REPORT ON A TESTING PROGRAM
WITH A UNITED McGILL
MOBILE ELECTROSTATIC PRECIPITATOR

PROCESS DESCRIPTION:
PAPER MILL COMBINATION BOILER
(CLIENT'S NAME WITHHELD AT THEIR REQUEST)

By

MARK A. BRYANT

12/14/76

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ABSTRACT

United McGill Corporation performed an air pollution control equipment testing program for a client at their Georgia paper mill.

One of the United McGill Mobile Electrostatic Precipitators was used to collect emissions from a combination boiler. The test results prove that the UM Electrostatic Precipitator can effectively reduce solid particulate emissions to acceptable levels.

I. Introduction

United McGill Corporation carried out a testing program evaluating the performance of the United McGill Electrostatic Precipitator on a combination boiler. The UM Mobile Electrostatic Precipitator (Exhibit 1) and UM Air Quality Testing Laboratory (Exhibit 2) were used in tests conducted at a Georgia mill during a period from October 28, 1976 through November 15, 1976. During this program, many precipitator operating conditions were varied to determine in what range the system operated most efficiently. Those results have been evaluated and enable United McGill to size a full-scale system for that customer's needs.

United McGill extends its sincere appreciation to the personnel of the Environmental Technology Department who assisted during the testing program.

II. Test Description

A. Review

The client operates a combination boiler process at a mill in Georgia. This process is in continuous operation and burns bark and fuel oil for combustion fuel. It was the client's desire to determine if a United McGill Electrostatic Precipitator could effectively control emissions from the boiler. A copy of the UM testing proposal is presented in Exhibit 3.

The client erected a temporary 20" diameter duct from a breech located in the exhaust stack to the inlet of the UM Mobile EP. The duct run (Exhibit 4) was approximately 60' in length and insulated. This system allowed a portion of the flue gas from the boiler to be drawn into the Mobile EP. The Mobile Precipitator exhaust fan was then used to control the rate of "pull" of flue gas from the existing emission system. The Mobile Precipitator horizontal evaporative cooler was used to control flue gas temperature.

The UM Mobile EP and Test Laboratory arrived on site October 25th, 1976 and were ready for operation on the following evening. Photographs of the job site are presented in Exhibit 14.

B. Testing Program

The Mobile EP was initially started on October 28, 1976 with a system warm-up of approximately 4 hours. Once the unit had reached a stable operating temperature, the internal plate fields were energized. A very dramatic change in outlet stack condition was evident, little or no effluent (plume). After several hours of operation, the formal testing program was initiated. This schedule, which is presented in Exhibit 5, centered around testing two independent variables - EP operating temperature and EP gas flow-through velocity.

Actual emission testing was accomplished by conventional EPA Method 5, as outlined in the Federal Register. The United McGill crew measured both inlet and outlet emissions. In addition to both of these test set-ups, Lear Siegler smoke opacity monitors mounted on the precipitator inlet and outlet were used to keep a record of EP performance. A total of 22 EPA Method 5 tests were made on the system inlet and outlet.

These results were then reviewed by UM engineers and have enabled them to accurately predict how a full-scale system will perform on this type process.

III. Results

A summary of data collected during the Mobile Precipitator Testing Program is presented in the following exhibits:

Exhibit 6	-	Testing Results
Exhibit 7	-	EP Operating Conditions
Exhibit 7a	-	Combination Boiler Conditions
Exhibit 8	-	Graph - Outlet Dust Concentration Vs. S.C.A.
Exhibit 9	-	Opacity Conversion Table
Exhibits 9a - 9d	-	Typical Opacity Charts at the 4 Different Boiler Conditions
Exhibit 10	-	Particle Size Distribution
Exhibit 11	-	Resistivity Graph
Exhibit 12	-	Hopper Dust Chemical Analysis

IV. Discussion

United McGill operated the Mobile Electrostatic Precipitator at a Georgia mill under four different fuel firing conditions from the combination boiler. Each condition represented a different mixture of bark and fuel oil needed to generate a given amount of steam power (usually 150,000 lbs./hr.). These conditions appear in Exhibit 7a. Review of Exhibit 6 shows that at no time during the testing program, under these four conditions, did the United McGill Mobile EP experience any difficulty in particulate collection. Therefore, United McGill is confident that the data collected is sufficient to design a full-scale electrostatic precipitator for whatever outlet particulate conditions the client would specify.

