be removed, this will return sulfidity to the process, a sometimes undesirable side effect. This side effect, and the

high cost of caustic soda reagent, normally argue in favor of using this option only on an intermittent basis during TRS emission surges.

5. Steam Stripper Column Vent

A steam stripper column will be designed if it proves necessary to remove volatile organic compounds (primarily methanol) and TRS gasses from the blow steam dirty condensate, turpentine decanter underflow, evaporator condensate, and other miscellaneous condensate streams. The steam stripping system, if needed will include a heat recovery step and reflux condenser. The concentrated stream of organic gasses will be directed to the lime kiln for NCG destruction.

Because air infiltration is minimal, the NCG gasses are highly concentrated and above UEL concentrations. The collection/transport system is called a UEL system. The gasses, rich in heating value, are handled as fuel gas similar to natural gas.

C. EXPLOSION RELIEF

The potentially flammable "as is" system and nonflammable systems include explosion relieving by rupture discs. These systems will be designed to contain and relieve explosions safely. However, particular care is taken in the design of the potentially flammable system to assure that the maximum explosion pressure (up to 8 times normal operating pressure) can be contained and safely relieved.

D. NCG EMISSIONS CONTROL

The final element in NCG control is destruction of odorous gasses present in the NCG collection system. The destruction of the odorous gasses at St. Joe Forest Products will take place in any one of the three lime kilns presently installed. The gasses will be destructed in only one of the operating kilns at any time.

To meet limits for TRS, the kilns will operate at approximately 2 percent O_2 at the wet end (compared with 1/2 to 1-1/2 percent O_2 in older kilns), which reduces thermal efficiency. Incineration of collected NCG/TRS gasses in the hot end, however, has little effect on thermal efficiency, since essentially all kiln TRS emissions are evolved at the wet end.

Most existing kilns are operating close to the allowable emission limit prior to introducing NCG into the firing end of the kiln. The added NCG compounds will, therefore, be designed to be destroyed at nearly 100 percent efficiency.

Proper design of the TRS burner is important in preventing the introduction of excess outside combustion air, and thereby reducing kiln thermal efficiency. Proper design will assure that the quantity of combustion air introduced with the NCG is offset by an equal decrease in primary fuel combustion air.

A small decrease in thermal efficiency may result from the presence of water vapor in the NCG stream. Water vapor is believed to slightly hinder transfer of radiant energy to the calcining lime. This effect can be minimized by removing water vapor from NCG in a condenser upstream of the lime kiln.

