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NATIONAL METAL CASTING RESEARCH INSTITUTE

Final Report

VOLUME 1: SAND RECLAMATION

By
L.F. Vondra
J.S. Burningham

August 1995

Work Performed Under Contract No. DE-FC07-92ID13164

For
U.S. Department of Energy
Office of Industrial Technologies
Washington, D.C.

By
University of Northern Iowa
Cedar Falls, Iowa

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VOLUME 1: SAND RECLAMATION

ABSTRACT

A mobile thermal foundry sand reclamation unit was designed and constructed. This unit consisted of thermal and mechanical sand reclamation equipment installed on the bed of a 50 foot low-boy trailer. It was transported to a number of midwest foundries for on-site demonstration of the sand reclamation process. This allowed participating foundries to have their own refuse sand (10-100 tons) processed and then reused in production for evaluation.

The purpose for building the unit was to demonstrate to foundries through "hands on" experience that refuse sands can be reclaimed and successfully reused particularly in regard to product quality. Most of the participating foundries indicated a high level of satisfaction with the reclaimed sand. Laboratory testing of samples of the used sand, before and after processing by the demonstration unit, verified the usability of the reclaimed sand.

One of the foundries participating was a brass foundry, the sand from this foundry contained lead and is classified as a hazardous material. After reclamation the sand was no longer hazardous and could also be reused in the foundry.

INTRODUCTION

Task 1 of the DOE Cooperative Agreement (No. DE-FC07-92ID13164) is titled Sand Reclamation. This report (Subtask 1.5) details the research conducted as Subtasks 1.1 through 1.4. as identified in the proposal.

Subtask 1.1: *A survey of the Midwest census region foundries will be conducted to determine the types and amounts of foundry sands and binders used. Of the estimated ~1800 foundries in this region, ~1200 questionnaires are expected to be completed. The results of this survey will be incorporated into a database program, and will be published as a separate report. A report summarizing the survey results will be mailed to each of the participating foundries.*

Subtask 1.2: *The waste sand from ~100 selected locations will be subjected to laboratory testing to determine the suitability of thermal reclamation for the various foundry sands. This data will be used to determine the operating parameters for potential field testing at various sites.*

Subtask 1.3: *A mobile thermal foundry sand reclamation unit will be designed and constructed. The unit will provide for processing of sand at a 1 ton/h rate for clay-bonded sand, and a 2 ton/h rate for resin-bonded sand. This unit will be started up and pilot tested at the UNI-MCC.*

Subtask 1.4: *The mobile reclamation unit will be used for ~30 on-site field tests. Following the successful completion of the field tests, the results will be summarized in a final report (Subtask 1.5).*

Subtask 1.5: *A final report will be written summarizing the results of this task. A draft copy of the report will be submitted to DOE for approval prior to publication.*

BACKGROUND OF THE STUDY

The idea of a mobile thermal foundry sand reclamation system was conceived by Dr. Scott C. Helzer, Metal Casting Center, Department of Industrial Technology at the University of Northern Iowa, and Mal Duncan, Klean Sand Inc. of

Waterloo, Iowa. The purpose for building the unit was to demonstrate to foundries through "hands on" experience that refuse sands can be reclaimed. Klean Sand Inc. obtained funding support for the project from the Iowa Department of Natural Resources (DNR) and in partnership with the Metal Casting Center at the University of Northern Iowa from the US Department of Energy (DOE). GMD Environmental Systems, Inc. (GMD), Fort Worth Texas, (formally known as GMD Engineered Systems, Inc.) provided the engineering design and construction of the mobile demonstration unit.

The mobile thermal foundry sand reclamation unit was under the control of the University of Northern Iowa Metal Casting Center (UNI-MCC) for evaluation purposes for the research period. Mr. Daniel B. Quick, director of the UNI-MCC, had overall responsibility, Dr. L. Fred Vondra was the UNI-MCC project director, and the unit was operated by Mr. Ken Dobbs of Klean Sand Inc.

Subtask 1.1 - Survey of Midwest Foundries

A survey was constructed (Appendix A) and mailed to 1016 foundries in the Midwest, 135 (13.3%) usable responses were received back. Foundries pouring iron encompassed 47%, with 32% exclusively pouring iron. Steel was poured at 19% of the surveyed foundries, 10% poured it exclusively; 31% of the responding foundries poured aluminum, 19% exclusively; 21%

poured copper, 7% exclusively. A variety of other metals were identified as used in 7% of the foundries, none exclusively.

An average of 6400 tons/year of foundry sand was disposed of at each facility. The range was 10-100K tons annually. Transportation costs to a disposal site average $21.09/ton, ranging between $2.00-$162.00 per ton. The distance the waste sand was hauled ranged from .25-1100 miles, with the average distance of 44.59 miles. Other internal costs associated with disposal of the foundry sand averaged $7.58/ton, ranging between $.28-$90.00. 84% of the responding foundries indicated an interest in sand disposal alternatives, 62% indicated an interest in the UNI-MCC sand reclamation project. 29% indicated that they already reclaim foundry sand; 27% use mechanical methods, 2% use a thermal process, 1% use a wash process, and 4% use a variety of other processes (note: some foundries use more than one reclamation process). The average expense organizations were willing to spend for commercial sand laundering was $23.26/ton, with a range of $3.50-$150.00.

Copies of this completed report will be mailed to each of the participating foundries in the survey, giving them not only the results of the sand survey, but also of the overall project. It is intended that this will incite foundries not involved in the on-site testing to consider the technology.

Subtask 1.2 - Laboratory Testing of Sand Samples

A survey of literature and communications with GMD, the company designing and building the mobile sand reclamation unit, indicated that testing of sand samples as defined in Subtask 1.2 was not needed, and that testing of actual samples of sand taken before and after processing would yield more useful data for evaluation of the process by participating and interested foundries.

Representative samples of raw and reclaimed sand taken during processing at different sites throughout the project period were sent to Ashland Chemical Foundry Product Division for independend laboratory analysis. Appendix B contains the Sand Analysis report.

The last site visited during the project, A.Y. McDonald in Dubuque IA, was a brass foundry. The sand at his site contained lead and was classified as a hazardous material. As there was no available information of the unit's emissions during processing of this type of sand, the Iowa Department of Natural Resources requested a test of inorganic lead emissions. The emission testing was performed by Compliance Services, Inc. of Edgewood, Iowa, a copy is in Appendix D.

In analyzing the sand tests conducted on sand before and after reclamation, generally the results were very positive. For instance, the LOI's were drastically reduced on the reclaimed sand as opposed to the raw system sand. An example is the Max-Cast Foundry sand: it had a 6.91 LOI prior to reclamation and a 0.05 LOI after reclamation.

Generally, the AFS Grain Fineness Numbers (GFN) were similar when comparing raw sand to system sand. When differences did occur, they can be explained by the removal of sand fines during the reclamation process. This is an added benefit of the reclamation process. Also, the pH numbers were generally constant with no perceived ill effects occurring because of pH changes.

Subtask 1.3 - Design, Construction, and Pilot Testing

GMD provided the engineering design and construction of the mobile demonstration unit. The mobile thermal foundry sand reclamation unit consists of a GMD THERMO-SCRUBBER® Model TSIII 102.00 TPH unit mounted on a Double Drop Frame Float Trailer (3 axle, 50' length X 96" width). See Appendix B for a complete system description, as supplied by GMD.

The facility is capable of processing sand at a 1 ton/hour rate for clay-bonded sand, and a 2 ton/hour rate for resin-bonded sand. This unit was started up and pilot tested at UNI-MCC during the Month of January, 1993. The pilot test was conducted with proper notification (in regard to air permitting) under Iowa Code section 455B.500.

Subtask 1.4 - On-Site Field Tests

After successful completion of the pilot test at the UNI-MCC facility, the unit was taken to the Chicago AFS Cast Exposition (04/22/93 - 04/27/93) where is was viewed by thousands of attendees; UNI-MCC and Klean Sand representatives were on hand to answer questions. This single activity generated a large volume of interest and gave the project national exposure. In excess of 200 requests for information on the project, including 75 possible partnerships were generated while in Chicago. The unit was then transported and operated at the following sites; sand from multiple locations were processed at some sites.

Chicago AFS CastExpo	04/22/93 - 04/27/93
Falco, Fairfield IA	04/28/93 - 08/30/93
John Deere, Waterloo IA	09/07/93 - 09/27/93
Viking Pump, Cedar Falls IA	09/27/93 - 10/07/93
Ford, Cleveland OH	10/08/93 - 12/20/93
Wagner Casting, Decater IL	01/04/94 - 01/20/94
Keokuk Steel, Keokuk, IA	01/27/94 - 06/07/94
Nibco, Blythville AR	06/27/94 - 07/21/94
Atchinson Casting, Atchinson KS	08/01/94 - 09/23/94
Machine Repair, Waterloo IA	10/04/94 - 10/14/94
Mercury, Fond DuLac WI	10/20/94 - 11/01/94
AY McDonald, Dubuque IA	11/20/94 - 11/23/94
UNI-MCC	11/24/94 - END

Typical Plant Visit - Ford Cleveland Casting Plant

In April 1993 the decision was made to take the mobile reclamation unit to the Ford Cleveland Casting Plant to reclaim spent core and molding sand for reuse in the production of cores and molds. Following meetings with UNI-MCC and Klean Sand it was decided to locate the reclamation unit in the west end of the sand bay. Water, electricity and natural gas had to be run to the area prior to the program initiation. A General Kinematics Vibramill was leased and belt conveyor with mag head pulley purchased to deliver particulated sand, free of metallics, to the hopper on the mobile reclamation unit.

A detailed process plan was prepared; the mobile reclamation unit was operated on the day shift and all reclaimed sand stored in plastic lined bin boxes for evaluation. Three specific refuse sands were reclaimed: core scrap, tank sand (molding sand) and mold line 7 refuse sand. The mold line 7 refuse sand was included because the line uses a substantial amount of low acid demand silica sand. It was hoped that this sand would not increase in pH when calcined, as does the lake sand used in the other lines. The mobile reclamation unit arrived at the plant on Friday, October 8, 1993, and was spotted in the sand bay.

The first month of the program was plagued with problems. A section of the experimental refractory membrane between the fire box and calcining chamber collapsed and new refractory and fluidizing nozzles had to be installed and the refractory cured. Additional time was lost in resolving tracking problems on the conveyor, trying to get the water recirculation system operable.

Reclaimed Core Sand

On Friday, November 5th the hopper was filled with particulated core scrap and the first phase of the test plan began. The core material was reclaimed at 1100° F and 1300° F. The reclaimed sand was evaluated in the lab for screen distribution, acid demand, pH, combustibles, cold box and hot box rebond tensile strength. Additional tensile tests were run on cold box core line 7 using both Ashland and Acme resin with 100% reclaimed sand and blends of 50% and 75% reclaim with new sand.

The screen distribution on the reclaimed sand was comparable to new sand. Experimentation was required to determine appropriate settings and maintaining the damper settings on the dust collection system and maintaining good fluidization in the cooler/classifier. This problem was more acute with the tank and mold line 7 sands due to the clay content.

4.6L AODE Blocks were produced on the jobbing floor using 100% reclaimed core sand. Core quality was as good or better than new sand. Nine 4.6L AODE Blocks were cast with the above cores. Two blocks were sectioned and seven checked in layout. The casting surfaces produced by the reclaimed sand was equivalent to regular production. The layout data showed no problems using the reclaimed sand.

Pre-Scrubbed Molding Sand

The clay bonded mold line refuse sand (tank sand and mold line 7 sand) was pre-scrubbed prior to calcining. The purpose of this step was to try to remove some clay from the surface of the grain prior to processing at elevated temperature.

The refuse sand was processed through the Vibramill to remove or break down any core butts and remove any large metallics. Discharge sand from the Vibramill was carried by belt conveyor to the surge bin on the Mobile Reclamation unit. Any metallics passing through the Vibramill were removed by the magnetic head pulley on the belt conveyor. During the pre-scrubbing step the calciner was operated on pilot burner only which produced a 200° F temperature in the bed to assure that the sand entering the cooler scrubber was completely dry. The pre-scrubbed sand was stored in bin boxes having a plastic liner.

Considerable dust was generated when this sand was passed through the Vibramill, particularly the mold line 7 sand which had a higher clay level. A considerable amount of clay was collected in the baghouse during this step. The mold line 7 sand, having a much higher clay content (-9% versus -5%) was still quite dusty after pre-scrubbing.

Reclaimed Mold Line 7 Sand

Pre-scrubbed mold line 7 sand was calcined at 1100° F, 1350° F, and 1420° F and scrubbed. The sand processed at 1100° F and 1350° F was still quite dusty and this sand was mixed with the remaining pre-scrubbed sand and processed at 1420° F and scrubbed. A total of 7.2 tons of reclaimed mold line 7 sand was produced for evaluation.

The AFS clay level was lowered appreciably (0.6%); however, the amount of material retained on the 140 and down screens was greater than desired. The pH increased at this process temperature to 10.9 which is much higher than desirable for use in the hot box process. This increase indicates that an appreciable amount of lake sand was present due to core sand input and was picked up in the process of taking sand out of the basement.

Cold box tensile strengths on samples prepared in the lab using 75% reclaimed sand and 25% new sand were only about 50% of the control sample with 100% new sand. Hot box tensile strengths were similarly lowered with an even greater reduction on the 5", 10" and 20" test bars. Eight bin boxes of this sand have been sent to National Engineering for additional attrition scrubbing to try and remove the material on the 140 and down screens, lower the AFS clay level and improve the rebond performance.

Reclaimed Tank Sand

Pre-scrubbed tank sand was calcined at 1100° F and 1350° F and scrubbed. A total of 14.4 tons of reclaimed tank sand was produced for evaluation. The lower temperatures were chosen to try and minimize the increase in pH common when a lake sand containing lime is calcined at temperatures above 1000° F.

The screen distribution on the reclaimed sand was very similar to new sand other than 0.3/0.6% material retained on the 270 and pan. The AFS Clay level at 0.48-0.60 is higher than desired.

Cold box tensile strengths on samples prepared in the lab using 75% reclaimed sand and 25% new sand were 65-80% of the control sample with 100% new sand. Hot box tensile strengths were 45-91% of the new sand control with the lowest strengths occurring on the 5" and 10" test bars (45-47%). Cold box tensiles run on core line 7 with 50%, 75%, and 100% reclaimed sand were 92%, 68%, and 58% of the control sample with 100% new sand. Based on these results it was decided to make production cores using 50% reclaimed tank sand.

4.6L AODE Isocure block jackets and front end cores were made using tank sand reclaimed at 1100° F following pre-scrubbing and 50% new sand. The front end cores were strong and displayed good scratch hardness. The jackets were reasonably strong and had fair scratch hardness. Scrap on the jacket cores was quite high primarily due to excessive screen plugging due to fines. Six 4.6L AODE blocks were cast using these cores. Layout data on these castings was comparable to blocks produced from cores made with new sand.

Seven bin boxes of this sand were sent to corporate engineering for additional attrition scrubbing to try and remove the 270 and pan material, lower the AFS clay level and improve the rebond performance.

Typical Mobile Thermal Reclamation System Operation

Sand Storage Hopper This hopper was able to hold approximately 11 tons of particulated sand. The Mobile Reclamation unit is usually not operated inside a covered structure and the hopper is filled using a small bucket elevator which discharges through an access hatch in the cover. When the bucket elevator was used to fill the hopper with sand an operator had to manually spread the sand away from the elevator discharge point in order to fill the hopper to capacity.

Screw Feeder A screw feeder delivered sand from the bottom of the hopper to the calciner. At previous locations problems had been encountered due to sand getting into the drive motor which was located at the low end of the feeder.

No problems were encountered with the screw feeder during the operation at Ford's CCP.

Fluidized Bed Calciner As mentioned previously, a section of the experimental refractory fluidizing membrane in the calciner collapsed during operation and/or transportation from the previous operating location. Two weeks were needed to repair and cure the refractory before the test program could begin. The replacement experimental refractor was of a new design to hopefully overcome the problem of the original. Other than this problem the calciner performed well. The control of process temperature to set point was excellent.

Cooler Scrubber Hot sand from the calciner discharged directly into a fluidized bed cooler scrubber. A 50 Hp motor and blower was used to fluidize the sand. The unit consisted of several zones created by baffle plates set slightly above the bottom of the unit and crossing the width. These plates forced retention time of sand in the cooler to achieve adequate cooling. Indirect cooling was achieved by contact of the hot sand with cooling fins through which cold water flowed. City water was used and discharged to the sewer.

The unit did a good job in bringing the sand to a temperature below 120° F. At times, particularly when molding sand was being processed, fluidization in the first stages of the cooler would deteriorate. When this happened, a compressed air lance would be used to help restore proper fluidization. The operator believed that there may have been some partial plugging of the fluidizing outlets in the bed.

A single cell pneumatic scrubber was an integral part of the cooler. When sand reached the "cool end" of the unit, it was propelled by air up a tube striking suspended sand in a target. At the point of impact intense grain on grain attrition takes place. Each grain impacted the target numerous times before dropping into the fluidized bed and flowing over a final weir and exiting the system. No specific problems were encountered with this portion of the equipment.

Baghouse A 6,150 scfm baghouse provided dust collection for the system. A number of dampers in the system were used to control pressure at various points in the system. The dampers were manually adjusted to produce the desired screen distribution of the reclaimed product. This was a "trial and error" operation which left much to be desired.

No specific problems were encountered with the baghouse. The loading of the baghouse while processing the molding sand, particularly the mold line 7 sand with the higher clay level, was extremely heavy requiring frequent dumping of the collection hopper.

Bucket Elevators A bucket elevator was used to deliver sand from the discharge point on the mobile reclaimer to plastic lined bin boxes. This elevator in conjunction with a fabricated sheet metal chute enabled the filling of several bin boxes. A second bucket elevator was used to fill the hopper on the mobile reclaimer with pre-scrubbed molding sand. A free-standing metal flange was fabricated to facilitate dumping of bin boxes of sand with a roll over fork truck. No problems were encountered with the elevator.

Sand Reclamation Process Plan

Day 1 & 2

Dry-Run Check Out The system will be run without heat energy to verify all safety interlocks and alarms in response to simulated malfunctions, check each function for proper startup and run, and to calibrate the speed range of the variable frequency speed drive to establish actual capacity at several settings on the variable frequency controller. Note: Core scrap will be delivered to the area using the dump truck presently used to remove scrap cores and core sand from the plant. Loading of the truck will be monitored to assure that uncured core sand and excessive garbage are not brought to the area.

Cold Run Check Out Turn on Vibramill and fill with core scrap using a front end loader. Continue adding core scrap until feed hopper is full of particulated core scrap. During the cold run check out, any residual sand retained in the system from running at the previous foundry will be flushed from the system.

Operate the system without heat and cooling water until system is filled with sand and sand begins discharging from the cooler scrubber. Check system for proper operation. Note: For the cold check out run as sand passes through the system it will be collected in bin boxes, returned to the Vibramill and fed back into the system.

Low Temperature Check Out Ignite burners and begin ramping up to an operating set point of 300° F. Turn cooling water on to the cooler scrubber. Verify the overall thermal stability of the system. Note: This low temperature operation will be used as a "Pre Treatment" on the clay bonded refuse sand.

High Temperature Check Out Set operating temperature to 1100° F. Following ramp up to operating temperature, verify overall thermal stability of the system. Once overall thermal stability of the system has been verified, the initial run of refuse sand is ready to begin.

Day 3

Core Scrap Reclamation Deliver core scrap to reclaimer in sand bay. A minimum of 10 ton of scrap cores should be available for initially charging the Vibramill. A supply of core scrap must be maintained in the area during the duration of the test program. During operation of the Vibramill a sample (quart) of the particulated sand should be taken twice per shift, identified (date and time) and retained for analysis. Set variable frequency speed drive, previously calibrated, to deliver particulated sand to the system at the desired rate.

Analyze a sample of the reclaimed sand for screen distribution and AFS clay. Target for setting up the system should be 0.3% maximum retained material on the 140 and down screens and 0.2% maximum on the AFS clay.

Day 4

Pneumatic Scrubber control valve and Pneumatic Cooler-Scrubber damper in the flue stack of the recuperator must now be adjusted to give the desired sand fines "cut off" point. Once these adjustments have been set, varying the volume of air increases or decreases the cut off point which the sand fines are allowed to pass through to the baghouse hopper. Adjust control valve and scrubber damper based on lab data.

Analyze another sample in the lab for retained material on the 140 and down screens and AFS clay. Repeat process until desired output is attained. By repeating the test for a series of valve settings, a calibration curve can be developed. This curve can be used to correct a "drift" in screen distribution should it occur. Sand reclaimed during the time the above adjustments are being made should be discarded.

Day 5

Produce one ton of sand reclaimed at 1100° F and store sand in a lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Change calcining temperature to 1300° F. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded. Produce one ton of sand reclaimed at 1300° F and store sand in a lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Day 6 & 7

Based on evaluation of the laboratory data select the optimum processing temperature. Change calcining temperature to the desired setting. During the time the temperature is adjusting to the set point and for the next four hours the reclaimed sand should be discarded. Produce five ton of sand reclaimed at the optimum temperature and store sand in lined bin boxes for future evaluation in production or on the jobbing floor. A sample of the reclaimed sand should be taken at the start, middle and end of the run, identified and retained for future analysis if required.

Day 8

Pre-Conditioning of Tank and Mold Line 7 Sand Deliver tank sand and mold line 7 sand to reclaimer area in sand bay as required. A minimum of 10 ton of tank sand should be available for initially charging the Vibramill. A supply of tank sand must be maintained in the area to operate during the day shift (8-12 ton per day). During operation of the Vibramill a sample (quart) of the tank sand should be taken twice per shift, identified (date and Time) and retained for analysis. Set calciner to the 300° F pre conditioning operating temperature.

Allow the feed hopper to run out of particulated core scrap. Turn on Vibramill, fill with tank sand, and begin filling the feed hopper (8 ton) on Mobile Reclaimer. Core butts will be broken down or removed in the Vibramill as well as any large metallic pieces. Fine metallics will be removed when the sand passes over a mag pulley before entering the hopper. Operate Vibramill as required to assure that an adequate supply of tank sand is maintained in the feed hopper.

Set variable frequency speed drive, previously calibrated, to deliver tank sand to the system at the desired rate. Operate the system for four hours to purge the system of core sand from the previous run. This sand, which will be a mixture of reclaimed core scrap and reclaimed tank sand, should be discarded.

Day 9

Analyze a sample of the reclaimed sand for screen distribution and AFS clay. Target for setting up the system should be 0.3% maximum retained material on the 140 and down screens and 0.2% maximum on AFS clay. Using the previously developed calibration curve, adjust air volume as required to attain the desired level of material on the 140 and down screens. Repeat this procedure, if required, to attain the desired levels. Sand processed during this "adjustment period" should be discarded.

Day 10, 11, 12, 13, 14, & 15

Produce 30 ton of "pre conditioned tank sand" and store in plastic lined bin boxes for use in calcining phases. Each bin box should be identified with a date and time. Samples should be taken at three hour intervals and analyzed for AFS Clay and screen distribution. When 25 ton of pre-conditioned tank sand has been accumulated, and with the feed hopper full, stop the addition of tank sand to the Vibramill. Allow the feed hopper to empty and begin adding mold line 7 sand to the Vibramill. For the next four hours discard the sand produced which will be a mixture of tank sand and mold line 7 sand. When 2 tons of pre-conditioned mold line 7 sand has been accumulated and with the feed hopper full, stop the addition of mold line 7 sand to the Vibramill. At the end of the run the feed hopper should be allowed to empty in preparation for the calcining runs.