Only once during the eighteen day testing program at the mill did the UM Mobile EP experience an adverse situation. This was hopper fires - a result of incompletely burned fuel particles emitted from the boiler stack. The particulate, collected by the Mobile EP, was allowed to accumulate in the bottom of the dust collection hoppers. As the dust level rose above the hopper capacity, the oxygen in the gas stream mixed with the hot particulate causing combustion of the incompletely burned particles, as seen in the photographs in Exibit 14.

The solution to the problem was to empty the hoppers more frequently preventing the dust level and temperature from rising and eliminating the hopper fires.

In cases where the resistivity of the particulate is high, temperature and moisture content are important factors to flue gas particulate collectibility. However, the boiler emissions were of such low resistivity that neither temperature nor moisture content had to be altered to insure good collection efficiency. United McGill did conduct three tests in which the evaporative cooler was used to cool the inlet stack gas (Exhibits 6 and 7, Test 10, 11, and 12). But again, the overall collection efficiency was so high that no conclusions can be drawn from the data.

Due to the excessively high grain loading of the process, United McGill found it necessary to use a somewhat frequent rapping sequence; ten seconds every ten minutes for the first field, ten seconds every twenty-five minutes for the second field, and ten seconds every one hour for the third field. The rapping sequence is very important and must be frequent enough to keep the plates clean in order to maximize collection efficiency of the EP; yet, it must be short enough to minimize reentrainment of the dust. United McGill feels the above information will help optimize a full-scale system.

The Specific Collection Area (S.C.A.) is the ratio of the plate area to the gas volume flow. This data is generated from tests conducted at various flow-through velocities and tests run with one and two fields energized. A graph is then derived from all the data generated by these tests. The S.C.A. number from a given test is used as the abscissa (x-axis) of the graph, and the outlet grain loading of the same test as the ordinate (y-axis). The two together form a point on the graph.

After all the tests are plotted, a computer produces a curve termed the "best-fit" curve. The best-fit curve is then referred to in order to determine what the S.C.A. number should be to achieve a prescribed outlet grain loading figure. Finally, that figure, in turn, yields the plate area of a full-scale EP. This data, along with other information pertinent to the particular process involved, is used in designing a full-size EP.

V. Conclusions

The following conclusions were drawn after the extensive Mobile Precipitator Testing Program with regard to actual full-size system design.

1. Temperature - The Mobile Precipitator operated in a range from 412°F to 480°F (measured at the EP inlet). Difference in EP efficiency was not noticed through this range. Past experience indicates that temperatures in excess of 350°F are required in order to maximize precipitator collection efficiency (and minimize precipitator internal corrosion). Efforts should be made to minimize heat loss in the inlet duct system as well as the EP chamber.

2. Moisture - Different humidity levels generally affect particulate resistivities, and therefore, EP efficiency. The Mobile Precipitator saw a range from 8.29% to 23.75% by volume (measured in the precipitator inlet duct). A full-size precipitator system should operate with a flue gas humidity of 8% or greater for optimum efficiency.

3. Precipitator Flow-Through Velocity - For an outlet particulate concentration of 0.02 gr./scfd, it appears that our full-scale precipitator design would be based on a flow-through velocity of about 5-6 fps for this mill. The Mobile EP operated above and below this point, and therefore, it is possible to predict outlet emissions from that data.

4. S.C.A. (Specific Collection Area) - This is the ratio of plate area to flue gas volume. The data suggests that it should be approximately 0.25 to 0.30 in the full-scale system for an EP outlet guarantee of 0.02 gr./scfd. The full-scale system will have three (3) fields in series.