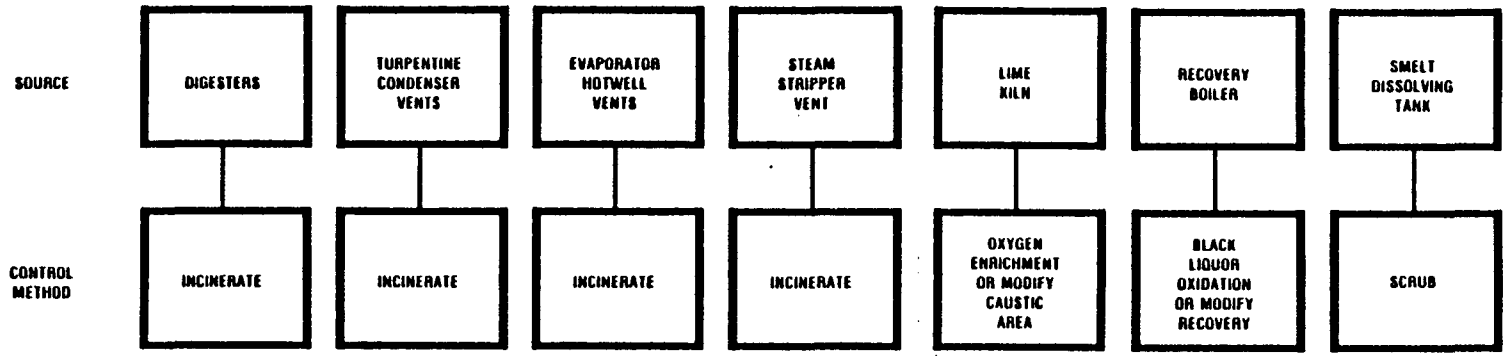


FIGURE 3-1. NONCONDENSIBLE GAS (NCG) EMISSION SOURCES AND CONTROLS