Day 16

Mold Line 7 Silica Sand Reclamation Set calcining temperature to 1100° F and begin adding pre-conditioned mole line 7 sand. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded.

Analyze a sample of the reclaimed sand for screen distribution and AFS clay. Target for setting up the system should be 0.3% maximum retained material on the 140 and down screens and 0.2% maximum on AFS Clay. Using the previously developed calibration curve adjust air volume as required to attain the desired level of material on the 140 and down screens. Repeat this procedure, if required, to attain the desired levels.

Day 17

Produce one ton of preconditioned mold line 7 sand reclaimed at 110° F and store sand in lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Change calcining temperature to 1300° F. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded. Produce one ton of pre conditioned mold line 7 sand reclaimed at 1300° F and store sand in a lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Day 18

Change calcining temperature to 1500° F. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded. Produce one ton of pre conditioned mold line 7 sand reclaimed at 1500° F and store sand in a lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Day 19 & 20

Based on evaluation of the laboratory data select the optimum processing temperature. Change calcining temperature to the desired setting. During the time the temperature is adjusting to the set point and for the next four hours the reclaimed sand should be discarded. Produce five tons of pre-conditioned mold line 7 sand reclaimed at the optimum temperature and store sand in lined bin boxes for future evaluation in production or on the jobbing floor. A sample of the reclaimed sand should be taken at the start, middle and end of the run, identified and retained for future analysis if required.

Day 21

Tank Sand Reclamation Allow the feed hopper to run out of pre conditioned mold line 7 sand. Turn on Vibramill, fill with pre conditioned tank sand, and begin filling the feed hopper (8 ton) on Mobile Reclaimer. Operate Vibramill as required to assure that an adequate supply of pre conditioned tank sand is maintained in the feed hopper.

Set variable frequency speed drive, previously calibrated to deliver pre conditioned tank sand to the system at the desired rate. Operate the system for four hours to purge the system of reclaimed pre conditioned mold line 7 sand from the previous run. This sand which will be a mixture of reclaimed mold line 7 sand and reclaimed tank sand should be discarded.

Set calcining temperature to 1100° F and begin adding pre-conditioned tank sand to the calciner. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded.

Day 22

Analyze a sample of the reclaimed sand for screen distribution and AFS Clay. Target for setting up the system should be 0.3% maximum retained material on the 140 and down screens and 0.2% maximum on AFS Clay. Using the previously developed calibration curve, adjust air volume as required to attain the desired level of material on the 140 and down screens. Repeat this procedure, if required, to attain the desired levels. Sand processed during this "adjustment period" should be discarded.

Day 23

Produce one ton of preconditioned tank sand reclaimed at 1100° F and store sand in lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Change calcining temperature to 1300° F. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded. Produce one ton of pre conditioned tank sand reclaimed at 1300° F and store sand in a lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Day 24

Change calcining temperature to 1500° F. During the time the temperature is ramping up to the set point and for the next four hours the reclaimed sand should be discarded.

Produce one ton of preconditioned tank sand reclaimed at 1300° F and store sand in a lined bin box properly identified. Note: When approximately half the reclaimed sand has been produced, take a sample to the lab for determination of sand properties and production of hot box and cold box tensile specimens.

Day 25 & 26

Based on evaluation of the laboratory data select the optimum processing temperature. Change calcining temperature to the desired setting. During the time the temperature is adjusting to the set point and for the next four hours the reclaimed sand should be discarded. Produce five ton of pre conditioned tank sand reclaimed at the optimum temperature and store sand in lined bin boxes for future evaluation in production or on the jobbing floor. A sample of the reclaimed sand should be taken at the start, middle and end of the run, identified and retained for future analysis if required.

Notes

Rebonding of Thermally Reclaimed Yuma Lake Sand. The adverse effects of calcining the high acid demand Yuma Lake Sand at temperatures above 1000° F have been well documented in past experimental work done at the Cleveland Casting Plant. In the work done with thermally reclaimed core scrap, ferric chloride was successfully used to achieve satisfactory rebonding of the reclaimed sand with both the phenolic hot box and Isocure processes. Acme/Borden and Ashland Chemical have been asked to work on a solution for this rebond problem. Acme/Borden has a material, Sigma Cure 7410, which has shown some promise of improving rebond properties on the reclaimed sand. Ashland has only documented, what is already known with respect to rebonding of thermally reclaimed sand, and have not made any suggestions to solve the problem.

<u>GMD THERMO-SCRUBBER® MOBILE UNIT (Process Flow)</u>

1. Particulated sand free of metallics is delivered to the 11 ton capacity feed hopper. (5.5 hour supply for resin bonded refuse sand processed at 2 ton per hour, 11 hours supply for clay bonded refuse sand processed at 1 ton per hour)

2. Variable speed, low speed screw conveyor takes sand to the feed point on the calciner located above the fluidized bed. Sand flows by gravity into the fluidized bed of the calciner.

3. In the bed, heat is added via a fossil fuel combustion system as required to supplement the 550° F secondary air, which has gained its heat via the recuperator located in the exhaust flue, and the heat generated by

combustion of organics in the feed material. All supplemental fuel is fired in the fire box below the calcining chamber. No supplemental fuel is fired in the bed.

4. Sand works its way through the bed and discharges by gravity flow into the GMD Pnu-Cooler Scrubber

5. As hot sand enters one end of the Cooler Scrubber, it is cooled by direct contact with fluidizing air and indirectly by contact with stainless steel "helical finned" water cooled coils. Rapid heat transfer occurs between the cooling coils and fluidizing air and the sand. The unit is designed for the addition of "fogging" water spray nozzles for first stage evaporative cooling where high inlet sand temperatures dictate.

6. Sand exits the cooler section at 90°—120° F and enters the two cell pneumatic scrubber section.

7. In the scrubber, sand is accelerated vertically up a tube and strikes a target. During operation a continuous pocket of sand exists in the target. The sand moving at a high velocity up the tube strikes the target creating an intense abrading action on the grain surface abrading the clay from the sand grain. An air curtain in the plenum sweeps the clay dust, silica fines and unwanted

fine sand grains from the negative pressure atmosphere that is maintained in the target area. Individual sand grains will make numerous "hits against the target" as they work their way through the two cells of the scrubber.

8. Reclaimed sand flows over a weir in the discharge end of the Cooler Scrubber and is collected in a suitable container.

<u>Mobile Thermal Sand Reclamation Unit</u>

The unit consisted of thermal and mechanical reclamation equipment installed on the bed of a 50 foot low-boy trailer. The unit was transported across secondary roads, and not across interstate highways due to limited ground clearance. The limited ground clearance made it impossible to negotiate the on and off ramps.

There were a number of components on the mobile reclaimer that had to operate efficiently as a system in order to produce an adequate reclaimed product. Each of these components can be broken down with regard to their function and operative characteristics.

Grain size refuse sand is first introduced to the sand storage hopper. The hopper initially had a cover on it to protect the refuse sand from the elements during operation outdoors. The cover was removed to ease the loading of sand into the unit. The hopper was able to hold approximately 11 tons of particulated sand. There were no problems associated with the hopper when used with the conveyor belt, but when the bucket elevator was used, there was a problem with sand dispersement. Individuals had to climb into the hopper and use a shovel to spread the sand to insure even filling and maximize the hopper volume. This problem was a result of the positioning and increased capability of the bucket elevator as opposed to the conveyor belt system.

Sand was taken from the bottom of the hopper by a screw feeding auger. According to the operator, this was to be one of the more sensitive pieces of equipment in the system as well as the most probable for failure. The motor for the auger was directly below the low end of the screw feeder. At previous locations the motor had become frozen due to the compaction of sand in the auger and sand leaking out of the auger and burying the motor. The screw feeder had a variable speed control on the main control panel of the unit, but for the most part was run between 50% and 75% of its total capacity.

As was previously mentioned, the experimental refractory inside the calciner collapsed during operation of the unit at the previous foundry and/or transportation of the unit to

Cleveland. Refractory people were supplied by GMD to repair the damage. An additional week of time was required to dry and slow cure the new refractory to prevent cracking during curing and use. Once this was completed, the calciner functioned with no noticeable problems.

The fluidized bed cooler which received sand directly from the fluidized bed in the calciner, required a minimal amount of maintenance. The sand in the bed maintained a fluid state due to air that was forced from the bottom of the bed, through the sand, and out of the top. The fluidizing air was able to maintain constant mixing of the sand, increasing the surface area and allowing for the greatest amount of cooling to occur. Pipes were run across the bottom of the fluidized bed through which water was run. The cold pipes extracted heat from the hot sand by conduction and convection. By mixing the sand continuously, greater amounts of the sand were cooled. At times, a dead spot would form in the bed resulting in a lack of cooling or mixing. To remedy the situation, compressed air would be introduced from an outside source. This would cause increased mixing as well as increased cooling. The need for this was infrequent.

During fluidization, dust would be removed from the sand along with the emissions from the calciner and sent through a bag house before being released to the atmosphere. Depending upon the type of sand being processed, the need for the unit to automatically empty the bags could be frequent or rare. The expected life of the bags (filter cartridges) is 4,000-6,000 tons of processed sand There were dampers throughout the ventilation system which could be adjusted to allow for increased air flow. This will either increase or decrease the efficiency of the bag house.

Sand was discharged from the fluidized bed into a bucket elevator which in turn loaded the sand into plastic lined bin boxes. The boxes were approximately one cubic yard and when filled with reclaimed sand weighed between 1700 and 1800 pounds. Depending upon the rate at which the screw feeder was set, the bin boxes could be filled within 30 to 45 minutes. There were no problems associated with the discharge portion of the unit.

When processing tank sand and Mold Line #7 sand, which did not need to be particulated, a bucket elevator was used to fill the main hopper of the mobile reclaimer. To make it easier when dumping a bin box with the roll over fork lift, a large extension was fabricated. The mouth of the extension was larger than that of the bucket elevator which allowed for the loading of sand form the bin boxes with a minimal amount of sand loss. As was previously mentioned, the only problem with the elevator was the lack of dispersement at the discharge of the unit resulting in uneven filling of the hopper.

PROBLEMS

Some of the operational problems encountered during the project period include:

1. Permits required for operation at sites.
2. Excessive bag house residue.
3. Cooler classifier sand flow.
4. Collapsed hearth.
5. Plugged fluidizing nozzles.
6. Sand feed problems.
7. Programmable controller failure.
8. Excessive water usage.
9. Ruptures of bag house transitions.
10. Gear box failures.
11. Magnathermic gas valve malfunction.
12. Excessive thermal losses in sub-zero weather.
13. Loss of natural gas due to service interruptions.

System problems resulted in unplanned delays and downtime. The mechanical equipment problems may well have been caused by the stresses placed on the unit during transportation that will have to be addressed in subsequent mobile units.

FAILURES

The main failure of the project was the inability to conduct the number of on-site field tests specified in Subtask 1.4, even with the project extension. As the mobile thermal sand reclamation unit was a first, unplanned operational problems were encountered. Besides maintenance, transportation, setup, and tear down delays, there were obstacles associated with obtaining the necessary permits for the operation of the unit (governmental regulations were not sometimes flexible enough for a "mobile factory" nor research activity). Also unforeseen was the length of time participating foundries wanted the unit on-site for evaluation, although this could easily be classified as a success because this corresponded with the interest level of participating foundries.

SUCCESSES

The biggest success of this project is the proof of concept and the demonstration that thermal sand reclamation is a viable alternative for foundry sand disposal. At each of the foundries the sand that was reclaimed was used for the production of cores and molds, discharging any concerns about the usability of the sand. Klean Sand is beginning the process of operating the unit as a commercial business venture. Reclamation of foundry sand is becoming an increasingly discussed topic as disposal becomes more expensive. The mobile unit is a good way to bring the technology to the smaller foundry. It is also the only way to perform complete on-site evaluations for foundries considering installation of fixed site processing facilities; it is a "try it before you buy it" concept for a typically large capital investment.

Another major success is the actual learning which took place in operating the unit with sands from fifteen different foundries. It took time, but time well spent, in learning how to adjust the unit to reclaim and move sand with AFS GFN ranges from 30-80. In the case of the AFS GFN 30 sand the unit had difficulty fluidizing the sand. Outside plant air had to be introduced into the cooler/scrubber to achieve fluidization. This problem is being rectified by the installation of a larger more powerful blower motor.

The problem of the failure of the original experimental refractory membrane caused a redesign of the replacement. The original unit consisted of 12" of Kaocrete 30 with 4% stainless needles, a .128" mid-layer of Kaowool mill board, topped with 4" of Kaocrete H.S. RFT with 10% Stainless needles. The redesigned replacement unit consisted of 12" of National EZ-Cast 3200 with 4% stainless steel needles, a

.128″ mid-layer of Kaowool mill board, topped with 4″ of National EZ-Cast 3000 with 4% stainless steel needles. The redesigned refractory membrane eliminated the problem and was a success.

COMMERCIAL BENEFITS OF SAND RECLAMATION

The benefits of sand reclamation include savings in energy required to excavate sand, transport sand to various foundries, and transport sand to various disposal sites. Based on an average shipping load of 20 tons, an average shipping distance of 500 miles to foundry and 50 miles to disposal site, and average fuel consumption of 10 miles per gallon of diesel fuel, it can be estimated that the average fuel consumption to ship and dispose of one ton of sand is approximately 2.75 gallons plus approximately .25 gallons/ton for excavation. Total energy savings is estimated at 3 gallons/ton of sand reclaimed. The energy saved is offset by approximately 33.5 KWH/ton electrical usage, and 125 ft^3/ton of natural gas usage for each ton of sand reclaimed.

Job creation in the commercialization of the (transportable) service will be approximately 1.4 FTE per unit incorporated (1 person to operate each unit, plus 2 support staff at approximately .20 FTE each). Job creation in the manufacture of additional sand reclamation systems and job savings from maintaining the competitiveness of domestic metal casters under tightening environmental regulations are additional.

Offsets in job creation are vague, however the following analysis is offered. Based on average shipping distance and an estimated travel speed of 60 miles/hour, labor required to transport 20 tons of foundry sand is estimated at 8.33 hours (500mi/60mi/hr). An additional .67 hours is estimated to excavate the 20 tons of sand. Total man-hours required for the excavation and delivery of one ton of foundry sand is estimated at .45 hours ((8.33+.67)/20). An additional hour is estimated for delivery of the foundry sand to the disposal site. In total, it is estimated that .50 hours of labor per ton of foundry sand will offset the estimated job creation by this process. Based on the estimated volume of 5400 tons of sand per year that can be processed by one unit, it is estimated that 2700 man hours or 1.35 FTE will be lost to this process. In summary, it is estimated that average job creation will approximately equal average job loss.

Environmental benefits of an approximate reduction of 5400 tons/year of foundry sand for each transportable sand reclamation unit incorporated. Of the estimated 275,000 tons of sand disposed of in Iowa per year, approximately 43,200 tons fit within the parameters of being profitably reclaimed through the transportable sand reclamation *service* (i.e-foundries which dispose of fewer than 1500 tons/year). If fully implemented, prior to the year 2000 approximately 8 transportable units are realistically expected to be incorporated by Klean Sand, Inc., in order to service the reclamation needs within the state of Iowa. Estimated benefits to the state of Iowa are the reduction of 43,200 tons/year in waste sand disposal, and energy savings equivalent to approximately 129,000 gallons of diesel fuel/year, offset by energy usage of 1.4 million KWH of electricity, and 5.4 million ft^3 of natural gas.

It is anticipated that additional (non-affiliated) sand laundering businesses will be initiated nationally to service other geographic sectors following proof of market feasibility (which should be evident prior to 1996) in Iowa. Sixty out of approximately 3,000 or (approximately 2%) of domestic metal casters are located within the state of Iowa. Proportionately, total national market potential for the *service* is estimated at 2.2 million tons of sand/year (43,200/.02). If implemented at full market capacity, 400 transportable units will be incorporated with a reduction in the disposal of 2.2 million tons of sand/year, and energy savings of 6.6 million gallons of fuel/year offset by energy usage of 73.7 million KWH of electricity and 275 million ft^3 of natural gas.

Realistic (domestic) market penetration by the year 2000 is estimated at 25%. This equates to the incorporation of 100 transportable units, a reduction in the disposal of 550,000 tons of sand/year, and energy savings of 1.65 million gallons of diesel fuel/year offset by energy usage of 18.4 million KWH of electricity and 68.8 million ft^3 of natural gas.

Tangible indications of the adoption of thermal sand reclamation are summarized as follows:

Klean Sand has begun commercialization of market-driven sand laundering service for small and medium sized foundries as indicated previously.

Atchison Castings has contacted GMD Engineered Systems regarding a permanently placed, (5-6 ton/hour) thermal reclamation unit at their facility.

NIBCO has issued corporate directive to investigate implementation of thermal reclamation through capital investment (dedicated unit), or service procurement.

Ford Motor Co. will probably incorporate thermal reclamation (dedicated unit) contingent upon the availability of adequate capacity to support the facility.

FALCO currently is not pressured by adverse landfill costs, however should landfill costs increase (highly probable), will incorporate thermal reclamation through service procurement.

CONCLUSIONS

The operation of the mobile thermal sand reclamation unit throughout the project uncovered some areas which were not foreseen prior to it's use. The general all around operation required substantial time for heat up and cool down of the unit in most cases. The host foundries which participated in the project in many cases were not ready for the unit's arrival. It took excessive time to hook up the energy delivery system to the unit. Also time was required to clean out prior to its move to the next foundry. Generally, the unit operated well. However, there were a few equipment breakdowns which contributed to project downtime. These instances all contributed to the reduction in the number of foundries visited during the course of the project.

The unit ran successfully in all of the foundries which participated. It displayed excellent results in foundries which used chemically bounded sands. The unit also displayed good results in green sand foundries. However, chemically bonded sand revealed better reclamation results than green sand.

The foundries which participated in this project all are considered, by their participation, progressive entities. They are looking to the future and are considering their costs and environmental responsibilities.

RECOMMENDATIONS

Any future mobile unit construction should consider redesign in some areas. The sand delivery from the surge bin to the calciner should be redesigned. While the auger feed worked well the motor drive and gear box should be relocated to the top of the auger rather than the bottom. Sand has a tendency to work its way through the seals and tear up the gear box. This happened on two occasions and caused some downtime.

An easier way to clean out the unit should also be incorporated. This unit operates under the push principle, where by sand already in the unit needs to be pushed out by follow up sand. Most foundries do not want sand left in the unit by the previous foundry. Also, the unit is heavy enough for over the road travel without adding approximately two tons of sand left in the calciner and cooler/scrubber.

Basically, the unit functioned quite well for a first of a kind unit. It traveled well over the road. It was not difficult to operate once one learned the unit.

APPENDIX A

SAND SURVEY

Metal Casting Center

University of Northern Iowa
Department of Industrial Technology
Cedar Falls, IA 50614-0178

TO: Midwest Regional Metal Casting Industry

DATE: March 24, 1993

RE: Sand Survey

The Metal Casting Center (MCC) is an entity within the University of Northern Iowa's Department of Industrial Technology. In conjunction with the U.S. Department of Energy, we are presently conducting an applied research project which examines the feasibility of commercial sand reclamation for foundries in the Midwest Census Region of the United States.

We ask that you take a moment to complete the attached sand survey which will help us to determine the degree of acceptance that sand reclamation has to midwestern foundries. **All information will remain confidential.** We will begin compiling data that we receive on June 1, 1993. Based on the survey results, we will be field testing a transportable sand reclamation unit, on-site, at selected locations.

The long-term objective of this project will be to encourage the formation of commercial sand laundering services throughout the region. Such services have tremendous potential to benefit the foundry industry through cost reductions in the purchase, disposal, and transportation of foundry sands.

Keep in mind that you will not need to complete the entire survey. We ask that you complete the first two pages, along with the pages which pertain to the types of sand which you use in your production operation. We will be distributing a summary report to all foundries which participate in this study.

Because the MCC's efforts are targeted toward applied research, we choose projects which display an immediate benefit to the operating metal casting industry. If you have any questions or concerns pertaining to this project or potential projects that would benefit your organization, please give us a call. We would like to thank you for your efforts in completing this survey.

Sincerely,

Daniel B. Quick, Director
Metal Casting Center

survey attached

Telephone: (319) 273-6894 FAX: (319) 273-5959

Foundry Sand Survey

General Information

Organization name: ______________________________

Facility (if captive): ______________________________

If captive, what percent? ______ % captive ______ % jobbing

Contact Person/Title: ______________________________

Mailing Address: ______________________________

City: ______________ State: _____ Zip: _________

Phone # : (_____) ______ - __________

What is your primary business? __________________

What are your top 3 products? __________________

____

____

Please indicate percentages for the types of metal that are poured at your facility (total to 100%):

iron _____ steel _____ aluminum _____ copper based _____

_____ Other ______________________________

1) Approximately how many tons of foundry sand does your facility purchase annually? __________ (tons)

2) What is the average shipping distance for purchased foundry sand? __________ (miles)

3) What is the average time lag between order and delivery of purchased foundry sand? __________ (days)

4) How does your facility currently dispose of foundry sand?