5. Rapping - Dust on the Mobile Precipitator collector and discharge plates was easily removed with the pneumatic rapping system, and similar rapping should be used on a full-scale system.

6. Boiler Conditions - The Mobile Precipitator operated under four (4) different boiler conditions, as outlined in Exhibit 7a. Precipitator operating efficiency was high in all cases and, therefore, it is concluded that neither of the four (4) conditions tested will greatly affect precipitator operation.

UM is satisfied that the United McGill Electrostatic Precipitator will perform well on emissions from the combination boiler if the aforementioned operating conditions are applied and maintained on a full-scale system.

A complete story of the unique United McGill Electrostatic Precipitator is presented in Exhibit 13, entitled "Electrostatic Precipitators".

CRAIG M. McMILLAN, M.D.
Air Pollution Control Officer

ROBERT F. SWAN
Deputy Air Pollution Control Officer

U.S.E.P.A.
REGION 9
COMM CNTR

OFFICE LOCATION:
890 North Bush Street
Ukiah, California
(707) 468-4391

MAY 17 12 00 PM '79

COUNTY OF MENDOCINO
AIR POLLUTION CONTROL DISTRICT
COURTHOUSE
UKIAH, CALIFORNIA 95482

May 16, 1979

R. Shoulders
Georgia-Pacific Corporation
90 W. Redwood Avenue
Ft. Bragg, California 95437

Dear Mr. Shoulders:

We have received the air impact analysis for the proposed construction of the wood fired boiler to be located at the Ft. Bragg mill. The report concludes that particulate emissions will be the main air contaminant consideration. The impact of particulate emissions, however, with completion and operation of this project, should result in all remaining boilers being equipped with wet scrubbers, which should have a marked improvement on downwind air quality. The other elements, nitrogen oxides, carbon monoxide, and hydrocarbons are not a problem in any case, so they were disregarded in this evaluation.

The projected final particulate emissions from the boiler complex will be 51 pounds per hour, which is considerably below the emissions of 460 pounds per hour measured in 1976, prior to the installation of new scrubbers on boilers 1 and 2 and also below the present emissions of 113 pounds per hour. After the official announcement period of thirty days for new source review requirements, we intend to issue an Authority to Construct for the proposed No. 5 wood-fired boiler based on the following conditions:

NSPS
0.11 lb/MMBtu

1. The new boiler, No. 5, shall be equipped with a wet scrubber capable of limiting particulate emissions to less than 0.05 grains per standard cubic foot, corrected to 12 percent carbon dioxide, and;

2. Particulate emission limits on boilers No. 1 and 2 shall be reduced to 0.10 grains per standard cubic foot of exhaust gases corrected to 12 percent carbon dioxide, and;

3. Boilers 3 and 4 shall cease operation within 90 days of startup of boiler No. 5 or;

   a). The total steam load on boilers 3, 4, and 5 shall be limited to the maximum design capacity of boiler No. 5 or;
   b). The applicant shall install the best available control technology (BACT) wet scrubbers on boilers No. 3 and 4.

Georgia-Pacific should advise the District which alternative it chooses.

Copies of the air impact analysis and the Negative Declaration have previously been forwarded to the Environmental Protection Agency, Region IX, and the California Air Resources Board for their review and comment.

Copies of this announced intent is likewise being forwarded to these agencies.

The required 30-day announcement time will expire on the 10th of June 1979. The District will review and respond to any comments received prior to that time.

If there any questions concerning the analysis or any of the requirements, please inform us.