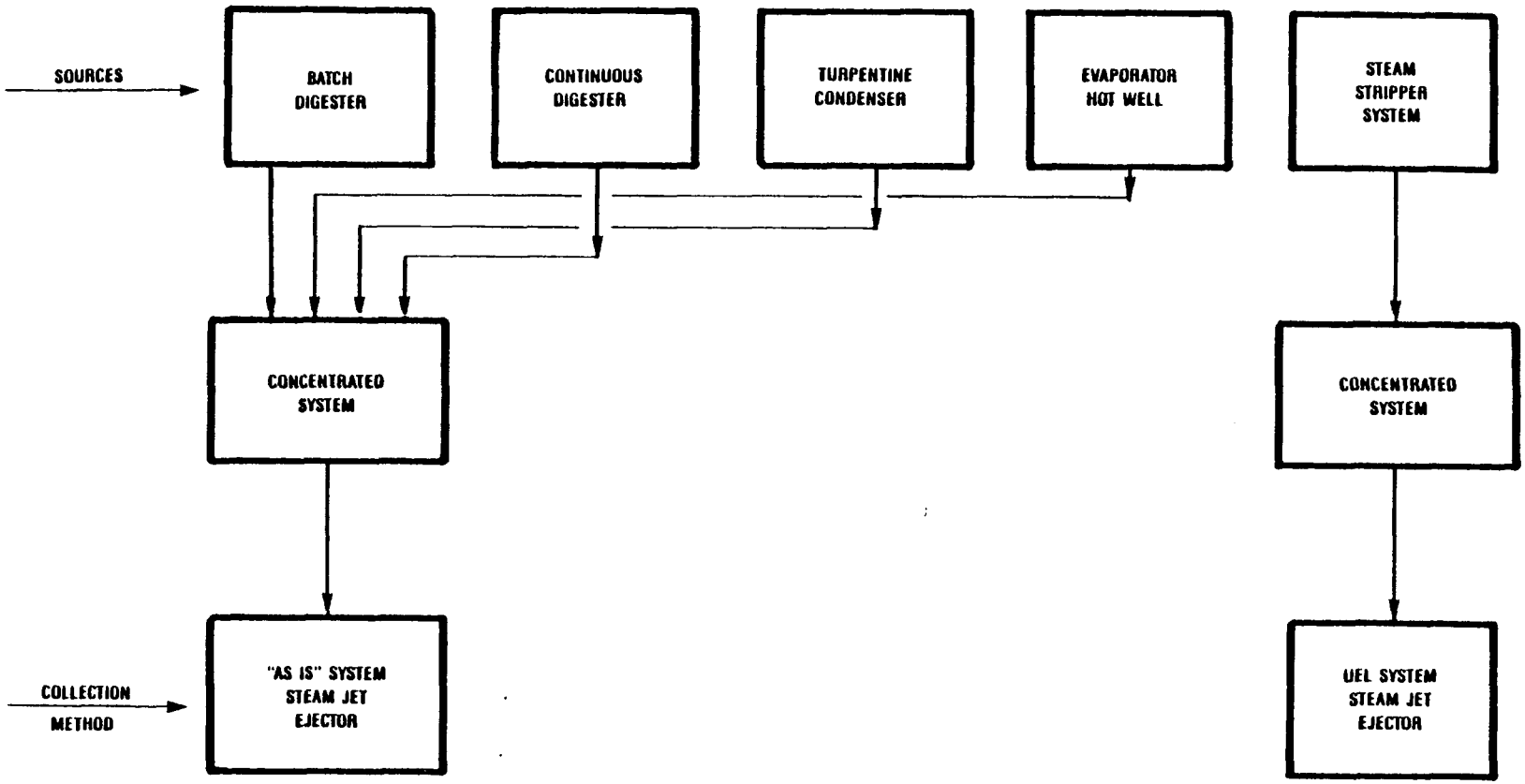
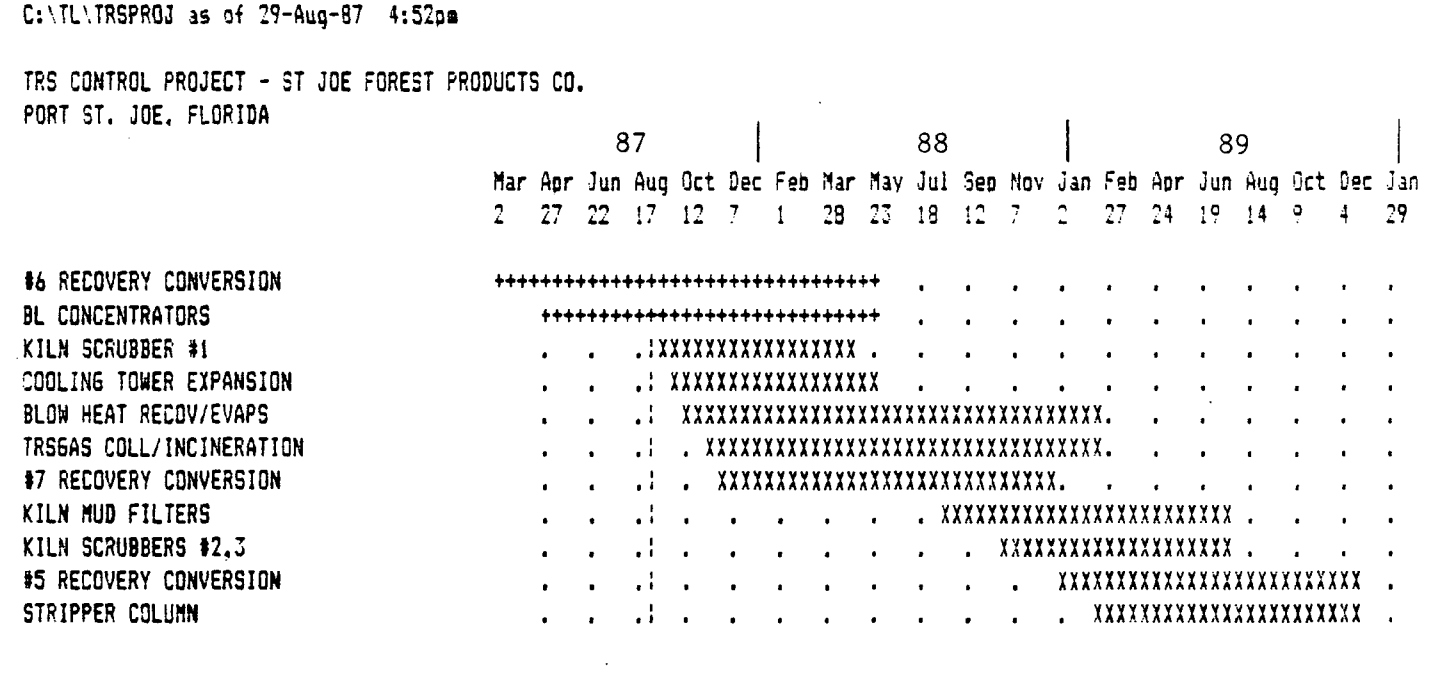