_____ Landfill/Monofill _____ Beneficial Reuse (non - foundry)

_____ Other ______________________________

5) Approximately how many tons of foundry sand does your facility dispose of annually? __________ (tons)

6) Name of city/state nearest to most predominant foundry sand disposal site: ____________________

6.a) Do you dispose of all of your foundry sand at this location? Yes ____ No ____

6.b) If not, what is the approximate percentage of total foundry sand disposed of at this location? __________ (%)

7) What is the average cost per ton for shipping waste foundry sand to the disposal site? __________ ($/ton)

8) What is the average distance to the disposal site? __________ (miles)

9) What is the average per ton tipping fee for disposal? __________ ($/ton)

10) What other internal costs are incurred to dispose of foundry sand (e.g.- loading, handling, etc.) __________ ($/ton)

11) Is your organization interested in investigating disposal alternatives? Yes ____ No ____

12) Does your organization reclaim foundry sand? Yes ____ No ____

If yes, what method? ____ Thermal ____ Mechanical ____ Wash

____ Other ______________________________

13) Is your organization interested in sand reclamation? Yes ____ No ____

14) Is your organization interested in participating in our sand reclamation project? Yes ____ No ____

15) Does your facility have a site that could be used to reclaim foundry sand (approximately 100' X 100,' electrical, natural gas, loader & operator)? Yes ____ No ____

16) What percentage of your waste foundry sand do you feel is suitable for reclamation? __________ (%)

17) What cost per ton would your organization be willing to pay for a commercial sand laundering service? __________ ($/ton)

18) Is your organization interested in Beneficial Reuse (e.g.- backfill, cement aggregates, etc.)? Yes ____ No ____

19) Does your facility have railroad access? Yes ____ No ____

SILICA SAND USED

If None, Check Here ____ and Skip to the Next Page

For Cores:

S.20) Quantity purchased: __________ (tons/year)

S.21) Cost of Sand: __________ ($/ton), Cost of Shipping: __________ ($/ton)

S.22) AFS Grain Fineness Number: __________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

S.23) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

S.24) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

For Molds:

S.25) Quantity purchased: __________ (tons/year)

S.26) Cost of Sand: __________ ($/ton), Cost of Shipping: __________ ($/ton)

S.27) AFS Grain Fineness Number: __________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

S.28) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

S.29) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

LAKE SAND USED

If None, Check Here ____ and Skip to the Next Page

For Cores:

L.20) Quantity purchased: __________ (tons/year)

L.21) Cost of Sand: __________ ($/ton), Cost of Shipping: __________ ($/ton)

L.22) AFS Grain Fineness Number: __________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

L.23) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

L.24) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

For Molds:

L.25) Quantity purchased: . __________ (tons/year)

L.26) Cost of Sand: __________ ($/ton), Cost of Shipping: __________ ($/ton)

L.27) AFS Grain Fineness Number: __________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

L.28) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

L.29) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

ZIRCON SAND USED

If None, Check Here ____ and Skip to the Next Page

For Cores:

Z.20) Quantity purchased: ____________ (tons/year)

Z.21) Cost of Sand: ____________ ($/ton), Cost of Shipping: ____________ ($/ton)

Z.22) AFS Grain Fineness Number: ____________

1 Screen __________ 2 Screen ____________ 3 Screen ____________ 4 Screen ____________

Z.23) Binders used: (Total Percentage)

____ ____________

____ ____________

____ ____________

Z.24) Additives used: (Total Percentage)

____ ____________

____ ____________

For Molds:

Z.25) Quantity purchased: ____________ (tons/year)

Z.26) Cost of Sand: ____________ ($/ton), Cost of Shipping: ____________ ($/ton)

Z.27) AFS Grain Fineness Number: ____________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

Z.28) Binders used: (Total Percentage)

____ ____________

____ ____________

____ ____________

Z.29) Additives used: (Total Percentage)

____ ____________

____ ____________

CHROMITE SAND USED

If None, Check Here ____ and Skip to the Next Page

For Cores:

C.20) Quantity purchased: __________ (tons/year)

C.21) Cost of Sand: __________ ($/ton), **Cost of Shipping:** __________ ($/ton)

C.22) AFS Grain Fineness Number: __________

1 Screen ________ 2 Screen __________ 3 Screen __________ 4 Screen __________

C.23) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

C.24) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

For Molds:

C.25) Quantity purchased: __________ (tons/year)

C.26) Cost of Sand: __________ ($/ton), **Cost of Shipping:** __________ ($/ton)

C.27) AFS Grain Fineness Number: __________

1 Screen ________ 2 Screen ________ 3 Screen ________ 4 Screen ________

C.28) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

C.29) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

OLIVINE SAND USED

If None, Check Here ____ and Skip to the Next Page

For Cores:

O.20) Quantity purchased: ___________ (tons/year)

O.21) Cost of Sand: ___________ ($/ton), Cost of Shipping: ___________ ($/ton)

O.22) AFS Grain Fineness Number: ___________

1 Screen _________ 2 Screen ___________ 3 Screen ___________ 4 Screen ___________

O.23) Binders used: (Total Percentage)

____ __________

____ __________

____ __________

O.24) Additives used: (Total Percentage)

____ __________

____ __________

For Molds:

O.25) Quantity purchased: ___________ (tons/year)

O.26) Cost of Sand: ___________ ($/ton), Cost of Shipping: ___________ ($/ton)

O.27) AFS Grain Fineness Number: ___________

1 Screen _________ 2 Screen _________ 3 Screen _________ 4 Screen _________

O.28) Binders used: (Total Percentage)

____ __________

____ __________

____ __________

O.29) Additives used: (Total Percentage)

____ __________

____ __________

OTHER SAND USED

If None, Check Here ____ and Skip to the Next Page

For Cores:

X.20) Quantity purchased: __________ (tons/year)

X.21) Cost of Sand: __________ ($/ton), Cost of Shipping: __________ ($/ton)

X.22) AFS Grain Fineness Number: __________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

X.23) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

X.24) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

For Molds:

X.25) Quantity purchased: __________ (tons/year)

X.26) Cost of Sand: __________ ($/ton), Cost of Shipping: __________ ($/ton)

X.27) AFS Grain Fineness Number: __________

1 Screen __________ 2 Screen __________ 3 Screen __________ 4 Screen __________

X.28) Binders used: (Total Percentage)

______________________________ __________

______________________________ __________

______________________________ __________

X.29) Additives used: (Total Percentage)

______________________________ __________

______________________________ __________

The UNI-MCC Cooperative agreement with the U.S. Department of Energy requires that part of the expenses relative to this project be incurred by a third party. By completing this survey, your organization has incurred in-kind costs associated with your participation. Such costs include a portion of your salary and fringe benefits, along with any other costs that were incurred by your organization and that are directly associated with retrieving and reporting the data that you have provided. UNI-MCC estimates the value of these costs to be $150. Please indicate below the actual costs incurred by your organization to complete this survey. All information that you have provided will remain confidential.

Actual costs to complete this survey: ______________________

_______________________________________ ____________________

(signature) (date completed)

We would like to thank you for the time and effort that you have incurred to complete this survey. It is our hope that a combined effort such as this will lead to an improved competitive position for the Midwest Regional Metal Casting Industry.

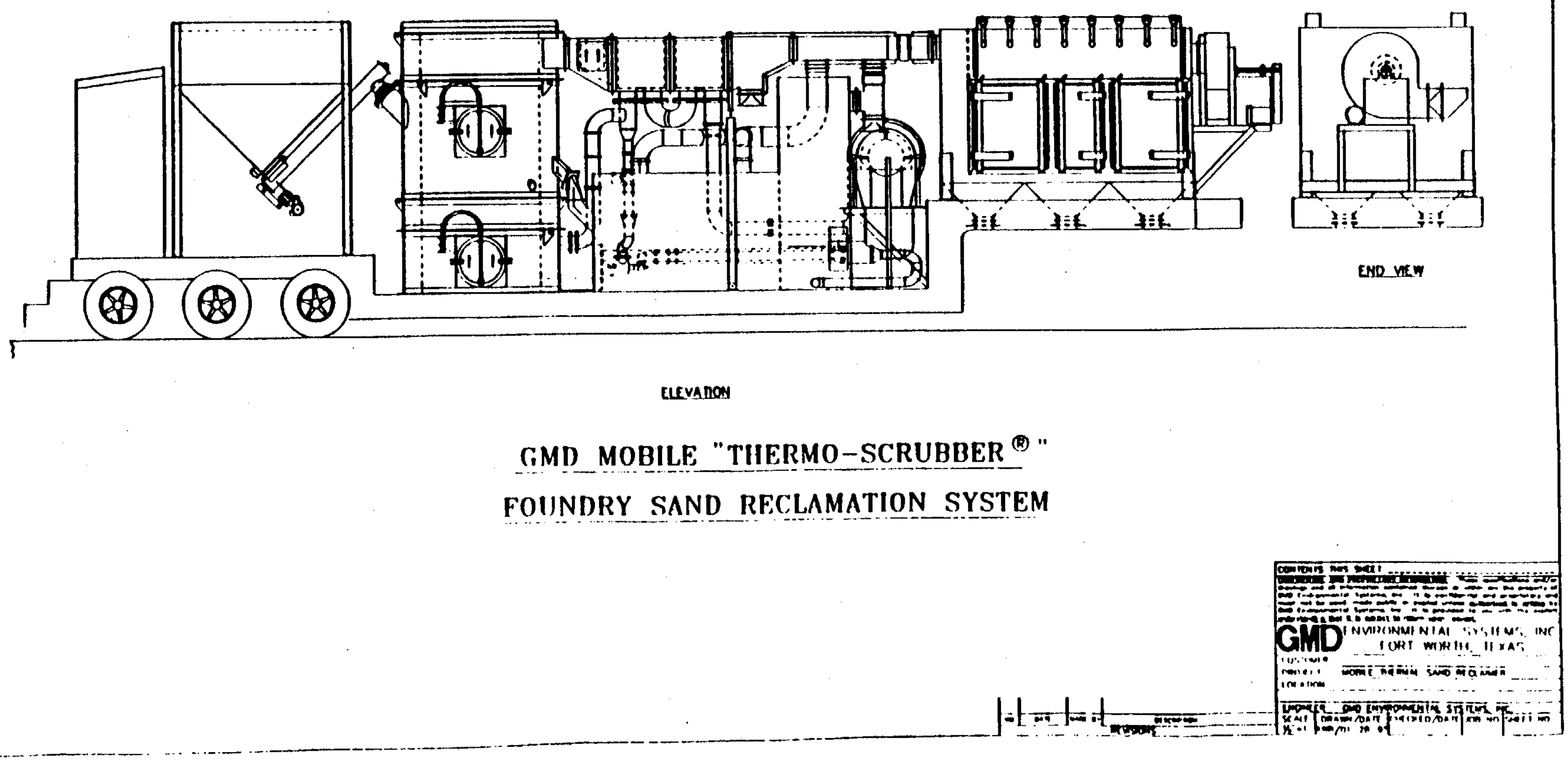
Please complete and return by June 1, 1993 to:

Metal Casting Center
Department of Industrial Technology
University of Northern Iowa
Cedar Falls, IA 50614-0178

The UNI-MCC is dedidicated to advancing the state of technology of the operating Metal Casting industry in the Midwestern United States. We appreciate your participation in this effort.

APPENDIX B

SYSTEM DESCRIPTION



GMD MOBILE "THERMO-SCRUBBER®"

FOUNDRY SAND RECLAMATION SYSTEM

OPERATION AND MAINTENANCE INSTRUCTIONS

FOR THE

GMD ENGINEERED SYSTEMS, INC.

GMD PNU COOLER-SCRUBBER^{TM}

INSTALLED IN A

SAND RECLAMATION SYSTEM

GMD ENGINEERED SYSTEMS, INC.

305 WEST ARLINGTON AVENUE

P.O. BOX 11375

FORT WORTH, TEXAS 76110

U.S.A.

GMD PNU COOLER-SCRUBBER™ SAND RECLAIMER
FOR
CHEMICALLY BONDED SANDS

One definition of sand reclamation states,

> "reclamation of sand requires that the sand grains receive the amount of work required to make the final product usable in the given casting situation. The process must assure that the sand grains receive this work on an individual grain-to-grain basis.

It is this individual treatment of the sand grains that assures consistent quality of the final product. Any treatment of the sand other than the treatment mentioned above is not considered sand reclamation, but rather sand reconditioning. Additionally, the binder systems used in today's foundry are more durable and effective than those in the past have been. It is this durability that dictates that a sand reclamation system must treat the sand grains more aggressively to assure a stable reclaimed product cycle after cycle. A Chemically-Bonded Sand Reclamation System requirement is to remove as much as possible of the residual binder attached to the sand grains or contained in the cracks, crevices and cleavage plains of the return sand grains along with the unwanted silica "fines" plus somewhere in the process of things there must be a cooling step. All of this is normally accomplished with two pieces of equipment; one unit would provide the pneumatic scrubbing step and a second unit would cool the sand grains. In the case of the GMD PNU COOLER-SCRUBBER™, cooling and scrubbing is accomplished in one unit.

The GMD PNU COOLER-SCRUBBER™ is a dual stage fluid bed combination SAND COOLING AND SCRUBBING UNIT, complete with continuous feed and retention control within the cooling modules and the compartments of the dry scrubbing section. The GMD PNU COOLER-SCRUBBER™ is designed to operate twenty-four (24) hours per day unattended in a continuous consistent manner.

The preprocessed spent sand is fed into a surge bin which should have a storage capacity of at least two hours operating time. From the surge bin, the material is fed via a variable speed, low speed, feeder into the GMD PNU COOLER-SCRUBBER™ at the sand cooler end. This section of the GMD PNU COOLER-SCRUBBER™ is of conventional design for the Fluidizing Air distribution, complete with finned water cooling tube banks, and baffle plates for directing the sand travel across the tube banks. The bed of sand behaves as a fluid having a density greater than water. The sand is introduced into the chamber through one end of the GMD PNU COOLER-SCRUBBER™ and will discharge from the opposite end. Conditions within the bed result in rapid and intimate mixing, which in turn produces rapid heat transfer from the sand to the Fluidizing Air which in turn carries off the heat in the form of exhaust air. Additional externally supplied cooling is needed to control and maintain sand discharge temperature to design conditions. The finned water cooling tube banks provide indirect cooling, providing a higher total efficiency when added to the direct cooling provided by the Fluidizing Air. The water is externally cooled by a conventional evaporative cooling tower after being pumped through the coils.

Above the bed of sand is a freeboard space which is kept at a slight negative by the exhaust connection to the dust collector system. This exhaust draws off the air introduced as Fluidizing Air and in addition will capture some of the fines that are in the sand as it enters the cooler. The fluidized bed extends under the dry scrubber cells. It is in this section of the GMD PNU COOLER-SCRUBBER™ that the scrubbing (attrition cleaning) takes place.

When the Blast Air in the Scrubber Section is first turned on, the sand initially passed up the Blast Tube is impacted on the metal Target. Some sand is held in place against the metal Target by the force of the air and other sand forced up the Blast Tube and it is against this sand that subsequent "blasted" sand grains impact. After the initial sand to metal impact, the condition of sand against sand impact remains constant until the unit is turned off.

The sand grains to be scrubbed are withdrawn from the fluidized bed by the velocity of the Blast Air as it emerges from the Blast Air Nozzle and forced up the Blast Tube so as to impact the layer of sand grains already held against the Target by the blast air. Giving up their kinetic energy, the sand grains fall back down to the fluid bed by the force of gravity where they are collected and again withdrawn and blasted up the Blast Tube and continue to recirculate until captured by the overflow weir current.

It is during this stage of scrubbing that the accurately controlled negative pressure atmosphere and air current in the Exhaust/Classifier Plenum of the **GMD PNU COOLER-SCRUBBER™** extracts the unwanted binder, the "free" minute traces of clays and oxides <u>and</u> the unwanted fine sand grains directing them to the fabric filter unit. Nearly all of the sand grains suitable for reuse are captured and deflected into the discharge section of the fluid bed where they flow over a weir by gravity and exit the **GMD PNU COOLER-SCRUBBER™** as clean, cooled, reclaimed sand at a temperature of 100°-120° F. This is a finished product with an acceptable grain fineness and characteristics suitable for reuse with minimum dilution or addition and blending with new sand.

This is accomplished in an atmosphere absent of moving parts.

A feature of the **GMD PNU COOLER-SCRUBBER™** is the control that the unit offers. An advantage of the **GMD PNU COOLER-SCRUBBER™** pneumatic sand reclaimer is that multiple passes of the sand grains takes place before being discharged from the unit. An easy adjustment can be made to increase recirculation to provide a cleaner product. If a very clean product is desired, the unit can be adjusted by use of Adjustable Vertical Baffles to increase the recirculation time to the desired final product requirements.

The **GMD PNU COOLER-SCRUBBER™** is energy efficient and minimizes the horsepower requirements. In the **GMD PNU COOLER-SCRUBBER™**, the sand grains are in a fluidized or dynamic state when drawn into the Blast Air stream instead of a static state, as is typical with other pneumatic scrubbing equipment. The force required to overcome the static inertia in the packed sand grains in the other designs of pneumatic scrubbers is eliminated in the **GMD PNU COOLER-SCRUBBER™**, therefore the required energy in the **GMD PNU COOLER-SCRUBBER™** is less than that required by the other designs.

A unique feature of the **GMD PNU COOLER-SCRUBBER™** Pneumatic Sand Reclaimer is that the final product being discharged is ready for immediate reuse without any further processing required. All scrubbing, dust removal, final dedusting cooling and classification takes place before the product is discharged.

Maintenance is minimal. The GMD PNU COOLER-SCRUBBER™ has only two wear items. The first is the vertical Blast Tube. This vertical Blast Tube is manufactured from a heavy duty pipe. The projected life on this Blast Tube is 1,000 - 2,000 hours of operation. The second wear item is the Target in each compartment. The Target is made of white iron and has a projected life of 3,000 - 5,000 hours. Other than the wear items listed, day-to-day maintenance is very minimal, if any.

GMD PNU COOLER-SCRUBBER™ Models have capacities ranging from 1/4 to 15 tons per hour.

GMD PNU COOLER-SCRUBBER™ features include....

Integration of Cooling and Scrubbing

High Scrubbing Efficiency

High Cooling Efficiency

Absence of Moving Parts

Low Energy Consumption

Continuous Processing

Unattended Operation

Low Capital Cost

GMD Engineered Systems, Inc. provides written guarantees that the GMD PNU COOLER-SCRUBBER™ will produce a high quality reclaimed sand with these consistent properties.

Sand Screen Distribution

Yield (on base silica)

Cooling Efficiency

Loss on Ignition

Rated Capacity

GMD Engineered Systems, Inc. can claim what no other manufacturer can.........

<u>GUARANTEED UNEQUALED PERFORMANCE</u>

I. SYSTEM DESCRIPTION

GMD Engineered Systems, Inc. is pleased to have provided you with a GMD THERMO-SCRUBBER® Thermal Sand Reclamation System. We would first like to point out some of the features of this system:

HIGH OVERALL THERMAL EFFICIENCY

LOW MAINTENANCE

CONTINUOUS FEED

NO MECHANICAL MOVING PARTS

UNATTENDED OPERATIONS

NO HIGH ALLOY METAL PARTS

The GMD THERMO-SCRUBBER® Thermal Sand Reclaimer supplied under this contract is:

One (1) GMD Engineered Systems, Inc.'s THERMO-SCRUBBER®, Model TS III #101.50 TPH rated at one and a half (1 1/2) tons per hour capacity. The feed material shall be preprocessed resin-bonded foundry system sand. The mixture shall have moisture content not exceeding two percent maximum; and agglomerate size of -1/8" mesh and the base sand shall be silica. The GMD THERMO-SCRUBBER® supplied consists of:

- Surge Hopper
- Variable Speed Screw Feeder
- GMD THERMO-SCRUBBER® TS III Reactor Unit
  - Combustion System
  - Combustion/Cooler Air Blower
  - Recuperator
  - Flue Duct from Reactor to Recuperator
  - Flue Duct from Recuperator to Cartridge Collector
  - Process Control Panel
- GMD PNU COOLER-SCRUBBER
- GMD DUST COLLECTION EQUIPMENT

The following is a brief description of the various pieces of equipment incorporated into the Thermal Sand Reclaimer System.

1. Surge Hopper:

   Quantity: One (1) Capacity: 22,000 lbs.

   Welded steel fabricated bin with flanged outlet for accepting the screw conveyor.

2. Screw Feeder: - Variable Speed:

   Quantity: One (1) @ Surge Hopper Discharge

   Capacity: .25 to 2.50 tons per hour.

   Welded steel fabricated screw, trough, and cover plate, complete with self-aligning sealed ball bearings, a gear reducer and 1 HP, 1800 RPM, 230/460V, 3-Phase, 60 Hz. TEFC, 143T-Frame electric motor. Electronic variable speed control is supplied via the Process Control Panel.

3. GMD THERMO-SCRUBBER® TS III Reactor Unit:

   Quantity: One (1) Capacity: One and a Half (1 1/2) tons per hour.

   One (1) compartment, fluid bed reactor unit consisting of a calcining chamber. All steel, welded construction, complete with top cover, hearth ring and burner box, capable of operating at a maximum calcining temperature of 1750 degrees F.

   a. Lining:

   The reactor compartments are factory lined with hydraulic-setting alumina castable refractory at the hot face, backed with silica fiber block insulating material at the metal casing; the overall lining is secured by stainless steel anchors welded to the inner face of the reactor shells.

   b. Hearth:

   The steel hearth ring are factory poured with hydraulic-setting alumina refractory and precured.

c. Gravity Feed Bypass Duct:

Welded steel construction, fabricated in flanged sections. Duct is factory lined with castable refractory.

d. Reactor Walls:

Insulation Board - Silica fiberboard heat insulation.

Refractory - Hydraulic-setting alumina castable refractory poured over insulation board.

4. Combustion Equipment:

Quantity: One (1) Burner System.

Capacity: 3,000,000 BTU/hr., maximum, based on 1,000 BTU per cubic foot gas fuel, using Eclipse Combustion MVTA nozzle mixing sealed burner, operating on preheated air.

Motorized gas/air modulating control valves by North American Company. Motorized automatic safety shut-off and blocking valves with approved venting. High/low gas fuel pressure switch, low air pressure switch. Ultra violet scanning flame safety monitoring by Protection Controls Inc. all conforming to FM approval and IRI requirements. All controls are suitable for service on 120V, 1-Phase, 60 Hz. supply.

5. Combustion & Cooling Air Blower:

Quantity: One (1). Capacity: 2400 SCFM @ 44 OSI/55.4" W.C.

Motor: 50 HP, TEFC, 3560 RPM, 460V, 3-Phase, 60 Hz., 326TZ Frame

Drive: Direct with Inlet Filter and Silencer

Manufacturer: North American

Motor Starters for the following equipment are housed within the panel:

* Surge Bin Feed Screw (AC Inverter)
* Baghouse Fan
* Combustion and Cooling Air Blower

The automatic systems controller is the TI545 Programmable Logic Controller (PLC). The process temperature in the Calcine Chamber is achieved and maintained by controlling natural gas flow, primary combustion air flow, and furnace pressure. The PID control is part of the PLC's program and access to its parameters is through the Texas Instruments CVU 100.

Manual control of the gas and air flows is also available with the CVU 100 at the Screen. The operator may manually operate the flow control values.

Flame safety is provided via a UV Flame Scanner and an IRI approved, Protection Control, Inc. Form 6642 VLT, Burner Flame Safety Package.

Both manual and automatic operation is permitted. Initial start-up is largely automatic. There are operator prompting messages to guide the ramping-up of temperature until the desired set point is achieved and the transition is made into running conditions. The automatic operation includes manual transitions to standby condition for overnight or weekends and return to full operating capacity.

Normal system shutdown is also a PLC controlled process with the THERMO-SCRUBBER® temperature being ramped-down over a period of time.

The system is also provided with monitoring and alarm features at the CVU 100.

7. Recuperator:

Quantity: Two (2)

Manufacturer: GMD Rec 64

Description: Welded steel construction with alloy tube bundles to provide preheated air for the calcining stage.

Insulation: Ceramic fiber board lined.

8. Process Control Panel:

The standard automatic controls for the sand reclaimation unit are furnished in full compliance with Federal Specifications and Codes for industrial equipment. The NEMA-12 enclosure is provided with a main 460 volt disconnect interlocked with the door for personnel safety. All control voltage is provided at 120 volts by a control transformer. All magnetic starters for the GMD supplied equipment are housed within the panel. For basic temperature control, a microprocessor provides a direct electric output to modulating fuel/air control valves in accordance with a seven day preprogrammed time clock sequence.

The system is also provided with complete monitoring and remote alarm features:

A graphic display acquisition unit is provided to display and document temperature profiles at all critical process points, alarm and status screens.

The acquisition unit is equipped with a touch pad to initiate display screens, set mode functions, acknowledge alarms, and change parameters.

Automatic Shutdown Operation feature with a 7-day preprogrammed time clock sequence. The automatic operation includes transition to standby condition over a weekend and return to full operation capacity after each standby period, continuous operation or manually shut-down.

a. A Chessel Chart Recorder provides a line graph of the Calcine Sand Temperature.

b. Displays on various screens show the current temperature, flows, and equipment status.

c. The Firebox Temperature is sensed by a type "R" Thermocouple and is used as a High Temperature Control Point to protect the Calcining Bed and the Diffuser Nozzles in the bed. If the Firebox Temperature EXCEEDS 2200 F, the main gas is modulated closed.