Sincerely,

Craig M. McMillan, M.D.
Air Pollution Control Officer

R. F. Swan
Deputy Air Pollution Control Officer

RFS/cr

cc: N. Waggoner
C. Sassenrath
EPA
ARB

Attachment

9.0. PRICES, TERMS AND CONDITIONS

9.1. Prices for equipment specified in this proposal as being furnished by Environeering, Inc. in Sections 3.0 and 4.0 are as follows:

One (1) A-33 - 75,000 ACFM Variable Ventri-Rod Scrubber as specified herein:	$28,118.00
One (1) 6,000 gallon capacity Hydro-Flight Clarifying Tank with 1,000 gallon Recycle Section as specified herein:	$20,841.00
Two (2) Rubber Lined Recycle Pumps and Motors as specified herein:	$ 8,671.00
System Control Panel as specified herein:	$ 3,575.00
Caustic Addition System as specified herein:	$ 3,921.00
Total Net Price:	$65,126.00

OPTIONS AND PRICE MODIFICATIONS

Adder for supplying a 10 gauge Type 316L Stainless Steel A-33 Variable Scrubber:	$26,751.00

9.2. Pricing Policy

Prices quoted are firm for orders placed within thirty (30) days of proposal date. If orders are placed after thirty (30) days of proposal date, or shipment is to be extended beyond the schedule outlined in Section 8.1, then Environeering reserves the right to update or revise the prices quoted in Section 9.1.

Prices are quoted in U. S. Currency, F.O.B. Point of Manufacture. Point of Manufacture is tentatively established at or in the Chicago, Illinois area. Environeering, Inc. reserves the right to alter point of manufacture in accordance with fabricator scheduling.

Equipment will be fabricated and shipped pre-paid to job site. Shipping and crating (if so requested) will be billed as separate items to Purchaser account.

RILEY environeering Inc.

9.3. Terms of Payment

Thirty (30) days from the date of each shipment of any part of the equipment, or performance of any part of the services, or if shipment is delayed by Purchaser, thirty (30) days from the date of notification of readiness to ship, Purchaser shall pay in cash that percentage of the purchase price for the equipment or services which equals the ratio of the equipment shipped or services performed, as determined by Seller, to the total amount of equipment or services purchased.

9.4. Terms and Conditions

Terms and Conditions are per EQ - 1f (2/75) (attached).

WGC/DCB:ctb

RILEY environeering Inc.

4233 NORTH UNITED PARKWAY, SCHILLER PARK, ILLINOIS 60176
TELEPHONE AREA CODE 312 671-6300

TERMS AND CONDITIONS

1. GENERAL

There are no understandings, representations or agreements outside of this written proposal. All previous communications between the parties hereto, either verbal or written, with reference to the subject matter of this proposal, are hereby abrogated and withdrawn, and this proposal shall constitute an agreement in its entirety. This proposal shall constitute a contract between the parties hereto when duly accepted by the Purchaser and approved in writing by Environeering, Inc. (hereinafter called Seller) at Schiller Park, Illinois, and shall not be binding upon Seller until so approved nor unless accepted by the Purchaser within thirty (30) days from date hereof. It is expressly understood that when so executed, such contract shall be considered as being made and entered into at Schiller Park, Illinois, under the laws of the State of Illinois. If any general or specific conditions of sales, including information and statements made in this proposal, conflict with any terms or provisions in the Purchaser's documents, the terms of this proposal shall govern unless Seller expressly agrees to the contrary in writing.

Seller reserves the right to correct typographical or clerical errors.

2. TAXES AND DUTIES

Any sales, use, excise, property or similar taxes imposed by any present or future law, Federal, State, Municipal or any other government agency, arising out of or relating to this order, or the goods delivered, are not included in the price except as otherwise specifically stated in the invoice. All such taxes are the responsibility of the Purchaser. The Seller shall have the right at any time to separately bill the Purchaser for any such tax which the Seller may be called upon to pay. No inspection or other fees or licenses are to be reported as chargeable to or are paid by Seller. Any duty on material described in this proposal is to be paid by Purchaser unless specifically included in another section of this proposal.

3. SHIPMENT

Shipment is to be made in accordance with the delivery schedule set forth in this proposal after receipt of order and full data or approved drawings from Purchaser necessary for execution of the same, subject, however, to delays consequent upon strikes, accidents, fires or other causes beyond Seller's control. Unless otherwise stated, shipments are F.O.B. works where made, freight not allowed, shipped collect. If the shipment of this material is postponed or delayed by Purchaser under any circumstances, Purchaser agrees to reimburse Seller for any storage costs or other additional expense resulting therefrom.