FIGURE 3-2 COLLECTION OF NONCONDENSIBLE NCG GASES

IV. TRS PROJECT ILLUSTRATIONS

St. Joe Forest Products Co.

Port St. Joe, Florida
TRS CONTROL PROJECT

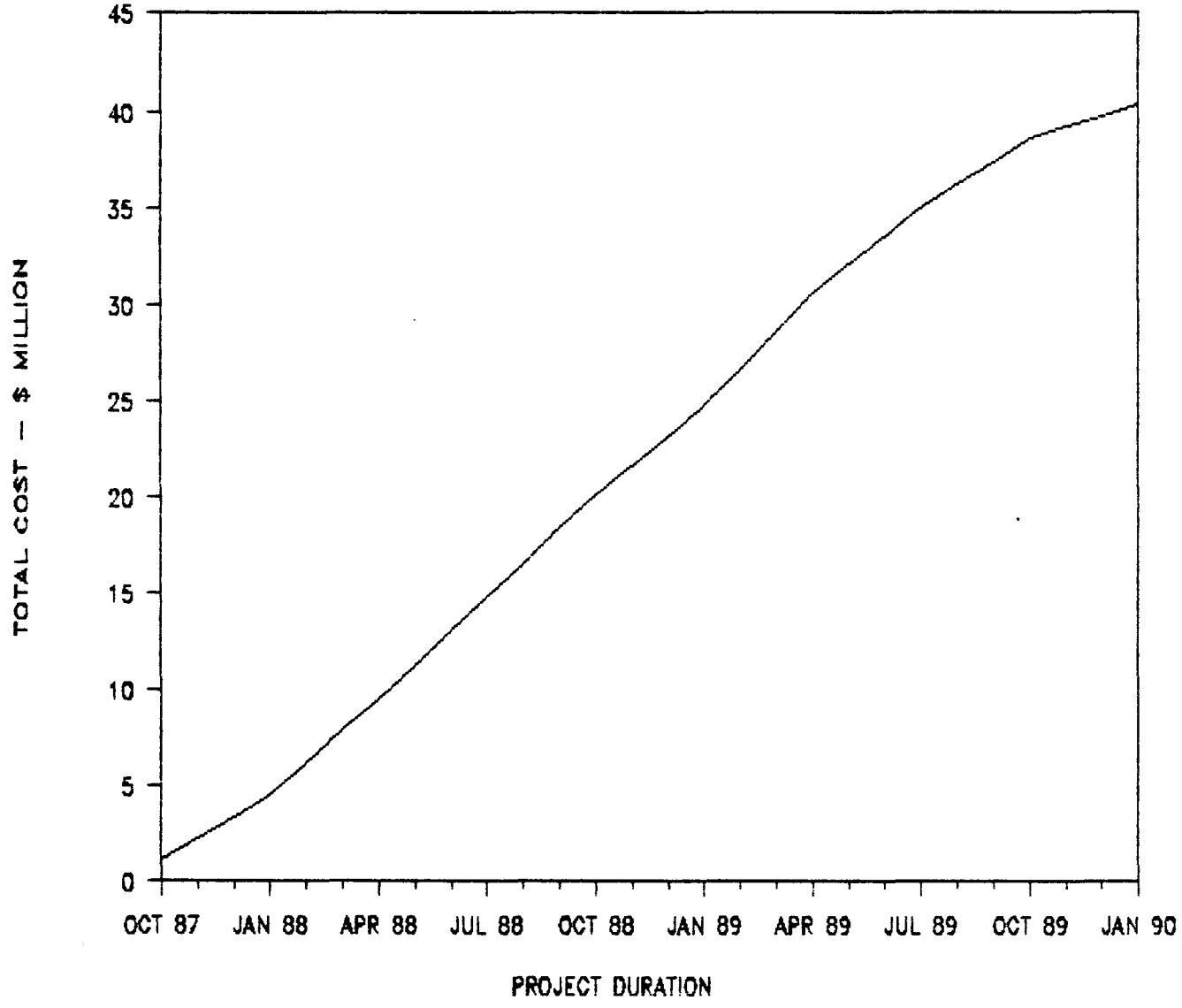


Project Schedule

RUST Contract 21-2982
Figure 4-1

St. Joe Forest Products Co.