Low Temperature Control protects the Firebox and the total system from losing to much heat. This condition could occur if sand with excessive combustible material is introduced into the Calcining Bed creating a condition where the gas valve would modulate to the closed position and the Calcining Bed Temperature being maintained by these external combustibles. Once the combustible material has been depleted the system could loose temperature until the heat "catches up", however with the Low Firebox Temperature Control the above condition is anticipated and the process temperature is maintained by decreasing the screw feeder speed.

d. The Texas Instrument Series 545 Programmable Logic Controller (PLC) controls the ramp valve setpoint being inputted to the CVU100. This unit also controls the temperature ramping of the system during start-up and the stand-by mode setpoint temperature.

APPENDIX C

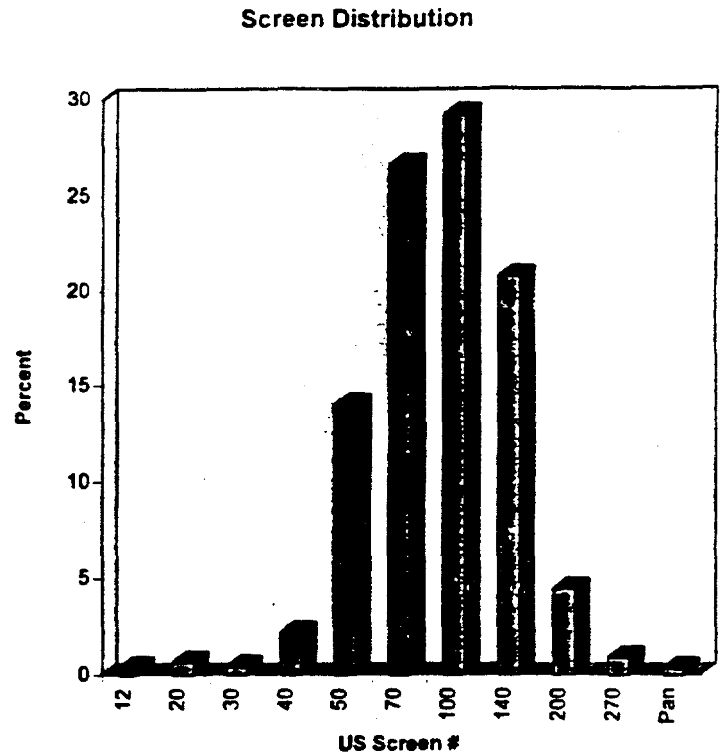
SAND ANALYSIS

Prepared by Ashland Chemical
Foundry Products Division

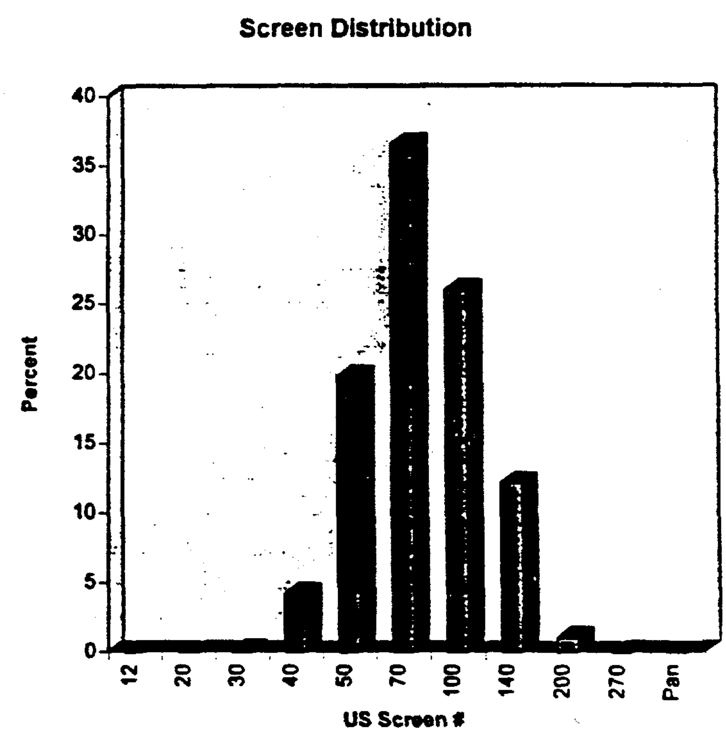
Sand Sample Key

Sand Sample ID	Foundry	Sand Type
1001	Falco	Raw Sand
1002	Falco	Reclaimed Sand
1003	Keokuk	Reclaimed Sand
1004	Keokuk	Raw Sand
1005	Bloomfield	Reclaimed Sand
1006	Crane	Reclaimed Sand
1007	Nibco-1	Raw Sand
1008	Nibco-1	Reclaimed Sand
1009	Atchison	Raw Sand
1010	Atchinson	Reclaimed Sand
1011	Bloomfield	Raw Sand
1012	Crane	Raw Sand
1013	Nibco-2	Raw Sand
1014	Nibco-2	Reclaimed Sand
1015	Viking	Raw Sand
1016	Viking	Reclaimed Sand
1017	Max-Cast	Raw Sand
1018	Max-Cast	Reclaimed Sand
1019	A.Y. McDonald	Raw Sand
1020	A.Y. McDonald	Reclaimed Sand
1021	Mercury Marine	Raw Sand
1022	Mercury Marine	Reclaimed Sand

University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1001
USA Sieve #	**Percent**
12	0.36
20	0.66
30	0.44
40	2.20
50	13.93
70	26.64
100	29.22
140	20.86
200	4.44
270	0.90
Pan	0.34
AFS GFN	**70.08**
% LOI	2.08
pH	8.6
ADV @ pH 5	13.5
ADV @ pH 7	10.5



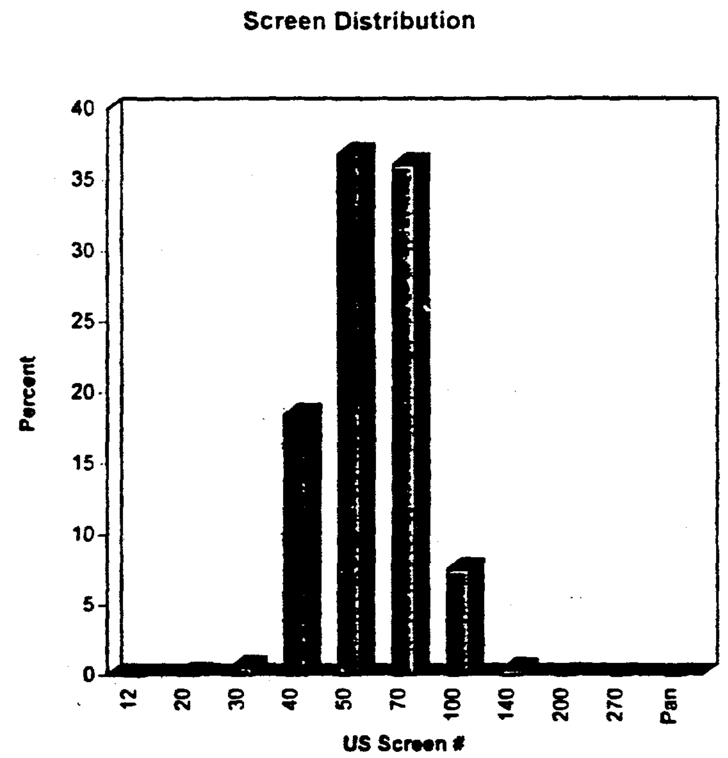
University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1002
USA Sieve #	**Percent**
12	0.00
20	0.02
30	0.16
40	4.22
50	19.79
70	36.51
100	25.99
140	12.20
200	1.06
270	0.06
Pan	0.00
AFS GFN	**59.46**
% LOI	0.03
pH	9.3
ADV @ pH 5	4.1
ADV @ pH 7	3.4



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1003

USA Sieve #	Percent
12	0.00
20	0.08
30	0.56
40	18.41
50	36.86
70	36.14
100	7.54
140	0.40
200	0.02
270	0.00
Pan	0.00

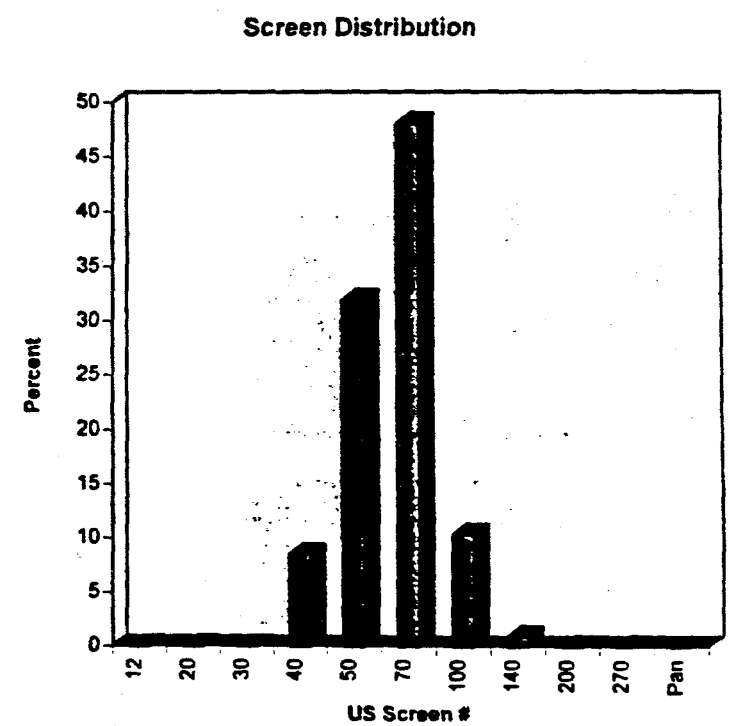
AFS GFN	44.16
% LOI	0.03
pH	6.8
ADV @ pH 5	0.5
ADV @ pH 7	-0.2



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1004

USA Sieve #	Percent
12	0.00
20	0.04
30	0.04
40	8.49
50	31.92
70	48.06
100	10.37
140	0.94
200	0.08
270	0.06
Pan	0.00

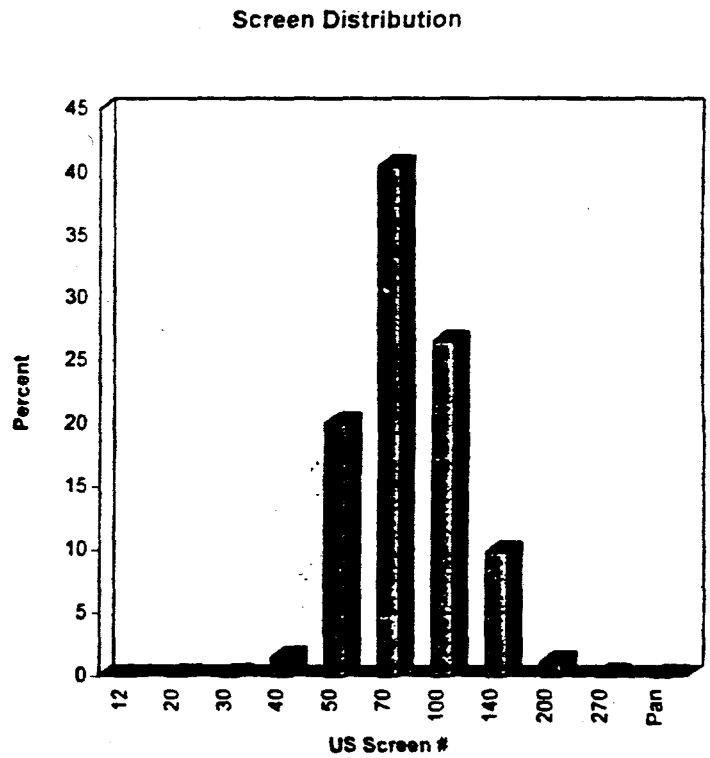
AFS GFN	47.79
% LOI	0.72
pH	6.3
ADV @ pH 5	3
ADV @ pH 7	0.5



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1005

USA Sieve #	Percent
12	0.02
20	0.10
30	0.12
40	1.46
50	19.95
70	40.56
100	26.59
140	9.82
200	1.10
270	0.18
Pan	0.10

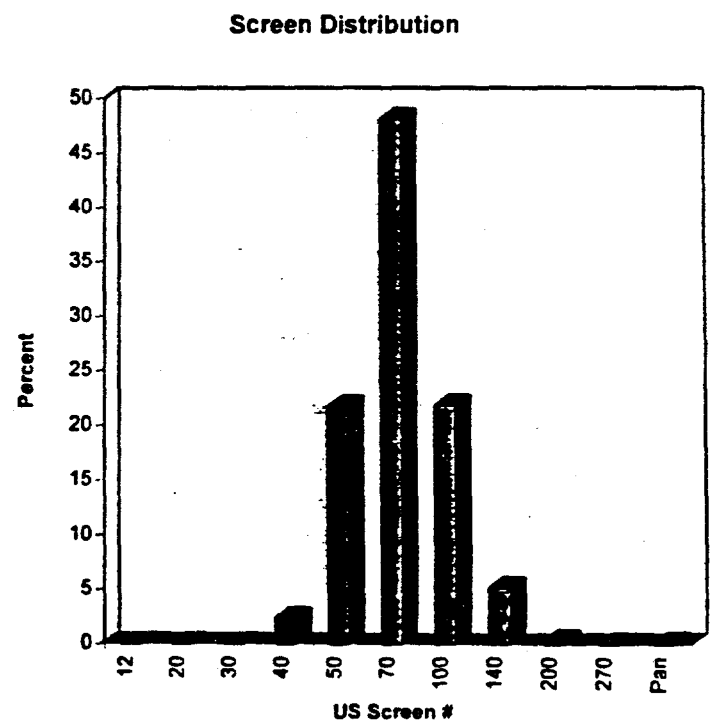
AFS GFN	59.37
% LOI	0.32
pH	9.8
ADV @ pH 5	8.8
ADV @ pH 7	7.0



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1006

USA Sieve #	Percent
12	0.00
20	0.02
30	0.04
40	2.38
50	21.75
70	48.11
100	21.87
140	5.21
200	0.38
270	0.08
Pan	0.16

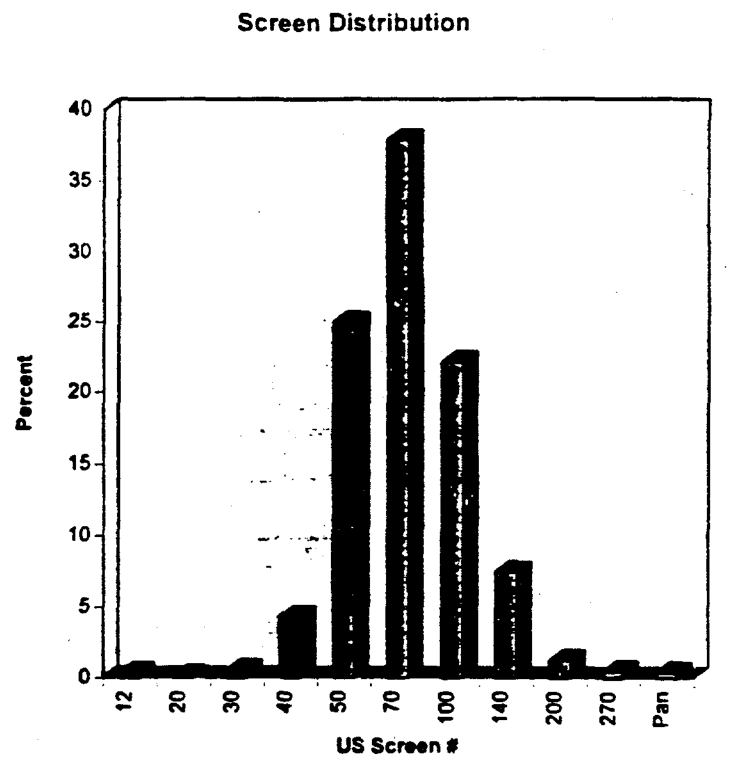
AFS GFN	55.17
% LOI	0.18
pH	10.8
ADV @ pH 5	7
ADV @ pH 7	5.8



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1007

USA Sieve #	Percent
12	0.36
20	0.12
30	0.54
40	4.30
50	24.95
70	37.92
100	22.13
140	7.50
200	1.26
270	0.50
Pan	0.42

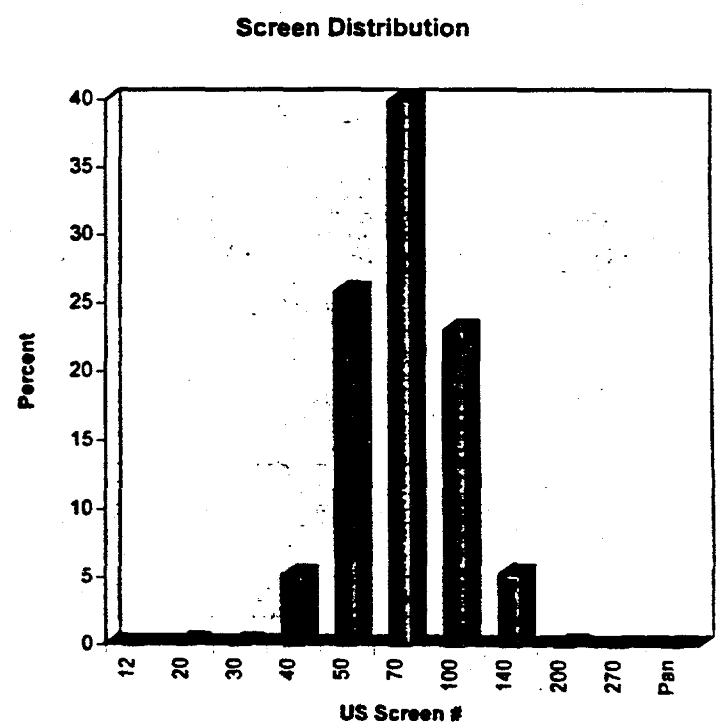
AFS GFN	57.38
% LOI	4.71
pH	9.6
ADV @ pH 5	30.2
ADV @ pH 7	16.0



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1008

USA Sieve #	Percent
12	0.02
20	0.20
30	0.16
40	5.15
50	25.79
70	39.94
100	23.10
140	5.33
200	0.16
270	0.04
Pan	0.10

AFS GFN	53.99
% LOI	0.13
pH	9.9
ADV @ pH 5	4
ADV @ pH 7	2.9



Ashland Chemical

Ashland Chemical Company
Division of
Ashland Oil Inc

Address Reply
PO Box 2219
Columbus, Ohio 43216

January 11, 1995

The University of Northern Iowa
Metal Casting Center
Cedar Falls, Iowa 50614-0178

Attention: Dr. Fred Vondra

Dear Fred,

Enclosed are the final results of the sand analysis project. The final results are reported in a new format that should be easier to read. In reentering the sand test data several errors were discovered in the first set of results. The errors that were found are:

Sample 1001	Screen distribution error.
Sample 1008	Screen distribution error.
Sample 1009	ADV @ 7, reported as 5.1 actually 5.4
Samples 1011-1013	The LOI reported on the original copy was actually moisture. The LOI number was not reported. The samples as received were wet, therefore moisture and LOI were run. The LOI reported is on an as received basis.

These are corrected in the final copy and all numbers were double checked.

If you have any questions regarding the data or testing procedures please contact me directly at 614-889-3595.

Sincerely,

Michael B Schlanser

Michael Schlanser
Lab Manager

Enclosure

cc: J. Elwood
G.P. Sturtz
M. W. Swartzlander

Headquarters:
5200 Blazer Parkway
Dublin Ohio 43017
(614) 889 3333

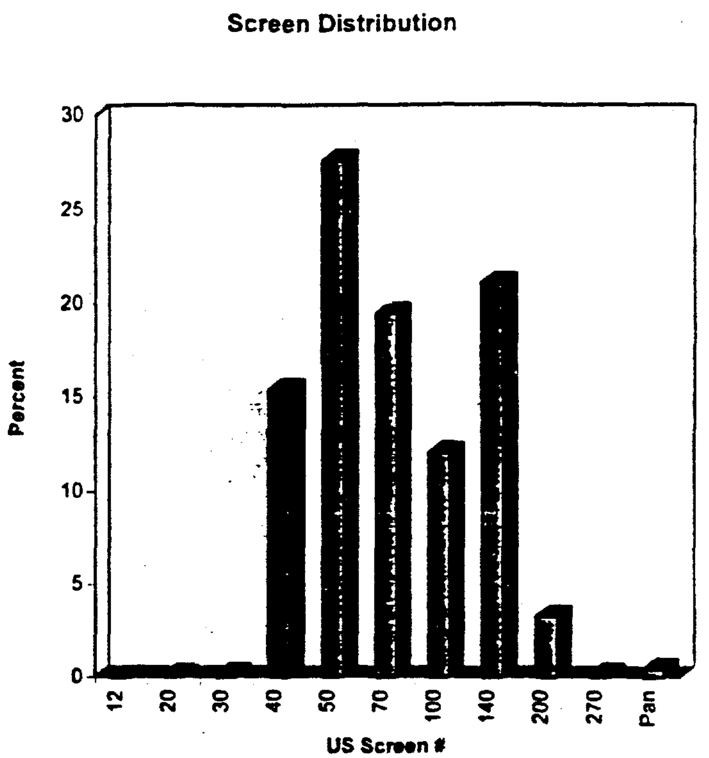
Cable Address Aroplaz OH
Telex 245385
Answerback ASHCHEM
Fax (614) 889-4119

University of Northern Iowa

Work Order	9155
Date	10/24/94
Sand Sample ID	1009

USA Sieve #	Percent
12	0.04
20	0.11
30	0.19
40	15.36
50	27.63
70	19.51
100	12.06
140	21.15
200	3.31
270	0.19
Pan	0.46

AFS GFN	61.44
% LOI	1.68
pH	8.1
ADV @ pH 5	10.1
ADV @ pH 7	5.4

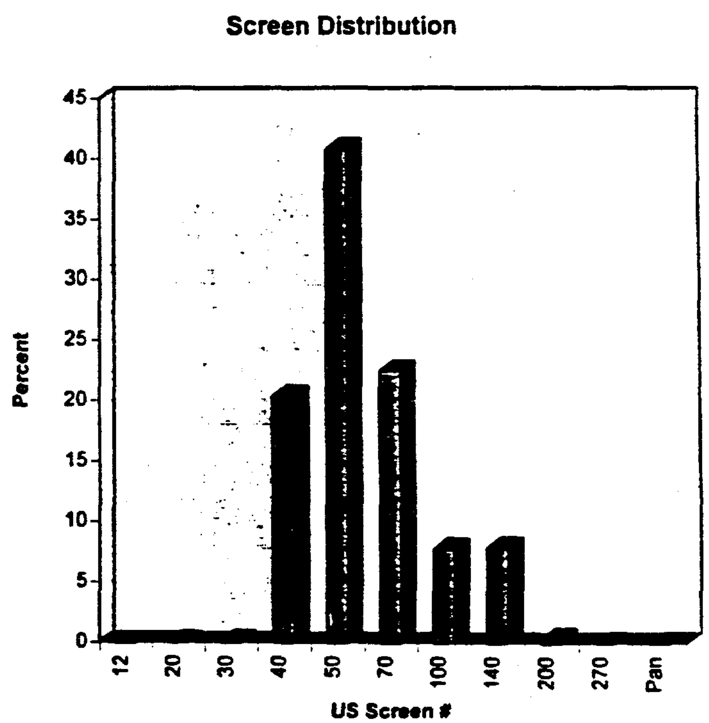


University of Northern Iowa

Work Order	9155
Date	10/24/94
Sand Sample ID	1010

USA Sieve #	Percent
12	0.00
20	0.09
30	0.16
40	20.38
50	40.79
70	22.47
100	7.78
140	7.87
200	0.38
270	0.04
Pan	0.04