Partial shipments may be made and invoiced at option of Seller.

4. ERECTION

Purchaser will assemble and erect material herein referred to at his own expense.

5. EQUIPMENT WARRANTY

Seller warrants that the equipment and materials provided are new and guarantees the equipment against defects in materials and workmanship for a year after it is placed in operation or eighteen months after shipment, whichever comes first. With respect to equipment purchased by the Seller and not manufactured by the Seller, only the warranty extended by such other manufacturers shall apply. In no event shall the Seller be liable for incidental or consequential damages resulting from any cause whatsoever with respect to all equipment manufactured or purchased by the Seller. It is also expressly understood that the Seller is not responsible for any damages that may arise due to corrosion or erosion.

6. LICENSES AND PERMITS

All required licenses and/or permits shall be supplied by Purchaser.

7. PIPING AND ELECTRICAL WIRING

All piping of any nature and electrical wiring and power incidental to the operation of the equipment supplied by the Seller are to be furnished and installed by Purchaser.

8. PRIORITIES

All deliveries are subordinate and/or subject to deferred shipment by reason of any direct governmental priority request, requirement or restriction.

9. CANCELLATION

Following acceptance by the Seller, this order may not be cancelled without the written consent of the Seller.

The Seller shall have the absolute right to cancel and refuse to complete this order:

(1) if, at any time, all terms and conditions governing this order are not strictly complied with by the Purchaser,

(2) if, at any time, the Purchaser becomes bankrupt or insolvent, or

(3) if the Purchaser fails to post security within twenty-one (21) days after Seller has requested same based on a good faith doubt of the Purchaser's ability to make prompt payment.

In the event of such a cancellation the Seller shall have the right to indemnification for any or all costs incurred to the date of cancellation in performing the order (including the costs of any engineering studies and/or special patterns) and for the loss of profit resulting from such cancellation, which shall be deemed to be 10% of the total contract price.

The Seller shall have the right, at its option, to waive its rights to indemnification with regard to any item scheduled for completion within sixty (60) days following the date of cancellation and to complete such items and request full payment for same. The Seller shall have no responsibility or liability to the Purchaser except for the return of any excess of the Purchaser's partial payments on the order less the foregoing costs and loss of profit.

10. PAYMENT DEFAULT

In case of default of any of the payments provided for, Seller may repossess itself of the above mentioned property wherever found without due process of law and Seller shall not be liable to any action at law or equity on the part of the Purchaser for such repossession of its property, nor for any payment of any monies which have been paid by Purchaser in part payment for said property. It is agreed that equipment furnished under this contract, upon installation on Purchaser's property, shall not be considered part of the real estate until full payment in cash has been made to Seller.

11. PATENT INDEMNITY

Seller shall defend at its expense any suit or proceedings brought against Purchaser based on any claim that the equipment or any part of it covered by this proposal infringes any United States patent, and pay any damages and costs awarded therein against Purchaser not exceeding the amount paid to Seller by Purchaser, if promptly notified by Purchaser in writing of such claim and given authority, information and assistance by Purchaser (at Seller's expense) to conduct such defense. If in such suit the use of the equipment or any part of it is enjoined, Seller shall either, at its expense and option, procure for Purchaser the right to use the equipment or part, or modify it so it no longer infringes, or replace it with non-infringing equipment or part. The foregoing states the entire liability of Seller for patent infringement.

12. BANKRUPTCY

In the event of any proceedings, voluntary or involuntary, in bankruptcy by or against Purchaser, including any proceedings for reorganization or for any arrangement with creditors, or in the event of the appointment, with or without Seller's consent, of an assignee for the benefit of creditors or of a receiver, then the Seller shall be entitled to cancel this agreement and recover damages from Purchaser for any loss, including loss of profits sustained by it.