Port St. Joe, Florida
TRS CONTROL PROJECT



Project Spending Curve

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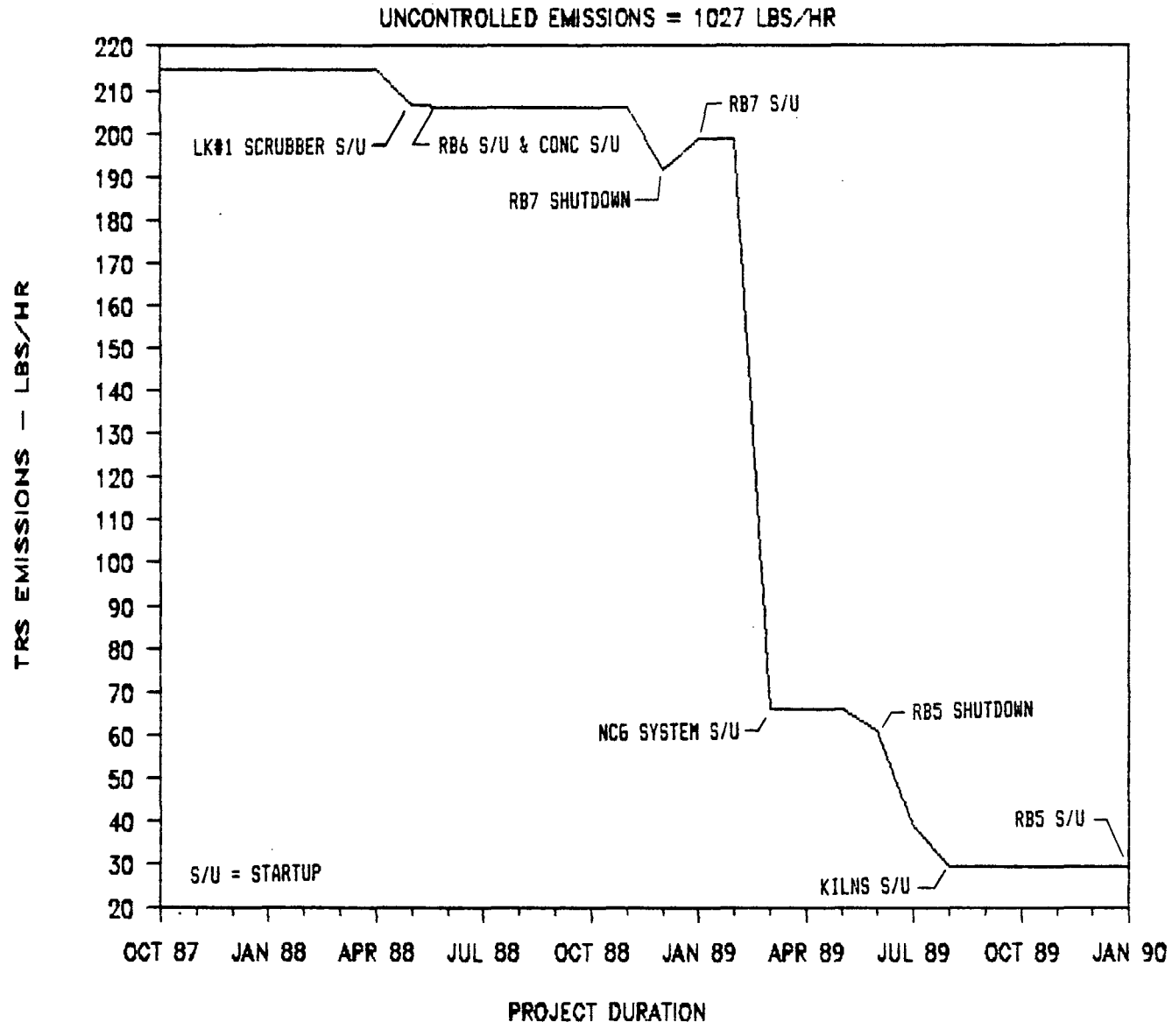
Figure 4-2

St. Joe Forest Products Co.