AFS GFN	47.74
% LOI	0.03
pH	7.7
ADV @ pH 5	1.9
ADV @ pH 7	1.0



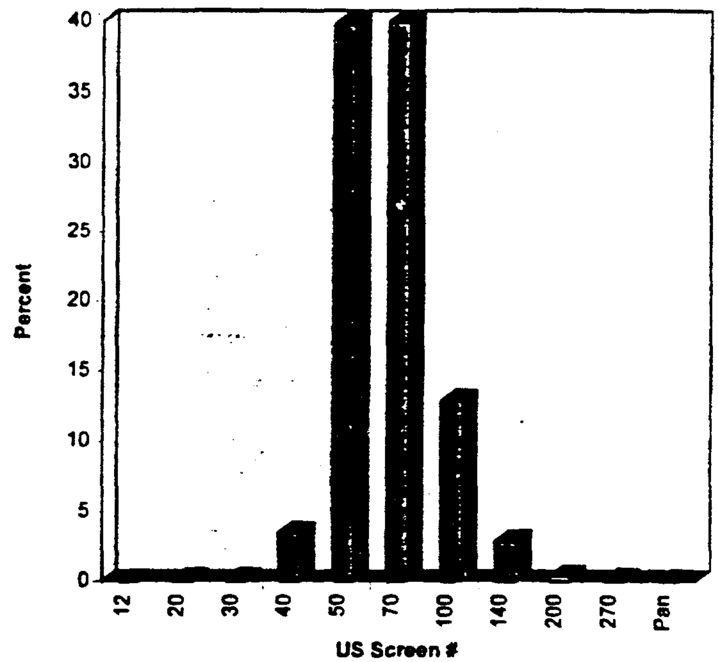
University of Northern Iowa

Work Order	9155
Date	10/24/94
Sand Sample ID	1011

USA Sieve #	Percent
12	0.00
20	0.16
30	0.20
40	3.48
50	39.79
70	39.94
100	12.87
140	2.88
200	0.40
270	0.18
Pan	0 10

AFS GFN	50.10
% LOI	7.19
% Moisture	3.42
pH	7.9
ADV @ pH 5	15.1
ADV @ pH 7	9.5

Screen Distribution



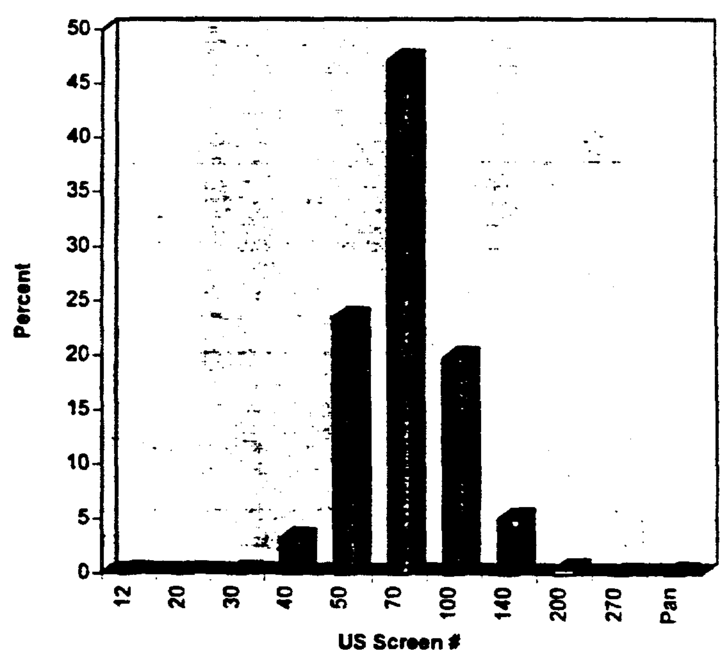
University of Northern Iowa

Work Order	9155
Date	10/24/94
Sand Sample ID	1012

USA Sieve #	Percent
12	0.09
20	0.09
30	0.20
40	3.25
50	23.48
70	47.13
100	19.83
140	5.13
200	0.50
270	0.11
Pan	0.18

AFS GFN	54.47
% LOI	5.50
% Moisture	2.19
pH	9.8
ADV @ pH 5	24.4
ADV @ pH 7	17.9

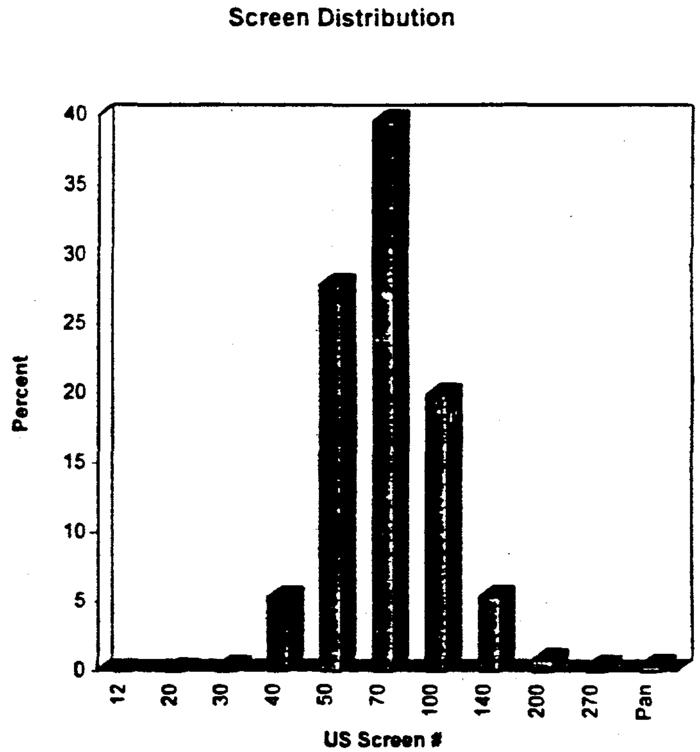
Screen Distribution



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1013

USA Sieve #	Percent
12	0.04
20	0.10
30	0.27
40	5.32
50	27.85
70	39.62
100	19.85
140	5.39
200	0.83
270	0.35
Pan	0.39

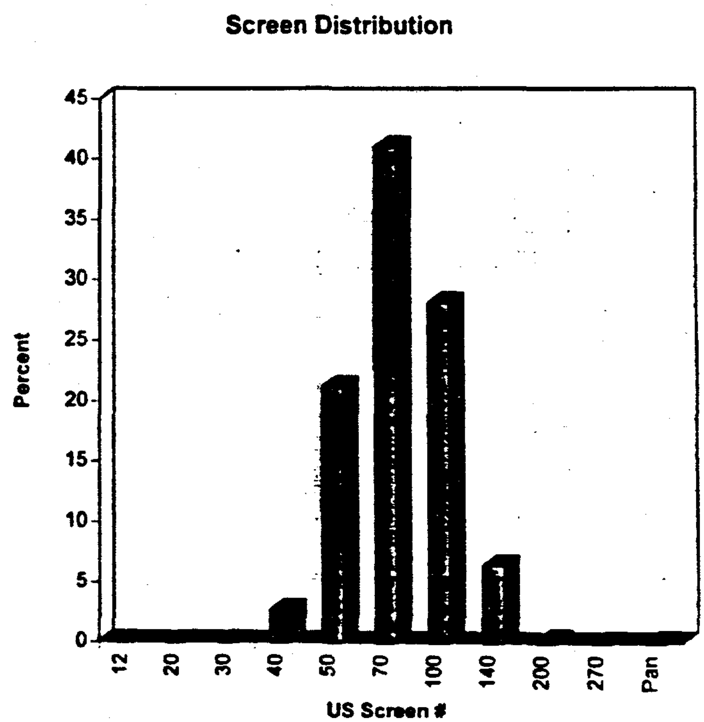
AFS GFN	54.92
% LOI	6.54
% Moisture	1.22
pH	9.7
ADV @ pH 5	26.0
ADV @ pH 7	18.5



University of Northern Iowa	
Work Order	9155
Date	10/24/94
Sand Sample ID	1014

USA Sieve #	Percent
12	0.00
20	0.02
30	0.04
40	2.69
50	21.22
70	41.01
100	28.14
140	6.48
200	0.26
270	0.04
Pan	0.10

AFS GFN	56.73
% LOI	0.18
pH	7.7
ADV @ pH 5	5.4
ADV @ pH 7	3.9

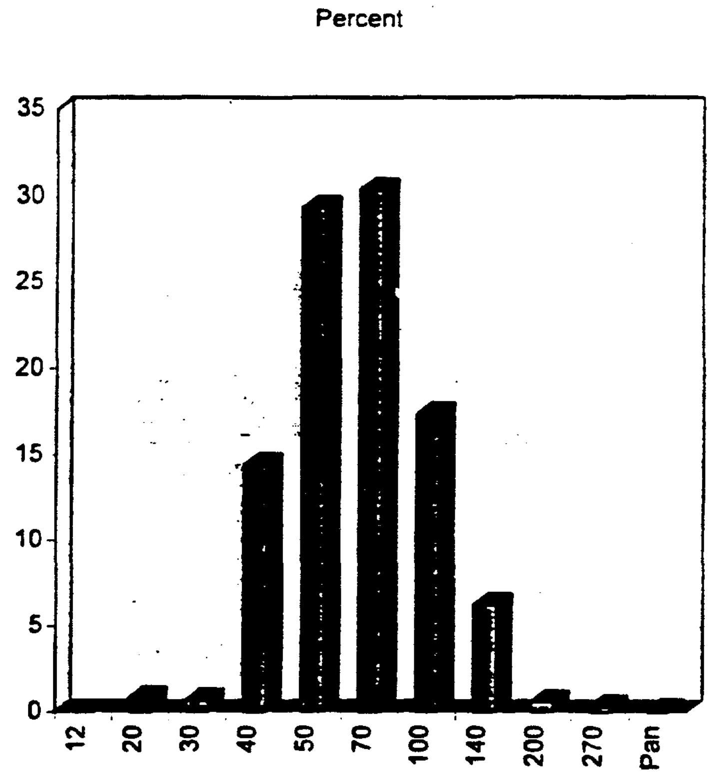


University of Northern Iowa

Work Order	9155
Date	1/10/95
Sand Sample ID	1015

USA Sieve #	Percent
12	0.00
20	0.78
30	0.66
40	14.38
50	29.33
70	30.35
100	17.29
140	6.25
200	0.56
270	0.30
Pan	0.10

AFS GFN	**51.47**
% LOI	0.16
pH	8.0
ADV @ pH 5	3.9
ADV @ pH 7	1.8

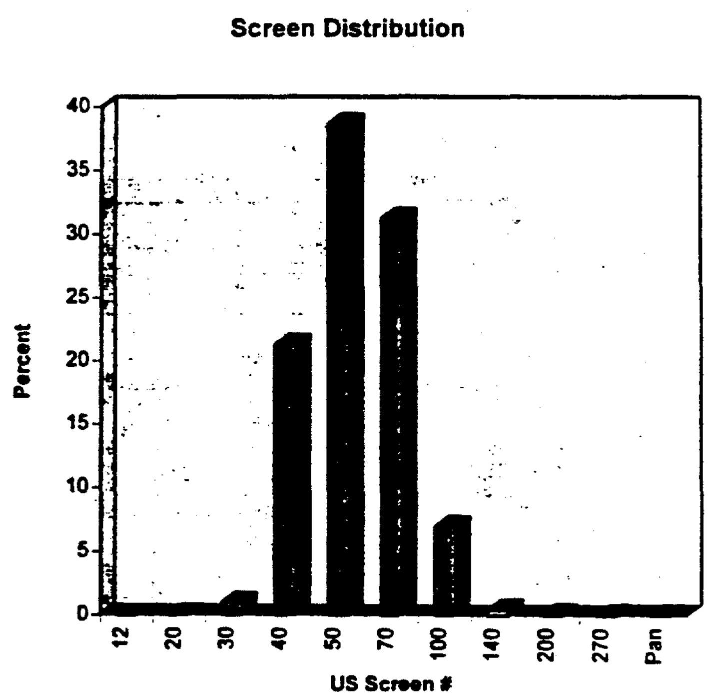


University of Northern Iowa

Work Order	9155
Date	1/10/95
Sand Sample ID	1016

USA Sieve #	Percent
12	0.00
20	0.04
30	1.01
40	21.29
50	38.66
70	31.27
100	7.00
140	0.50
200	0.14
270	0.06
Pan	0.04

AFS GFN	**43.52**
% LOI	0.04
pH	7.8
ADV @ pH 5	2.5
ADV @ pH 7	1.7

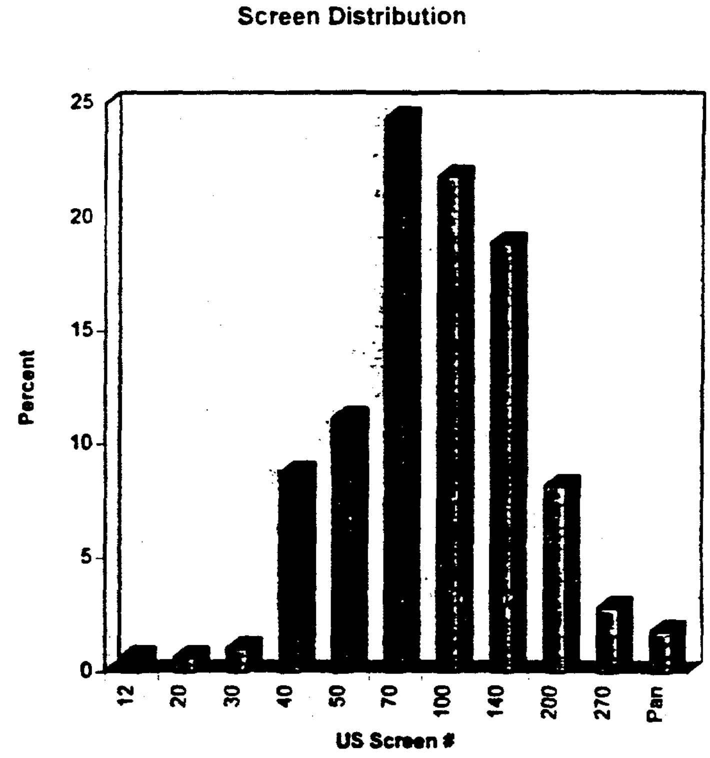


University of Northern Iowa

Work Order	9155
Date	1/10/95
Sand Sample ID	1017

USA Sieve #	Percent
12	0.64
20	0.62
30	1.02
40	8.70
50	11.08
70	24.35
100	21.84
140	18.90
200	8.18
270	2.85
Pan	1.82

AFS GFN	76.31
% LOI	6.91
pH	6.6
ADV @ pH 5	8.2
ADV @ pH 7	5.0

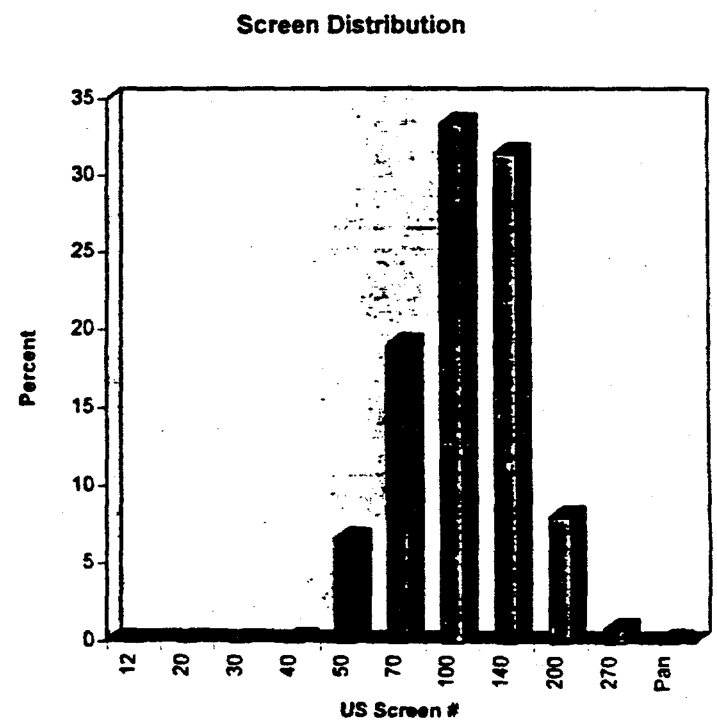


University of Northern Iowa

Work Order	9155
Date	1/10/95
Sand Sample ID	1018

USA Sieve #	Percent
12	0.00
20	0.06
30	0.06
40	0.16
50	6.65
70	19.06
100	33.41
140	31.45
200	8.11
270	0.88
Pan	0.16

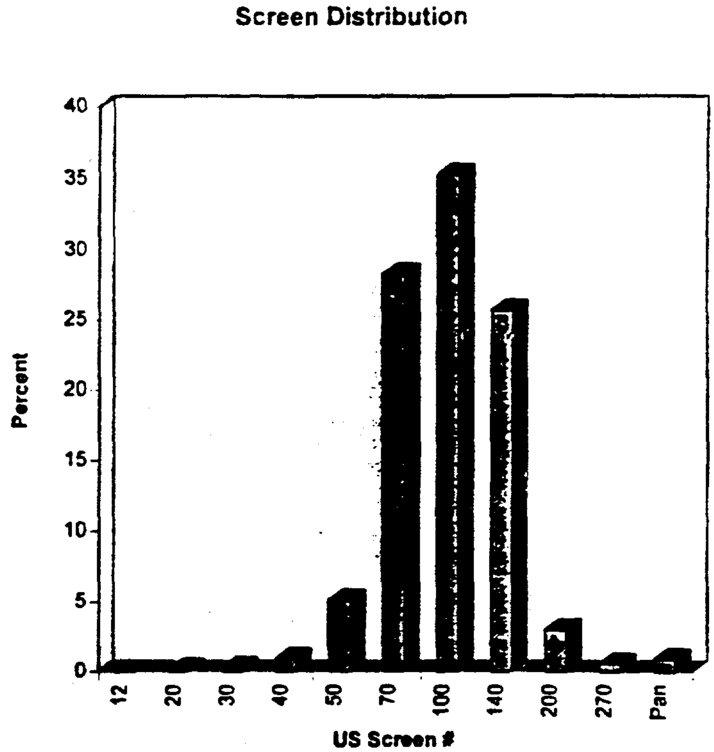
AFS GFN	80.69
% LOI	0.05
pH	9.8
ADV @ pH 5	8.1
ADV @ pH 7	3.8



University of Northern Iowa	
Work Order	9155
Date	1/10/95
Sand Sample ID	1019

USA Sieve #	Percent
12	0.00
20	0.16
30	0.28
40	0.90
50	5.07
70	28.21
100	35.28
140	25.63
200	3.00
270	0.58
Pan	0.90

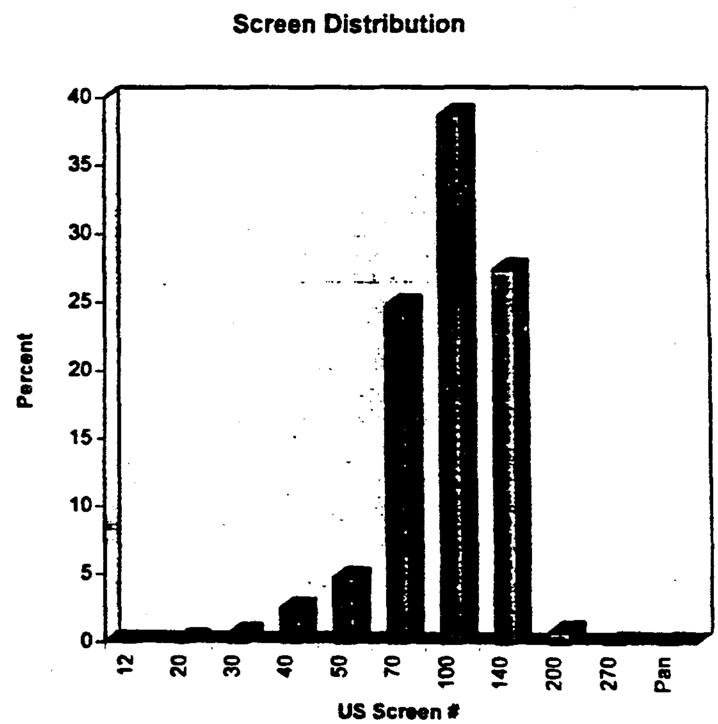
AFS GFN	**74.84**
% LOI	4.43
pH	8.4
ADV @ pH 5	50.0
ADV @ pH 7	14.8



University of Northern Iowa	
Work Order	9155
Date	1/10/95
Sand Sample ID	1020

USA Sieve #	Percent
12	0.00
20	0.18
30	[illegible]
40	2.52
50	4.78
70	24.78
100	38.70
140	27.38
200	0.87
270	0.10
Pan	0.06

AFS GFN	**71.27**
% LOI	0.11
pH	6.3
ADV @ pH 5	44.4
ADV @ pH 7	12.2

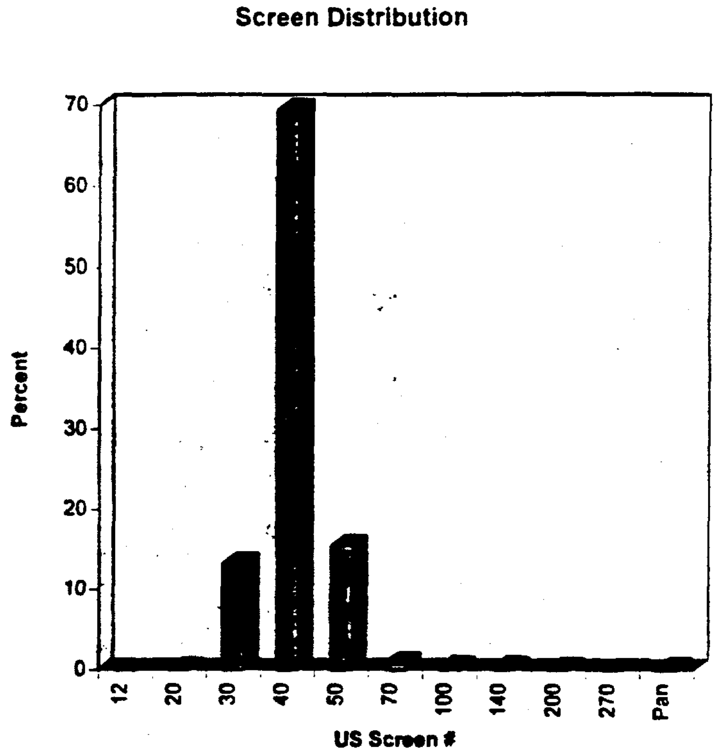


University of Northern Iowa

Work Order	9155
Date	1/10/95
Sand Sample ID	1021

USA Sieve #	Percent
12	0.00
20	0.12
30	13.13
40	69.43
50	15.37
70	0.82
100	0.36
140	0.34
200	0.14
270	0.04
Pan	0.26