Port St. Joe, Florida
TRS CONTROL PROJECT



Projected TRS Emissions

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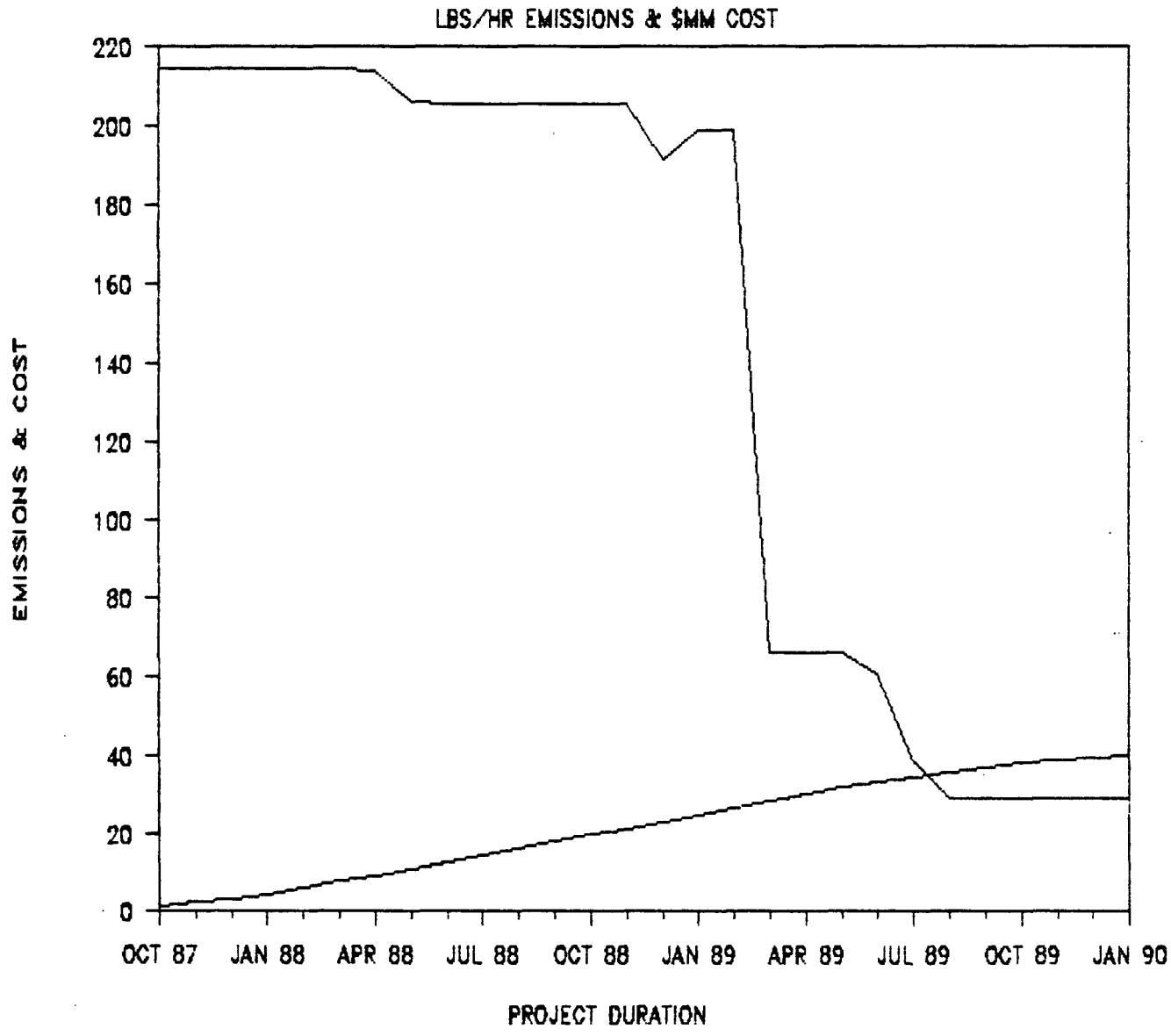
Figure 4-3

St. Joe Forest Products Co.

Port St. Joe, Florida
TRS CONTROL PROJECT



TRS Emissions vs Project Cost

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Figure 4-4