AFS GFN	31.67
% LOI	0.31
pH	6.5
ADV @ pH 5	0.8
ADV @ pH 7	0.2

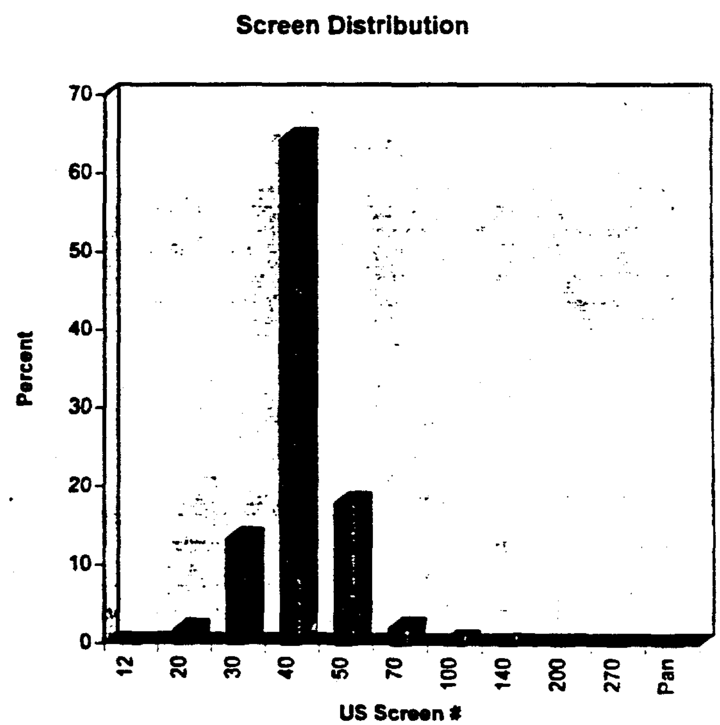


University of Northern Iowa

Work Order	9155
Date	1/10/95
Sand Sample ID	1022

USA Sieve #	Percent
12	0.00
20	1.68
30	13.36
40	64.31
50	17.93
70	2.04
100	0.53
140	0.08
200	0.02
270	0.02
Pan	0.02

AFS GFN	30.91
% LOI	0.02
pH	5.6
ADV @ pH 5	0.4
ADV @ pH 7	-0.1



University of Northern Iowa

Work Order	9155	9155	9155	9155	9155	9155	9155	9155	9155	9155	9155
Date	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94	10/24/94
Sand Sample ID	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011
USA Sieve #	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
12	0.36	0.00	0.00	0.00	0.02	0.00	0.36	0.02	0.04	0.00	0.00
20	0.66	0.02	0.08	0.04	0.10	0.02	0.12	0.20	0.11	0.09	0.16
30	0.44	0.16	0.56	0.04	0.12	0.04	0.54	0.16	0.19	0.16	0.20
40	2.20	4.22	18.41	8.49	1.46	2.38	4.30	5.15	15.36	20.38	3.48
50	13.93	19.79	36.86	31.92	19.95	21.75	24.95	25.79	27.63	40.79	39.79
70	26.64	36.51	36.14	48.06	40.56	48.11	37.92	39.94	19.51	22.47	39.94
100	29.22	26.23	7.54	10.37	26.59	21.87	22.13	23.10	12.06	7.78	12.87
140	20.86	11.96	0.40	0.94	9.82	5.21	7.50	5.33	21.15	7.87	2.88
200	4.44	1.06	0.02	0.08	1.10	0.38	1.26	0.16	3.31	0.38	0.40
270	0.90	0.06	0.00	0.06	0.18	0.08	0.50	0.04	0.19	0.04	0.18
Pan	0.34	0.00	0.00	0.00	0.10	0.16	0.42	0.10	0.46	0.04	0.10
AFS GFN	70.08	59.39	44.16	47.79	59.37	55.17	57.38	53.99	61.44	47.74	50.10
% LOI	2.08	0.03	0.03	0.72	0.32	0.18	4.71	0.13	1.68	0.03	7.19
pH	8.6	9.3	6.8	6.3	9.8	10.8	9.6	9.9	8.1	7.7	3.42
ADV @ pH 5	13.5	4.1	0.5	3.0	8.8	7.0	30.2	4.0	10.1	1.9	7.9
ADV @ pH 7	10.5	3.4	-0.2	0.5	7.0	5.8	16.0	2.9	5.4	1.0	15.1
											9.5

Prepared by Ashland Chemical

Work Order	9155	9155	9155	9155	9155	9155	9155	9155	9155	9155	9155
Date	10/24/94	10/24/94	10/24/94	1/9/95	1/9/95	1/9/95	1/9/95	1/9/95	1/9/95	1/9/95	1/9/95
Sand Sample ID	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022
USA Sieve #	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
12	0.09	0.04	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00
20	0.09	0.10	0.02	0.78	0.04	0.62	0.06	0.16	0.18	0.12	1.68
30	0.20	0.27	0.04	0.66	1.01	1.02	0.06	0.28	0.63	13.13	13.36
40	3.25	5.32	2.69	14.38	21.29	8.70	0.16	0.90	2.52	69.43	64.31
50	23.48	27.85	21.22	29.33	38.66	11.08	6.65	5.07	4.78	15.37	17.93
70	47.13	39.62	41.01	30.35	31.27	24.35	19.06	28.21	24.78	0.82	2.04
100	19.83	19.85	28.14	17.29	7.00	21.84	33.41	35.28	38.70	0.36	0.53
140	5.13	5.39	6.48	6.25	0.50	18.90	31.45	25.63	27.38	0.34	0.08
200	0.50	0.83	0.26	0.56	0.14	8.18	8.11	3.00	0.87	0.14	0.02
270	0.11	0.35	0.04	0.30	0.06	2.85	0.88	0.58	0.10	0.04	0.02
Pan	0.18	0.39	0.10	0.10	0.04	1.82	0.16	0.90	0.06	0.26	0.02
AFS GFN	54.47	54.92	56.73	51.47	43.52	76.31	80.69	74.84	71.27	31.67	30.91
% LOI	5.50	6.54	0.18	0.16	0.04	6.91	0.05	4.43	0.11	0.31	0.02
pH	2.19	1.22	7.7	8.0	7.8	6.6	9.8	8.4	6.3	6.5	5.6
ADV @ pH 5	9.8	9.7	5.4	3.9	2.5	8.2	8.1	50.0	44.4	0.8	0.4
ADV @ pH 7	24.4	26.0	3.9	1.8	1.7	5.0	3.8	14.8	12.2	0.2	-0.1
	17.9	18.5									

APPENDIX D

SOURCE TEST REPORT

SOURCE TEST REPORT

Inorganic Lead Emissions
From A
Fluid-Bed Type Sand Reclaim Furnace
(Permit Number 93-A-153)

Operated by: UNI Metal Castings Center
Cedar Falls, Iowa.

Compliance Services, Inc.
Project No. UNI1294

Prepared By:

Neil E. Sherman, M.S.
Senior Industrial Hygienist

Neil Sherman

Compliance Services, Inc.
P.O. Box 440
Edgewood, Iowa, 52042
(319) 928-6400

Test Date: November 22, 1994
Report Date: December 27, 1994

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TEST PROGRAM AND OVERVIEW

A series of stack tests were conducted to determine inorganic lead emissions form a Fluid-Bed Type Sand Reclaim Furnace (Permit # 93-A-153). The unit is owned and operated by the University of Northern Iowea Metal castings Center and was in operation at the A.Y. McDonald facility, Dubuque, Iowa, the day of the testing.

Mr. Neil Sherman of Compliance Services was the test company project manager. Mr. Fred Vondra, UNI Metal Castings Center, retained the testing consultants and served as point of contact. Mr. Jim Houtiker, A.Y. McDonald, served as the host facilty coordinator. Mr Dave Phelps, Iowa Department of Natural Resources, represented the State of Iowa and declined observing the testing. These tests were performed to satisfy an informal request by Mr. Pete Hamlin, Iowa Department of Natural Resources.

SOURCE OPERATING CONDITIONS

For all test periods, operation was considered as representing normal production activities. On the day of testing, production activities were documented and are included in Appendix I. The laboratory data are presented in Appendix IV. The results of these analyses are presented in Appendix V.

TEST METHODS

Table 1 shows the appropriate state and EPA references for all methods used to conduct this test. The following discussion reiterates key portions of these reference methods.

Table 1. Test References

Test Parameters	Reference Method(s)
Determination of sampling location and number of traverse points	40CFR60, Appendix A, EPA Reference Method 1
Stack Gas Velocity and Volumetric Flow Rate	40CFR60, Appendix A, EPA Reference Method 2
Determination of Dry Molecular Weight by Gas Analyses	40CFR60, Appendix A, EPA Reference Method 3
Determination of Moisture Content	40CFR60, Appendix A, EPA Reference Method 4
Determination of Inorganic Lead Emissions from Stationary Sources	40CFR60, EPA Reference Method 12

The stack sample was withdrawn isokinetically, filtered through a quartz filter, then condensed in a series of impingers containing dilute nitric acid. The impingers were kept in an ice bath to maintain a sample discharge temperature less than 68 degrees F.

At the end of each test run the filter was removed from the assembly and placed in a clean identified Petri dish (Container 1). The nozzle assembly, probe and front half of the filter assembly was rinsed with 0.1 N HNO_3 (nitric acid) using a teflon/stainless steel brush. These components were rinsed until the rinse showed no visible sign of contamination and the rinses were stored in a glass sample container (container 2). The impinger catch was transferred into a glass sample container (Container 4) and the impinger assemblies and connecting glassware were rinsed with 0.1 N HNO_3 (nitric acid) and stored in the respective impinger catch sample containers. The silica gel was transferred into an identified plastic container (Container 3), was weighed to the nearest 0.5 gram and compared to the preweighed value assigned to each respective sample..

Containers 1, 2 and 4 were combined the laboratory for anlysesa according to EPA Method 12. All analytical testing was performed by Clayton Environmental Consultants, Novi. Michigan.

The dry molecular weight of the flue gas was determined by collecting as representative sample of the flue gas in a Tedlar bag and analyzing the sample with an Orsat apperatus. All procedures for Orsat analyses were followed according to EPA Reference Method 3. All sorbent chemicals were newly charged prior to the analyses.

Flue gas moisture content was determined utilizing EPA Reference Method 4, which is integral to the particulate sampling method described above. Water vapor in the gas sample is condensed in the impinger train/ice bath. Water collected was indicated by an increase in impinger volume and silica gel weight.

TEST EQUIPMENT

The equipment used to perform the compliance test included CAE (Clean Air Engineering) metering console, pump and glassware according to 40 CFR Pt 60, Method 5. The probe used to perform this test were constructed of stainless steel sheathing with a Pyrex liner equipped with an appropriately sized stainless steel nozzle.

QUALITY ASSURANCE

The quality assurance procedures used for this test program are associated with the reference methods cited above, as well as those published by EPA in the Quality Assurance Handbook for Air Pollution Measurement Systems: Vol.III. Stationary Source Specific Methods. The following discussion is excerpted from the references above.

The construction and condition of the standard S Pitot tube used was verified by visual inspection and was assigned a 0.84 coefficient. Pitots were periodically inspected during use to ensure proper operating condition (no tip damage or blockage).

The dry gas meter utilized received a five (5) point calibration against a certified calibration dry gas meter. Only those meters with a calibration factor of 1.0 +/- 2% were used. On the day of the test a field calibration was performed and was within +/- 3 % specifications. All calibration data and field calibration data are presented in Appendix VI.

The isokinetic sampling rate for each run was within the 100 +/- 10 % limit. No production stoppages, nor test equipment failures were experienced during any portion of the testing.

A clean area was designated for the preparation of the sampling train, collection of samples, cleaning of the sampling train and preparation of field blank. After sampling all sampling train components open to the environment were either immediately cleaned or capped/sealed for further cleaning. Compliance Services Laboratory was used to transfer filterable particulate from the filter holders to the weighing containers.

Field blanks were prepared and analyzed for the 0.1 N HNO_3 and quartz filter for each test batch.

RESULTS AND DISCUSSION

Results of the test program present inorganic lead concentrations and emission rates which were relatively consistent from run to run. The Summary of Stack Test Field Data indicate an average emission rate of 0.005 lbs/hour and an average inorganic lead concentration of 0.00011 grains/dscf. All field data and calculations are presented in Appendix III. All laboratory data are presented in Appendix IV. Results of the test program are presented in Appendix V.

Initial traversing indicated extreme pressure differentials across each traverse (2.9 to - 0.2 and 3.9 to - 0.12). It was indicated by UNI Metal Casting representatives that the two dampers force the airstream one side of the stack (the side where flow was identified. The negative pressure in absence of cyclonic flow may be caused by the configuration of the dampers when considering the velocity in the flow portion of the stack (> 100 f/sec) and the duct diameter distance downstream from the flow straightener (2.4). This may cause a vacuum effect in presence of uniform non-cyclonic flow. A longer stack may allow positive pressure throughout the stack, but may also allow more cyclonic flow downstream from the flow straightener when considering the extreme pressure differential from one side of the stack to the other.

Sampling was conducted over a 72 minute period, but traverse locations indicating a negative pressure were not sampled. Negative pressure was considered as 0 when calculating velocity and flow. For this reason the overall area of the stack sampled was 1.09 ft^2, rather than 2.18 ft^2 and the overall number of traverse locations sampled was 12. Additionally, the overall sample time for those traverse locations sampled was 3 minutes yielding a metered volume greater than the minimum required volume of 30 cubic feet.

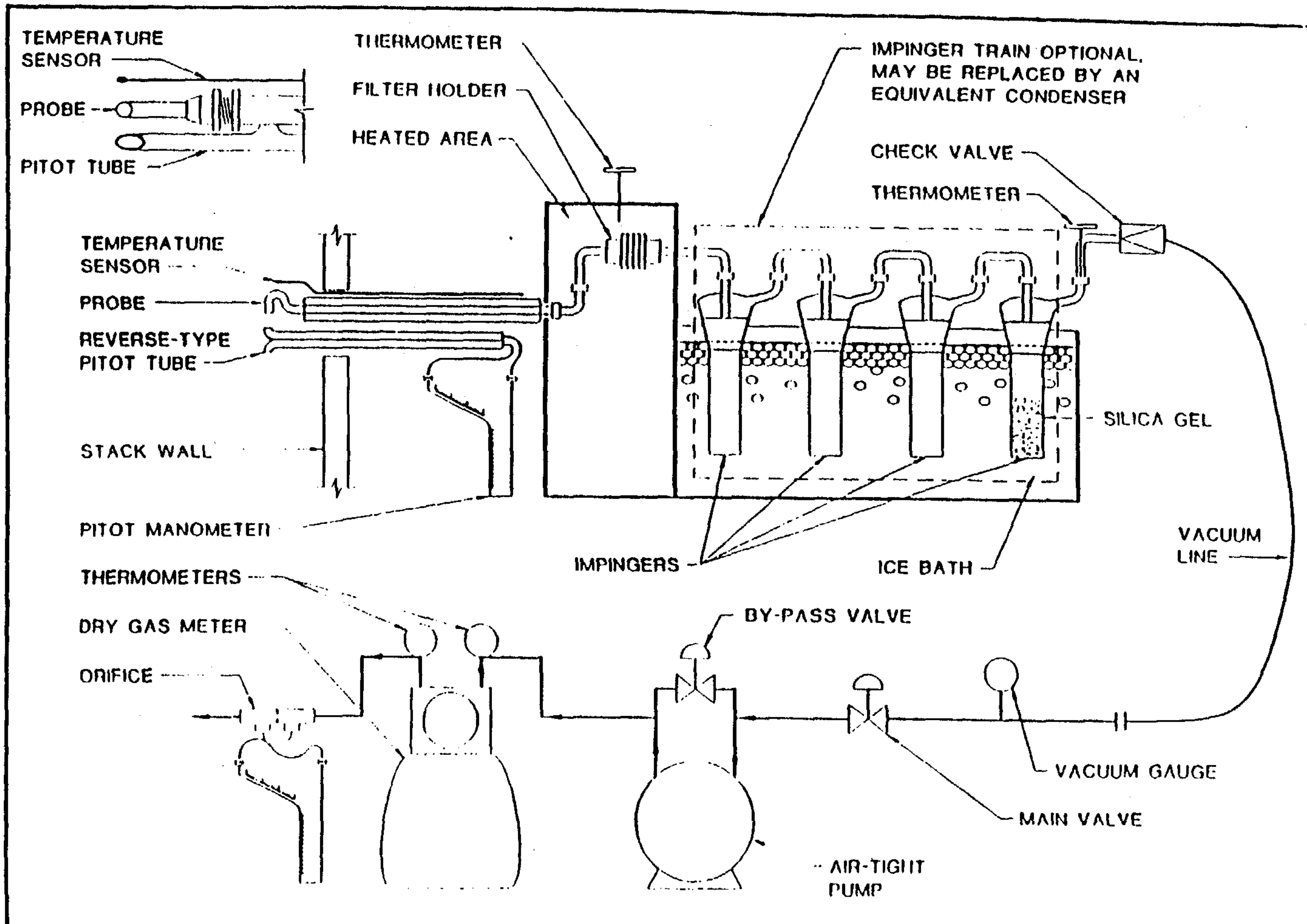


FIGURE / PARTICULATE-SAMPLING TRAIN

APPENDIX I

SOURCE OPERATING DATA

PARTICULATE EMISSION TEST
_______________ OPERATING DATA*
(Type of Source)

Owner University of Northern Iowa Run No. 1
Source I.D. Fluid-Bed Type Sand Reclaim Furnace Date 11-22-94

Maximum Continuous Process Weight (Manufacturer's Rating) 2000 lbs./hr.
Historical Average Process Weight 1200 lbs./hr.
Historical Maximum Process Weight 1600. lbs./hr.
Type and Sources of Fuels Normally Burned Natural gas

Approximate Quantities of Each of Above Fuels Burned Annually Not available

Recycling Capability: Yes _______ No ✓

Process Data During Run (Averaged)

Process Weight (Dry) 1200 lbs./hr.
Percent Moisture < 1% %
Process Weight (Wet) 1200 lbs./hr.
How Process Weight Determined weight of finished product

Type of Fuel Burned During Run Natural gas

Recycling in Progress Yes _______ No ✓

Person Responsible for Data: Fred Vondra
Signature: Fred Vondra
Title/Position: PROJECT DIRECTOR

*Averages of operating data taken during actual test run unless requested otherwise.

A-5

AIR POLLUTION CONTROL EQUIPMENT OPERATING DATA*

Plant Univ. of Northern Iowa Location A. Y. McDonald
Source Type ______ Rated Production 1 TPH
Date 11-22-94 Time 1030 Actual Production .6 TPH
Air Flow Data ______ Run No. 1

Mechanical Collector:
Tube Dia. ____ in. No. of Tubes ____. Design p ____ in. H_2O @ Gas Temp ____ °F
Observed Δp ____ in H_2O. Design cfm/tube @ Observed Δp ____ @ ____ °F.
Fan Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Electrostatic Precipitator:

Field No.	Primary Voltage (volts)	Primary Current (amps)	Secondary Voltage (KV)	Secondary Current (ma)	Spark Rate (per min.)

Scrubber:
Type ______. Δp (across scrubber) ______ in. H_2O.
Fan Rated H.P. ____. Operating Volts ____. Operating Amps ____.
Liquid Circulation Rate ____ gal/min. % Make-up ____. Blowdown ____ gpm.
Scrubbing Water Change Interval ______
Settling Tank Cleaning Interval ______

Baghouse:
Pressure-Positive ✓. Negative ____. No. Compartments ____.
Type Cleaning ______. Clean Cycle ____ min.
Avg. Baghouse Δp 2.59 in H_2O. Δp Range 2.5 - 2.8 in. H_2O.
Fan: Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Cyclone:
Type ____. Δp ____ in. H_2O. Diameter ______.
Fan: Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Person Responsible for Data: Fred Vondra
Signature: Fred Vondra
Title/Position: Project Director

*Averages of operating data taken during actual test run unless requested otherwise.

1st Test	Calcine Temp	Collector Temp	Diff. Pressure	Gas Volume
10:35	1342 F	201	2.8	0704429 10:2 0655705
10:45	1300	193	2.5	
10:55	1275	188	2.5	0701645 10:25 0655873
11:05	1325	189	2.5	
11:15	1290	186	2.6	
11:25	1320	191	2.5	
11:35	1290	189	2.6	
11:45	1321	194	2.6	
11:55	1290	192	2.7 [2.59]	0710494 12:0 0656715
2nd Test 1:05	1284	188	2.7	0711195 1:0 0657396
1:15	1320	195	2.8	
1:25	1308	199	3.0	
1:35	1287	200	2.9	
1:45	3000	197	2.9	
1:55	1290	199	2.9	
2:05	1309	198	2.8	5.5 PS
2:15	1277	194	2.9	0712169
2:25	1317	200	2.9	0658350
			[2.87]	

PARTICULATE EMISSION TEST
______________ OPERATING DATA*
(Type of Source)

Owner University of Northern Iowa Run No. 2
Source I.D. Fluid-Bed Type, Sand Reclaim Furnace Date 11-22-94

Maximum Continuous Process Weight (Manufacturer's Rating) 2000 lbs./hr.
Historical Average Process Weight 1200 lbs./hr.
Historical Maximum Process Weight 1600 lbs./hr.
Type and Sources of Fuels Normally Burned Natural Gas

Approximate Quantities of Each of Above Fuels Burned Annually Not Available

Recycling Capability: Yes ______ No ✓

Process Data During Run (Averaged)

Process Weight (Dry) 1200 lbs./hr.
Percent Moisture < 1% %
Process Weight (Wet) 1200 lbs./hr.
How Process Weight Determined weight of finished product

Type of Fuel Burned During Run Natural Gas

Recycling in Progress: Yes ______ No ✓

Person Responsible for Data: Fred Vondra
Signature: F. J. Vondra
Title/Position: PROJECT DIRECTOR

*Averages of operating data taken during actual test run unless requested otherwise.

A-5

AIR POLLUTION CONTROL EQUIPMENT OPERATING DATA*

Plant University of Northern Iowa ______ Location A.Y. McDonald Dubuque IA
Source Type Fluid Bed Type Sand Reclam' ______ Rated Production 1 TPH
Date 11-22-94 Time Day 1306 Actual Production 0.6 TPH
Air Flow Data ______ Run No. 2

Mechanical Collector:

Tube Dia. ____ in. No. of Tubes ____. Design p ____ in. H_2O @ Gas Temp ____ °F.
Observed ∆p ____ in H_2O. Design cfm/tube @ Observed ∆p ____ @ ____ °F.
Fan Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Electrostatic Precipitator:

Field No.	Primary Voltage (volts)	Primary Current (amps)	Secondary Voltage (KV)	Secondary Current (ma)	Spark Rate (per min.)

Scrubber:

Type ____. ∆p (across scrubber) ____ in. H_2O.
Fan Rated H.P. ____. Operating Volts ____. Operating Amps ____.
Liquid Circulation Rate ____ gal/min. % Make-up ____. Blowdown ____ gpm.
Scrubbing Water Change Interval ____
Settling Tank Cleaning Interval ____

Baghouse:

Pressure-Positive ✓. Negative ____. No. Compartments ____.
Type Cleaning ____. Clean Cycle ____ min.
Avg. Baghouse ∆p 2.87 in H_2O. ∆p Range 2.7 - 3.0 in. H_2O.
Fan: Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Cyclone:

Type ____. ∆p ____ in. H_2O. Diameter ____.
Fan: Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Person Responsible for Data: Fred Vondra
Signature: Fred Vondra
Title/Position: PROJECT DIRECTOR

*Averages of operating data taken during actual test run unless requested otherwise.

(1st Test)	Calcine Temp	Collector Temp	Diff. Pressure	Gas Volume	
10:35	1342 F	201	2.8	0709429 0655705	10:2
10:45	1300	193	2.5		
10:55	1275	188	2.5	0709645 0655873	10:25
11:05	1325	189	2.5		
11:15	1290	186	2.6		
11:25	1320	191	2.5		
11:35	1290	189	2.6		
11:45	1321	194	2.6		
11:55	1290	192	2.7 [259]	0710494 0656715	12:
(2nd Test) 1:05	1284	188	2.7	0711195 0657396	1:
1:15	1320	195	2.8		
1:25	1308	199	3.0		
1:35	1287	200	2.9		
1:45	3000	197	2.9		
1:55	1290	199	2.9		
2:05	1309	198	2.8		
2:15	1277	194	2.9	5.5 P 0712169	
2:25	1317	200	2.9	0658350	
			[2.87]		

PARTICULATE EMISSION TEST

_______________ OPERATING DATA*

(Type of Source)

Owner University of Northern Iowa Run No. 3

Source I.D. Fluid Bed Type Sand Reclaim Furnace Date 11-22-94

Maximum Continuous Process Weight (Manufacturer's Rating) 2000 lbs./hr.

Historical Average Process Weight 1200 lbs./hr.

Historical Maximum Process Weight 1600 lbs./hr.

Type and Sources of Fuels Normally Burned Natural Gas

Approximate Quantities of Each of Above Fuels Burned Annually Not Available

Recycling Capability: Yes _____ No ✓

Process Data During Run (Averaged)

Process Weight (Dry) 1200 lbs./hr.

Percent Moisture <1% %

Process Weight (Wet) 1200 lbs./hr.

How Process Weight Determined weight of finished product

Type of Fuel Burned During Run Natural Gas

Recycling in Progress: Yes _____ No ✓

Person Responsible for Data: Fred Vondra

Signature: Fred Vondra

Title/Position: PROJECT DIRECTOR

*Averages of operating data taken during actual test run unless requested otherwise.

AIR POLLUTION CONTROL EQUIPMENT OPERATING DATA*

Plant University of Northern Iowa Location SV McDonald Dubuque Et
Source Type Fluid-Bed Type Sand Reclaim Rated Production 1 TPH
Date 11-22-94 Time Day 1525 Actual Production 0-6 TPH
Air Flow Data ________ Run No. 3

Mechanical Collector:

Tube Dia. ____ in. No. of Tubes ____. Design p ____ in. H_2O @ Gas Temp ____ °F.
Observed Δp ____ in H_2O. Design cfm/tube @ Observed Δp ____ @ ____ °F.
Fan Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Electrostatic Precipitator:

Field No.	Primary Voltage (volts)	Primary Current (amps)	Secondary Voltage (KV)	Secondary Current (ma)	Spark Rate (per min.)

Scrubber:

Type ________. Δp (across scrubber) ________ in. H_2O.
Fan Rated H.P. ____. Operating Volts ____. Operating Amps ____.
Liquid Circulation Rate ____ gal/min. % Make-up ____. Blowdown ____ gpm.
Scrubbing Water Change Interval ________
Settling Tank Cleaning Interval ________

Baghouse:

Pressure-Positive ✓. Negative ____. No. Compartments ____.
Type Cleaning 2.93 ________. Clean Cycle ____ min.
Avg. Baghouse Δp ____ in H_2O. Δp Range 2.9 - 3.0 in. H_2O.
Fan: Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Cyclone:

Type ____. Δp ____ in. H_2O. Diameter ________.
Fan: Rated H.P. ____. Operating Volts ____. Operating Amps ____.

Person Responsible for Data: Fred Vondra
Signature: Fred Vondra
Title/Position: PROJECT DIRECTOR

	Calcine Temp	Collector Temp	Diff Pressure	Gas Volume
3rd Test				0713021 0659174
3:25	1340	206	2.9	
3:35	1320	205	2.9	
3:45	1303	201	2.9	
3:55	1275	197	3.0	
4:05	1335	199	2.9	
4:15	1293	199	2.9	
4:25	1323	201	2.9	
4:35	1288	197	3.0	
4:45	1315	202	2.9 [293]	0713942 0660061

APPENDIX II

STACK CONFIGURATION AND TRAVERSE POINT LOCATIONS

PARTICULATE TRAVERSE POINT LOCATION

SOURCE: DATE: 11/22/94

Facility: UNI Metal Casting Center
Location: Cedar Falls, Iowa (Dubuque, Iowa, test site)
Stack Source: Fluid-Bed Type Sand Reclaim Furnace (Permit # 93-A-153)

STACK DIAMETER:
DIAMETER 20.0 inches

STACK AREA (feet): 2.18 ft^2 (actual)
1.09 ft^2 (utilized)

SAMPLING PORT:

DIST. DOWNSTREAM FROM FLOW DISTURBANCE (feet): 4.0

DIST. UPSTREAM FROM FLOW DISTURBANCE (feet): 4.0

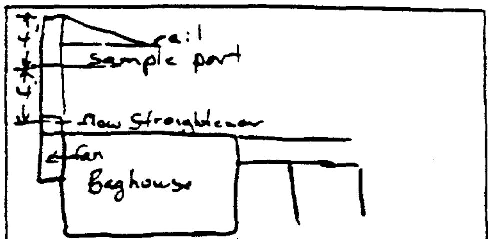
FLOW STRAIGHTENING DEVICE: 5" x 5" x 9 " grid system installed in base immediately downstrean from dampers and 2.4 duct diameters upstream from the sampling ports.

Note:

Initial traversing indicated extreme pressure differentials across each traverse (2.9 to - 0.2 and 3.9 to - 0.12). It was indicated by UNI Metal Casting representatives that the two dampers force the airstream one side of the stack (the side where flow was identified. The negative pressure in absence of cyclonic flow may be caused by the configuration of the dampers when considering the velocity in the flow portion of the stack (> 100 f/sec) and the duct diameter distance downstream from the flow straightener (2.4). This may cause a vacuum effect in presence of uniform non-cyclonic flow. A longer stack may allow positive pressure throughout the stack, but may also allow more cyclonic flow downstream from the flow straightener when considering the extreme pressure differential from one side of the stack to the other.

COMPLIANCE SERVICES EPA METHOD 2 FIELD DATA SHEET

Job *UNI Metal Casting Center*
Source *Fluid-Bed Type Sand Reclaim*
Test *1* Run *0* Date *11-22-94*
Stack dimen. *20"* IN.
Dry bulb *220* F Wet bulb ____ F
Manometer: ✓Reg. __Exp. __Elec.
Barometric Pressure *30.65* in Hg
Static Pressure *-1.05* in WC
Operators *N. Sherman*
Pitot # *1* Cp *0.84*
Port Dia. *4* Port Length *0*



Schematic of Cross Section

Traverse Point No.	Frac. of Dia.	Dist. from Wall	Velocity Pressure (in WC)	Temp. of gas (F)	Pressure at 0 deg Reference	Angle° Yielding Null P
1	2.1	1.0	2.8		0.05	5
2	6.7	1.34	2.8	205	0.05	5
3	11.8	2.36	2.8		0.05	5
4	17.7	3.54	2.7		0.05	5
5	25.0	5.0	1.6	220	0.05	5
6	35.6	7.12	1.1		0.05	5
7	64.4	12.9	-0.15	223	0.08	10
8	75.0	15.0	-0.18		0.08	10
9	82.3	16.5	-0.20	218	0.08	10
10	88.2	17.6	-0.20		0.08	10
11	93.3	18.7	-0.20	215	0.08	10
12	97.9	19.0	-0.10		0.08	10
13			3.9	200	0.05	5
14			3.8		0.05	5
15			3.8		0.05	5
16			3.6	220	0.05	5
17			2.2		0.06	5
18			1.15	225	0.05	5
19			-0.12		0.07	10
20			-0.12	218	0.07	10
21			-0.10		0.07	10
22			-0.10	215	0.07	10
23			-0.10		0.07	10
24			-0.10		0.07	10
Average Value			2.70	215.4		7.5°

APPENDIX III

FIELD DATA AND CALCULATIONS

STACK TEST CALCULATIONS

stack absolute pres, "Hg, Ps	$Pg/13.6 + Pbar$
sample volume, standard cond., Vm std	$17.64 \times Vm \times Y \times \frac{Pbar + (\text{delta } H/13.6)}{Tm}$
water vapor volume, Vw std	$V\,lc \times 0.04071$
stack gas moisture content, %, Bws	$\frac{Vw\ std}{Vm\ std + Vw\ std}$
stack gas velocity, ft/sec, vs	$85.49 \times Cp \times \text{sq rt delta } P \times \sqrt{\left(\frac{Ts}{Ps\ Ms}\right)}$
stack gas flow rate, dscfh, Q	$3600 \times (1\text{-}Bws) \times vs \times A \times \frac{Tstd \times Ps}{Ts\ \ Pstd}$
particulate concentration, grn/dscf, cs	$mn \times 15.43\ /\ Vm\ std$
particulate emission rate, lb/hr, E	$\frac{cs \times Q}{7000}$
flue gas molecular weight, dry, Md	$0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%\ CO)$
flue gas molecular weight, wet, Ms	$Md\ (1\text{-}Bws) + 18.0 \times Bws$
isokinetic sampling rate, % I	$I = \frac{0.0944 \times Ts \times Vm\ std}{Ps \times vs \times An \times \text{theta} \times (1\text{-}Bws)}$

Particulate Field Data

Very Important — Fill in all Blanks

Plant [illegible]
Run no. 1
Location [illegible]
Date 11-22-94
Operator [illegible]
Sample box no. [illegible]
Meter box no. [illegible]
Nomograph ID no. [illegible]
Orsat no. 1 Date rebuilt 1/94
Fyrite no. ___ Date rebuilt ___ 38.8 Sec

C_p .85
$\Delta H_@$ 1.851
P_m, in. Hg ___
P_s, in. Hg -1.05
B_{ws} (assumed) 2%
M_d ___
M_s ___
T_m, °R 45.75
T_s, °F 211.6
Δp_{avg}, in. H_2O 2.55

Test start time 1127
Stop time 1145
D_n calculated (in.) 0.187
D_n used (in.) [illegible]
Ambient temp., °F 42
Bar. pressure, in. Hg [illegible]
Heater box setting, °F [illegible]
Probe heater setting, °F [illegible]
Average ΔH 2.55
Leak rate@15 in. Hg Pre-test [illegible] Post test [illegible]

Point	Clock time (min)	Dry gas meter CF	Pitot in H_2O Δp	Orifice ΔH in H_2O		Dry gas temp. °F		Pump vacuum in. Hg gauge	Box temp. °F	Impinger temp. °F	Stack press. in. Hg	Stack temp. °F	Fyrite %CO_2
				Desired	Actual	Inlet	Outlet						
1	3	391.690	2.8		2.8	45	46	[illegible]	250	36		195	
2	6	393.700	2.8		2.8	45	46	[illegible]	250	35		205	
3	9	396.320	2.8		2.8	45	46	7.0	252	35		210	
4	12	398.910	2.8		2.8	45	46	7.0	251	40		214	
5	15	401.403	2.5		2.5	45	47	7.0	251	40		218	
6	18	403.195	1.2		1.2	45	47	[illegible]	250	42		222	

Comments: ___

Test observers: ___ ___

continued

Particulate Field Data

Very Important—Fill in all Blanks

Plant ______
Run no. 2
Location ______
Date ______
Operator ______
Sample box no. ______
Meter box no. ______
Nomograph ID no. ______
Orsat no. ____ Date rebuilt ____
Fyrite no. ____ Date rebuilt ____

C_p ______
$\Delta H_@$ ______
P_m, in. Hg ______
P_s, in. Hg ______
B_{ws} (assumed) ______
M_d ______
M_s ______
T_m, °R ______
T_s, °R ______
Δp_{avg}, in. H_2O ______

Test start time ______
Stop time ______
D_n calculated (in.) ______
D_n used (in.) ______
Ambient temp., °F ______
Bar. pressure, in. Hg ______
Heater box setting, °F ______
Probe heater setting, °F ______
Average ΔH ______
Leak rate@15 in. Hg Pre-test ____ Post-test ____

Point	Clock time (min)	Dry gas meter CF	Pitot in H_2O Δp	Orifice ΔH in H_2O		Dry gas temp. °F		Pump vacuum in. Hg gauge	Box temp. °F	Impinger temp. °F	Stack press. in. Hg	Stack temp. °F	Fyrite %CO_2
				Desired	Actual	Inlet	Outlet						
7	21	406.765	4.0		4.0	45	46	11.0	251	42		197	
8	24	409.525	4.0		4.0	45	46	11.0	251	42		202	
9	27	412.29	4.0		4.0	45	47	11.0	251	43		210	
10	30	415.44	4.0		4.0	45	47	11.0	251	43		219	
11	33	[illegible]	2.5		2.5	45	47	8.0	256	44		222	
12	36	419.[illegible]	1.2		1.2	45	47	5.0	250	44		219	
		21.385	3.38		3.38		45.75					214.6	

Comments: Cp 1.05

Test observers: ______ ______

continued

5-27

Particulate Field Data

Very Important—Fill in all Blanks

Plant [illegible]
Run no. 2
Location [illegible]
Date 11-27-91
Operator [illegible]
Sample box no. [illegible]
Meter box no. [illegible]
Nomograph ID no. [illegible]
Orsat no. 1 Date rebuilt 5/91
Fyrite no. ____ Date rebuilt ____
420.00

C_p 0.84
$\Delta H_@$ 1.53
P_m, in. Hg ____
P_s, in. Hg -1.05
B_{ws} (assumed) .2
M_d ____
M_s ____
T_m, °R 43.3
T_s, °R 214.2
Δp_{avg}, in. H_2O 2.235

Test start time 1306
Stop time 1423
D_n calculated (in.) 0.155
D_n used (in.) 0.175
Ambient temp., °F 38
Bar. pressure, in. Hg 30.65
Heater box setting, °F 250
Probe heater setting, °F 250
Average ΔH 2.238
Leak rate@15 in. Hg Pre-test [illegible] Post-test [illegible]

Point	Clock time (min)	Dry gas meter CF	Pitot in H_2O Δp	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry gas temp. °F Inlet	Dry gas temp. °F Outlet	Pump vacuum in. Hg gauge	Box temp. °F	Impinger temp. °F	Stack press. in. Hg	Stack temp. °F	Fyrite %CO_2
	3	422.585	2.8		2.8	41	44	7.5	230	43		192	
[illegible]	6	425.180	2.8		2.8	41	44	7.5	240	43		205	
3	9	427.785	2.5		2.5	41	44	7.5	244	43		216	
[illegible]	12	430.365	2.5		2.8	41	44	7.5	250	43		223	
[illegible]	15	432.450	1.7		1.7	42	45	5.5	250	47		226	
[illegible]	18	433.91	1.95		1.95	42	45	3.0	251	43		223	

Comments: ____

Test observers: ____ ____

continued

Particulate Field Data

Very Important—Fill in all Blanks

Plant ______
Run no. 2
Location ______
Date ______
Operator ______
Sample box no. ______
Meter box no. ______
Nomograph ID no. ______
Orsat no. ____ Date rebuilt ____
Fyrite no. ____ Date rebuilt ____

C_p ______
$\Delta H_@$ ______
P_m, in. Hg ______
P_s, in. Hg ______
B_{ws} (assumed) ______
M_d ______
M_s ______
T_m, °R ______
T_s, °R ______
Δp_{avg}, in. H_2O ______

Test start time ______
Stop time ______
D_n calculated (in.) ______
D_n, used (in.) ______
Ambient temp., °F ______
Bar. pressure, in. Hg ______
Heater box setting, °F ______
Probe heater setting, °F ______
Average ΔH ______
Leak rate @ 15 in. Hg Pre-test ______ Post-test ______

Point	Clock time (min)	Dry gas meter CF	Pitot in H_2O Δp	Orifice ΔH in H_2O		Dry gas temp. °F		Pump vacuum in. Hg gauge	Box temp. °F	Impinger temp. °F	Stack press. in. Hg	Stack temp. °F	Fyrite %CO_2
				Desired	Actual	Inlet	Outlet						
1	21	436.945	4.0		[illegible]	[illegible]	46	11.0	236	43		192	
2	24	440.075	3.8		3.8	43	46	11.0	250	44		215	
3	27	443.095	3.8		3.8	43	46	11.0	251	45		216	
[illegible]	30	446.125	3.8		3.8	43	46	11.0	251	45		223	
[illegible]	33	448.56	2.5		2.5	44	47	7.5	251	45		226	
[illegible]	36	450.205	1.0		1.0	44	47	4.0	250	46		223	
		[illegible]	2.995		2.55		43.8					214.2	

Comments: $\sqrt{\Delta p}$: 1.655

Test observers: ______ ______

continued

Particulate Field Data

Very Important—Fill in all Blanks

Plant [illegible]
Run no. 3
Location [illegible] McDonnell, [illegible], IA
Date [illegible]
Operator [illegible]
Sample box no. [illegible]
Meter box no. [illegible]
Nomograph ID no. [illegible]
Orsat no. ✓ Date rebuilt [illegible]
Fyrite no. ____ Date rebuilt ____

C_p [illegible]
$\Delta H_@$ [illegible]
P_m, in. Hg ____
P_s, in. Hg [illegible]
B_{ws} (assumed) [illegible]
M_d ____
M_s ____
T_m, °R 439.0
T_s, °R 223.5
Δp_{avg}, in. H_2O [illegible]

Test start time [illegible]
Stop time [illegible]
D_n calculated (in.) [illegible]
D_n used (in.) [illegible]
Ambient temp., °F [illegible]
Bar. pressure, in. Hg [illegible]
Heater box setting, °F [illegible]
Probe heater setting, °F [illegible]
Average ΔH [illegible]
Leak rate @ 15 in. Hg Pre-test [illegible] Post-test [illegible]

Point	Clock time (min)	Dry gas meter CF	Pitot in H_2O Δp	Orifice ΔH in H_2O		Dry gas temp. °F		Pump vacuum in. Hg gauge	Box temp. °F	Impinger temp. °F	Stack press. in. Hg	Stack temp. °F	Fyrite %CO_2
				Desired	Actual	Inlet	Outlet						
1	3	453.29	2.8		2.8	42	44	2.5	250	42		181	
2	6	455.84	2.1		2.2	42	44	2.5	250	42		209 (?)	
3	9	458.45	2.8		2.8	42	45	2.5	251	44		231 (?)	
4	12	460.90 (?)	2.8		2.8	42	45	2.5	251	44		247	
5	15	463.135 (?)	1.8		1.8	43	46	5.5	251	44		234	
6	18	464.36 (?)	2.8		3.8 (?)	43	46	2.5 (?)	250	44		238	

Comments: ____

Test observers: ____ ____

continued

Particulate Field Data

Very Important—Fill in all Blanks

Plant ______
Run no. [illegible]
Location ______
Date ______
Operator ______
Sample box no. ______
Meter box no. ______
Nomograph ID no. ______
Orsat no. ____ Date rebuilt ____
Fyrite no. ____ Date rebuilt ____

C_p ______
$\Delta H_@$ ______
P_m, in. Hg ______
P_s, in. Hg ______
B_{ws} (assumed) ______
M_d ______
M_s ______
T_m, °R ______
T_s, °R ______
Δp_{avg}, in. H_2O ______

Test start time ______
Stop time ______
D_n calculated (in.) ______
D_n used (in.) ______
Ambient temp., °F ______
Bar. pressure, in. Hg ______
Heater box setting, °F ______
Probe heater setting, °F ______
Average ΔH ______
Leak rate@15 in. Hg Pre-test ____ Post-test ____

Point	Clock time (min)	Dry gas meter CF	Pitot in H_2O Δp	Orifice ΔH in H_2O		Dry gas temp. °F		Pump vacuum in. Hg gauge	Box temp. °F	Impinger temp. °F	Stack press. in. Hg	Stack temp. °F	Fyrite $\%CO_2$
				Desired	Actual	Inlet	Outlet						
1	21	465.560	3.8		3.8	42	44	10.5	250	43		196	
5	24	470.525	3.8		3.8	42	44	10.5	251	43		217	
[illegible]	27	473.510	3.8		3.8	43	46	10.5	257	43		231	
10	30	476.446	3.5		3.5	43	42	10.0	251	44		232	
11	33	479.[illegible]	2.2		2.2	43	42	8.5	256	45		235	
12	36	481.[illegible]	[illegible]		1.5	43	42	5.0	256	45		236	
		33.255	2.74		2.74		43.96					773	

Comments: $\sqrt{\Delta p}$ 1.655

Test observers: ______ ______

continued

APPENDIX IV

LABORATORY DATA

Table 1
Analytical Results
for
COMPLIANCE SERVICES INC.
Clayton Project No. 21961.00
Client Reference#: UNI

Sample Type: Filter
Method /Reference: EPA 12
LOD (mg): 0.02
Analyst: DF

Date Sampled: 11/22/94
Date Received: 12/06/94
Date Analyzed: 12/20/94

Lab No.	Sample Identification	Air Volume (liters)	Lead (mg)	Lead (mg/m3)
001a	UNI-Pb-1 (Probe & Imp.)	--	0.22	--
002a	UNI-Pb-2 (Probe & Imp.)	--	0.20	--
003a	UNI-Pb-3 (Probe & Imp.)	--	0.30	--
004a	UNI-Pb-BLANK	--	<0.02	--

General Notes
<: Less than the indicated limit of detection (LOD)
--: Information not available or not applicable.

COMPLIANCE SERVICES, INC.
319/928-6400

EPA Method 3 Data Reporting Sheet
Orsat Analysis

Job *UNI Metal Casting Center* Source *Fluid-Bed Type Sand Reclaim*
Technician N. Sherman Test Site *A.Y. McDonald, Dubuque IA*
Date of Analyses ______ Date of Test *11-22-94*
Test No. 1 2 3 No. of Runs 3

Test/Run	Sample Log No. Type	No. of An.	Buret Readings (ml) Zero Pt	After CO_2	After O_2	Conc. CO_2 %v/v dry	Conc. O_2 %v/v dry	F_o
1	1	1	0.0	0.8	20.4	0.8	19.6	1.63
		2	0.0	0.8	20.4	0.8	19.6	1.63
	Ted Bag	Avg	***************************			0.8	19.6	1.63
2	2	1	0.0	0.8	20.6	0.8	19.8	1.83
		2	0.0	0.8	20.6	0.8	19.8	1.83
	Ted Bag	Avg	***************************			0.8	19.8	1.83
3	3	1	0.0	0.8	20.5	0.8	19.7	1.5
		2	0.0	0.8	20.5	0.8	19.7	1.5
	Ted Bag	Avg	***************************			0.8	19.7	1.5
		1						
		2						
	Ted Bag	Avg	***************************					
		1						
		2						
	Ted Bag	Avg	***************************					
		1						
		2						
	Ted Bag	Avg	***************************					
		1						
		2						
	Ted Bag	Avg	***************************					

✓ Ambient Air Check
✓ Orsat Analyzer QA Leak Check
✓ F_o Within EPA M-3 Guidelines for Fuel Type

F_o = 1.6 - 1.836

COMPLIANCE SERVICES, INC.
EPA Method 5 Data Reporting Sheet
Silica Gel Gravimetrics
Impinger Volumes

Job UNI Metal Casting Center	Source Fluid-Bed Type Sand Reclaim
Technician N. Sherman	Test Site A.Y. McDonald, Dubuque, IA
Date of Analyses	Date of Test 11-22-94
Test No. 1	No. of Runs 3
Sorbent Type Silica Gel	Water Type DI/Distilled

Run 0		S.G Jar Tare Wt.	367.8 g
Field Blank		Jar & Sample Wt.	367.8 g
Log Number	4a	Sample Wt.	0.0 g
Run 1			
Log Number	3a		
Final Vol. Imp	203 ml	S.G. Jar Tare Wt.	366.5 g
Initial Vol. Imp.	200 ml	Jar & Sample Wt.	375.3 g
Condensed H20	3 ml	Sample Wt.	8.8 g
		Total H20	11.8 g
Run 2			
Log Number	3b		
Final Vol. Imp	206 ml	S.G. Jar Tare Wt.	370.9 g
Initial Vol. Imp.	200 ml	Jar & Sample Wt.	377.7 g
Condensed H20	6 ml	Sample Wt.	6.8 g
		Total H20	12.8 g
Run 3			
Log Number	3c		
Final Vol. Imp	206 ml	S.G. Jar Tare Wt.	353.8 g
Initial Vol. Imp.	200 ml	Jar & Sample Wt.	361.4 g
Condensed H20	6 ml	Sample Wt.	7.6 g
		Total H20	13.6 g
Run 4			
Log Number			
Final Vol. Imp	ml	S.G. Jar Tare Wt.	g
Initial Vol. Imp.	ml	Jar & Sample Wt.	g
Condensed H20	ml	Sample Wt.	g

Results:	Run 0	Run 1	Run 2	Run 3	Run 4
Total H20	0 g	11.8 g	12.8 g	13.6 g	g

APPENDIX V

RESULTS AND SUMMARY

RESULTS AND SUMMARY
STACK TEST FIELD DATA

Facility: UNI Metal Casting Center
Location: Cedar Falls, Iowa (Dubuque, Iowa, test site)
Stack Source: Fluid-Bed Type Sand Reclaim Furnace (Permit # 93-A-153)

	Run # 1	Run # 2	Run # 3
Date	11/22/94	11/22/94	11/22/94
Run Time (min)	72	72	72
Barometric Pressure (in. Hg)	30.65	30.65	30.65
Static Pressure (in. Hg)	- 1.05	- 1.05	- 1.05
Y-factor	1.0045	1.0045	1.0045
Delta H@ (in H2O)	1.851	1.851	1.851
Area of stack (X-sec*ft2)	1.09	1.09	1.09
Nozzle Diameter (in.)	0.1875	0.1875	0.1875
Traverse Points	12	12	12
Sample Time/Traverse Point	3	3	3
Average Delta H (in. H2O)	2.88	2.74	2.74
Ave. Sqrt. delta P (in. H2O)	1.698	1.655	1.655
Meter Temperature (F)	45.75	43.80	44.00
Stack Temperature (F)	211.6	214.2	223.5
Sample Vol. Actual, dcf (Vm)	31.335	30.205	30.255
Sample Vol. Standard, dscf (Vmstd)	33.87	32.79	32.83
Sample Vol. Wet Std, wscf (Vmwstd)	0.56	0.60	0.64
Condensate Collected (ml)	11.8	12.8	13.6
Moisture Concentration (%)	1.61	1.80	1.91
Moisture Conc. @ Saturation (%)	97.1	100.	100.
Molecular Weight, Dry (lb/lb-mole)	28.91	28.92	28.92
Molecular Weight, Wet (lb/lb-mole)	28.74	28.72	28.71
% Isokinetic	97.1	96.8	97.6

RESULTS AND SUMMARY
STACK TEST FIELD DATA

Facility: UNI Metal Casting Center
Location: Cedar Falls, Iowa (Dubuque, Iowa, test site)
Stack Source: Fluid-Bed Type Sand Reclaim Furnace (Permit # 93-A-153)

		Run # 1	Run # 2	Run # 3
VOLUMETRIC FLOW:				
Stack Gas Velocity (f/sec)		106.6	104.1	104.9
Actual Flow Rate (acfm)		6,971	6,809	6,858
	(dscfm)	5,509	5,349	5,309
	(dscfh)	330,540	320,940	318,540
FLUE GAS ANALYSIS:				
	% O2	19.6	19.8	19.7
	% N2	79.6	79.4	79.5
	% CO2	0.80	0.80	0.80
	% CO	0.00	0.00	0.00
LABORATORY DATA: Inorganic Lead Collected:				
Sample Catch (mg)		0.22	0.20	0.30
EMISSIONS CALCULATIONS:				
Inorganic Lead Conc. (gr/dscf):		0.00010	0.00009	0.00014
Emission Rate (lbs/hr)		0.005	0.004	0.006

Ave. Inorganic Lead Conc. (gr/dscf): 0.00011

Average Emission Rate (lbs/hr): 0.0050

APPENDIX VI

QUALITY ASSURANCE CALIBRATION DATA

COMPLIANCE SERVICES FIELD CALIBRATION

Orifice Meter Coefficient Check

DATE 11/22/94
TIME 930

Time (min)	Dry Gas Meter Volume		Inlet Temp	Outlet Temp
0	Initial	381.05	41	41
1		381.77	41	41
2		382.48	41	41
3		383.18	41	42
4		383.91	41	42
5		384.62	41	42
6		385.32	41	42
7		386.04	41	42
8		386.75	41	42
9		387.44	41	42
10		388.17	41	43
			451	460

Volume Meter	7.12
Pbar	30.65
Time	10
Y	1.0045
Meter Temp (R)	505.55
Yc/Y =	1.01422

0.97 < 1.01422 <1.03

Meter Box Full Test Calibration

Date: 8 9 94

Operator: M. KUBERA

Meter Box No: 85-5065-6J-M	Meter Box ΔH@: 1.8510	Meter Box Yd: 1.0045	Barometric Pressure: 29.4

				Standard Meter Gas Volume			Meter Box Gas Volume (ft³)			Std Meter Temperature (°F)			Meter Box Temperature (°F)					
Q	ΔH	ΔP	Y_{ds}	Initial	Final	V_{ds} Net	Initial	Final	V_d Net	In	Out	T_{ds} Ave.	In	T_o Out	T_d Ave.	Θ Time	Y_d	ΔH@
0.93	3.0	-4.0	1.0000	0	12.80	12.80	608.514	621.212	12.698	76	76	76	86	76	81	13.22	0.9997	1.8611
0.93	3.0	-4.0	1.0000	0	10.00	10.00	621.212	631.185	9.973	76	76	76	89	79	84	10.36	0.9999	1.8621
0.38	0.5	-1.7	1.0000	0	5.00	5.00	636.210	641.260	5.05	76	76	76	91	87	89	12.51	1.0085	1.7837
0.38	0.5	-1.7	1.0000	0	5.00	5.00	641.260	646.502	5.042	76	76	76	91	87	89	12.52	1.0101	1.7865
0.64	1.5	-2.5	1.0000	0	10.00	10.00	648.217	658.317	10.1	76	76	76	92	85	89	14.91	1.0040	1.9073
0.64	1.5	-2.5	1.0000	0	10.00	10.00	658.317	668.442	10.125	76	76	76	94	87	91	14.93	1.0051	1.9054
																Average	1.0045	1.8510

Nomenclature

Symbol	Definition
P_b	Barometric Pressure (in. Hg)
Q	Flow Rate (cfm)
ΔH	Orifice Pressure Differential (in. H_2O)
ΔP	Inlet Pressure Differential (in. H_2O)
V_d	Gas Meter Volume - Dry (ft³)
V_{ds}	Standard Meter Volume - Dry (ft³)
T_d	Average Meter Box Temperature (°F)
T_o	Outlet Meter Box Temperature (°F)
T_{ds}	Average Standard Meter Temperature (°F)
Y_d	Meter Correction Factor (unitless)
Y_{ds}	Standard Meter Correction Factor (unitless)
ΔH@	Orifice Pressure Differential giving 0.75 cfm of air at 68°F and 29.92 in. Hg (in. H_2O)

Equations

$$Y_d = (Y_{ds})\left[\frac{V_{ds}}{V_d}\right]\left[\frac{T_d + 460}{T_{ds} + 460}\right]\left[\frac{P_b + \Delta P / 13.6}{P_b + \Delta H / 13.6}\right]$$

$$\Delta H@ = \frac{0.0319(\Delta H)}{P_b(T_o + 460)}\left[\frac{(T_{ds} + 460)\Theta}{(V_{ds})(Y_{ds})}\right]^2$$

$$Q = \frac{17.64\ (V_{ds})(P_b)}{(T_{ds} + 460)(\Theta)}$$

Calibrations

Vacuum Gauge		Thermometers		
Standard (in. Hg)	Vacuum Gauge	Standard (°F)	Inlet	Outlet
6.1	6			
10.3	10			
15.4	15			
20.4	20			
25.4	25			
26.3	26			

CS 001 Full Test-English
CNVS/TRG R1 0/13/93

Pyrometer Calibration Sheet

Pyrometer No.: 85-5065-63-M

Office: Palatine

Calibrated by: MK

Client:

Date: 8-8-94

Job or Ref No.:

Temperature Scale Used: ☑ Fahrenheit ☐ Celsius

Full Test ☑

Post Test ☐

Calibration Reference Settings for Fahrenheit Scale	Pyrometer Reading	Calibration Reference Settings for Celsius Scale
50 °F	50	25 °C
100 °F	99	50 °C
150 °F	150	75 °C
200 °F	201	100 °C
250 °F	251	125 °C
300 °F	301	150 °C
350 °F	351	175 °C
400 °F	400	200 °C
450 °F	449	225 °C
500 °F	49	250 °C
550 °F	549	275 °C
600 °F	600	300 °C

Calibration Reference Information

Reference Used: Digimite/Other (Other circled)

Serial No.: T 87859

Calibrated By: J H. METROLOGY

Date Calibrated: 5 19 94

Calibration Report No.: 022976

APPENDIX VII

TEST PERSONNEL

STACK TEST PERSONNEL

NAME	AFFILIATION	RESPONSIBILITY
Neil Sherman	Compliance Services, Inc.	Project Manager
Fred Vondra	UNI Metal Casting Center	Unit Operation
Jim Houtaker	A.Y. McDonald	Facility Cood.
Dave Phelps	Iowa DNR	State Rep.

APPENDIX E

MONTHLY REPORTS

FOR PERIOD APRIL 12, 1992 THROUGH MAY 25, 1992

Subtask 1.3 A sand reclamation unit has been designed and is being manufactured by GMD Engineered Systems of Fort Worth, TX. Estimated delivery is in October. The unit has been designed to process 1 ton/hour for clay-bonded sand, and 2 tons/hour for resin bonded sand.

FOR PERIOD MAY 25, 1992 THROUGH JUNE 25, 1992

Subtask 1.3 A time line for the manufacture of the transportable sand reclamation unit has been obtained. In the interim period(now to date of delivery), testing parameters will be developed. (see attached memo from Klean Sand, Inc.)

FOR PERIOD JUNE 25, 1992 THROUGH JULY 25, 1992

Subtask 1.2 A sand laboratory is being installed within the UNI-MCC laboratory by a graduate assistant to facilitate testing of reclaimed sand. Testing parameters are being developed. Design of a sand survey is being initiated and will follow installation of the sand laboratory. Other aspects of task 1 are subject to delivery of the Sand Reclaim unit.

FOR PERIOD JULY 25, 1992 THROUGH AUGUST 25, 1992

Subtask 1.1 Items for the sand laboratory have been calibrated and delivered to the UNI-MCC. The sand laboratory is expected to be operational by the end of September. Further progress on the development of testing parameters has been completed. Preliminary sand tests have been discussed and are being reviewed for possible use with the sand reclamation unit. Initial design of a sand survey is complete. A mailing list is being prepared, and is approximately 80% complete.

Subtask 1.3 Due to problems experienced by the manufacturer, delivery of a Sand Reclamation Unit has been delayed by 2 weeks. Expected delivery of the unit should be delivered by the middle of October.

FOR PERIOD AUGUST 25, 1992 THROUGH SEPTEMBER 25, 1992

Subtask 1.1 Equipment for the Sand Laboratory is now in-house, rebuilt, and fully operational. Preliminary sand tests are being reviewed for incorporation with the sand reclamation unit. The initial sand survey is being revised, and the methodology has been changed to include a preliminary phone survey, followed by a detailed, written survey.

Subtask 1.3 Personnel for UNI and Klean Sand, Inc. have visited the GMD plant located in Fort Worth, TX to review progress on the construction of the Sand Reclamation Unit. Delivery is scheduled for Mid-October.

FOR PERIOD SEPTEMBER 25, 1992 THROUGH OCTOBER 25, 1992

Subtask 1.1 The initial phone sand survey has been revised and is progressing. Approximately 40 businesses have been contacted, response is good. The written sand survey is pending completion of the phone survey.

Subtask 1.3 Delivery of the sand reclamation unit by GMD has been further delayed until Mid-November. The delay is due to software generation problems and the addition of a computer controlled surge bin auger to the original design.

FOR PERIOD OCTOBER 25, 1992 THROUGH NOVEMBER 25, 1992

Subtask 1.1 The initial phone sand survey is still progressing. Approximately 250 businesses have been contacted. The written sand survey is pending completion of the phone survey. Completion of the phone survey is due December 11.

Subtask 1.3 Shipment of the sand reclamation unit is scheduled for November 30, 1992. Currently , sand movement and fluidization tests are being conducted at GMD. Operation training for the project manager and technician were completed on November 11-13,1992 on site GMD.

FOR PERIOD NOVEMBER 25, 1992 THROUGH DECEMBER 25, 1992

Subtask 1.1 Due to the unexpected number of projects (including the onsite delivery of the mobile sand reclamation unit) that occurred in the month of December, the phone survey was not entirely completed. The new date for completion of the phone survey is not January 25, 1993.

Subtask 1.3 The mobile sand reclamation unit has arrived at the University. Currently, electrical, natural gas, cooling water, and compressed air requirements are being reviewed with representatives of the first (3) foundries that the unit will visit. Delivery of the unit to the first foundry is scheduled for early-to mid-February. Preliminary tests will be conducted at the University on sand being generated by the first foundry (Viking Pump).

FOR PERIOD DECEMBER 25, 1992 THROUGH JANUARY 25, 1993

Subtask 1.1 Completion of the phone survey is on target for January 25, 1993.

Subtask 1.3 The mobile sand reclamation unit has been operated under temporary permit at the University of Northern Iowa. Movement of the unit to the first scheduled foundry is on hold until an operating permit has been granted by the Iowa Department of Natural Resources.

FOR PERIOD JANUARY 25, 1993 THROUGH FEBRUARY 25, 1993

Subtask 1.1 The phone survey has been expanded to include 30 more foundries. This will be completed the week of February 22, 1993. Inputting data from the phone surveys into a database is continuing. Design of the written survey is to commence immediately after the phone survey database is completed.

Subtask 1.3 Movement of the transportable sand reclamation unit is on hold until a permit has been obtained to operate from the Iowa Department of Natural Resources. However, operation of the unit may be achieved under the Iowa Legislative Code which allows research in waste management by a State Board of Regents institution. We are investigating this avenue. Negotiations are also progressing to operate the unit at a number of foundries out of state.

FOR PERIOD FEBRUARY 25, 1993 THROUGH MARCH 25, 1993

March Activity The University of Northern Iowa is awaiting final permitting of the transportable sand reclamation unit from the Department of Natural Resources of the State of Iowa. In order to get this project moving the Metal Casting Center researcher consulted with University attorneys concerning exercising the rights of the University to conduct research without having the final approval of the Department of Natural Resources. This right has never been used by any of the universities in the State of Iowa, therefore we approach this with extreme caution (see Appendix I). Based on the action taken, the Metal Casting Center has finalized an agreement with the John Deere Foundry in Waterloo, Iowa to begin on-site research at their facility beginning this month. It is anticipated that this initial research activity will take approximately four weeks. The Deere facility was selected as the first sight due to its proximity to the University.

FOR PERIOD MARCH 25, 1993 THROUGH APRIL 25, 1993

April Activity Final permitting of the transportable sand reclamation unit from the Department of Natural Resources of the State of Iowa has been received. The transportable reclamation unit was displayed at the American Foundryman's Society International Casting Exposition in Chicago, Illinois. Approximately 300 inquiries were answered, and over 90 expressed extreme interest in becoming an industrial partner in this project by operating the unit at their facility. Following the Casting Exposition, the unit was transported to the Falco Company in Fairfield, Iowa, where the first on-site research will begin. Falco was chosen instead of John Deere because of their closes proximity to 3 other foundries located in Fairfield. These foundries will transport sand to the Falco facility for reclamation. In addition, approximately 120 sand surveys have been returned by the respondents.

FOR PERIOD APRIL 25, 1993 THROUGH MAY 25, 1993

May Activity The sand reclamation unit is currently operating at Fairfield Aluminum Foundry (Falco) in Fairfield, Iowa. Eight sand surveys were returned from eight more respondent foundries. Telephone follow-up will begin in June. Follow-up via phone and written communication has begun with the 90 foundries which showed interest at the AFS CastExpo in participating in the sand reclamation project. The 90 foundries indicated an interest in providing locations for on-site field tests for sand reclamation. Permitting activities have begun in those states in which the interested foundries reside.

FOR PERIOD MAY 25, 1993 THROUGH JUNE 25, 1993

June Activity The sand reclamation unit is still operating at Fairfield Aluminum Foundry (Falco) in Fairfield, Iowa. However, the unit has completed running sand for Falco. It is currently reclaiming sand from Dexter Iron Foundry. Samples of Falco's sand have been labeled and saved and tests will be conducted at the University on that sand at the end of the month. Falco has also made cores out of 100% reclaimed sand with virtually no problems. They did not change the 1.5% resin and catalyst mixture percentage and experienced no problems. Preliminary research shows that shakeout may even be easier with reclaimed sand. There also seems to be some problems running the unit in the summer heat. A control panel cooling system is being investigated and a recirculating cooling system for the cooler/scrubber is also being considered. Telephone follow-up on the sand survey is also progressing with approximately 160 calls made to date.

FOR PERIOD JUNE 25, 1993 THROUGH JULY 25, 1993

July Activity Dexter foundry sand has been run through the reclamation unit. Large metal concentrations in the sand caused the ceramic nozzles in the calciner to plug up. These nozzles require replacement and, therefore, the unit will probably be down until the first or second week in August. Iowa Malleable Iron Foundry is having financial trouble has elected to not participate in the project. However, Bloomfield Foundry, Crane Valve and Griffin Wheel foundry are planning to participate once the unit is operational. Ford has also postponed their scheduled participation in the project. A report covering the first year of activity has been written and is being reviewed internally (MCC) before submission to DOE.

FOR PERIOD JULY 25, 1993 THROUGH AUGUST 25, 1993

August Activity The Sand Reclamation unit has completed its experimentation with Bloomfield Foundry's sand. Approximately 20 tons of sand from Crane Valve is currently being reclaimed in the Sand Reclamation Unit. Griffin Wheel is scheduled to ship approximately 20 tons of sand for reclamation on or about August 27m 1993. After the reclamation experiments are complete, this unit will be shipped to the John Deere Foundry in Waterloo, Iowa.

FOR PERIOD AUGUST 25, 1993 THROUGH SEPTEMBER 25, 1993

September Activity The Sand Reclamation Unit has completed reclamation of sand for (5) foundries in the Fairfield, IA area. It has been transported to the John Deere Foundry in Waterloo, IA and has also completed reclamation there. It has subsequently been relocated to, and is in the process of reclaiming sand at the Viking Pump Foundry in Cedar Falls, IA.

FOR PERIOD SEPTEMBER 25, 1993 THROUGH OCTOBER 25, 1993

October Activity The unit arrived at Ford's Cleveland Casting Plant on October 8th. Upon arrival at Ford, it was discovered that the membrane dividing the combustion chamber and the calcining chamber in the calciner collapsed.

FOR PERIOD OCTOBER 25, 1993 THROUGH NOVEMBER 25, 1993

November Activity The unit has been in operation since the membrane was replaced and cured. Currently, the unit is reclaiming chemically bonded sand at the Ford Cleveland Casting Plant.

FOR PERIOD NOVEMBER 25, 1993 THROUGH DECEMBER 25, 1993

December Activity The unit has completed operation at the Ford Cleveland Casting Plant on December 13, 1993. The unit has reclaimed chemically bonded core sands as well as two different green sands used at Ford. Final results of the testing conducted on these sands is being completed and should be available in early January, 1994. Upon full cool down of the unit, it will be shipped to Wagner Castings in Decatur Illinois. Due to holiday shut downs, the unit will not operate until January 3, 1994 for an approximate two week duration.

FOR PERIOD DECEMBER 25, 1993 THROUGH JANUARY 25, 1994

January Activity The unit has completed operation at Wagner Castings of Decatur, Illinois. The unit did not operate during the week of January 16, due to extremely cold temperatures. Wagner's management decided that sufficient sand (approximately 20 tons) was reclaimed through the unit during the previous week. Therefore, operations were ceased and the unit was prepared for transportation to Keokuk Steel Castings Company of Keokuk, Iowa. The unit was transported to Keokuk on January 24, 1994, and is currently being prepared for operation.

FOR PERIOD JANUARY 25, 1994 THROUGH FEBRUARY 25, 1994

February Activity The unit has operated at for one week at Keokuk Steel Castings Company. Keokuk has since shut down production due to a natural gas shortage. The unit will operate again at Keokuk after natural gas supply has been restored to their facility. Keokuk is also going to bring in sand for reclamation from 2 sister foundries while the unit is on site.

FOR PERIOD FEBRUARY 25, 1994 THROUGH MARCH 25, 1994

March Activity The unit is still at Keokuk Steel Castings reclaiming sand. Natural gas has been restored, however, the unit experienced a partial memory loss in its CPU. Repairing required reinstallation of the entire software package. A technician familiar with the hardware and software was required on site. This delay cost the project 2 weeks. We are still anticipating reclaiming sand from the Keokuk sister foundries which will take us into April at the Keokuk site.

FOR PERIOD MARCH 25, 1994 THROUGH APRIL 25, 1994

April Activity The unit is still at Keokuk Steel castings. Keokuk has had many problems in their facility which has caused us to remain on hold. We will give them three weeks to finish running sand at their facility. In May, we will attempt to move into the Kansas City area. The unit now has a fully functional closed loop cooling system which we incorporated to eliminate sending cooling water into the sewer.

FOR PERIOD APRIL 25, 1994 THROUGH MAY 25, 1994

May Activity The unit is going through extensive re-design of the liquid cooling recirculation system while at Keokuk Steel Castings. It is projected the unit will move the Kansas City area in early June. As of this date 3 foundries have expressed interest in participating in the project in the Kansas City area. There are also 2 additional foundries potentially interested in participating.

FOR PERIOD MAY 25, 1994 THROUGH JUNE 25, 1994

June Activity The foundry that was going to host the unit in Kansas City is having problems with power hookups. Therefore, the decision was made to move the unit to Arkansas. Two brass foundries in Arkansas were interested in running sand reclamation experiments. However, due to EPA concerns with the lead content in the sand, it was decided not to operate at these locations. The unit was then moved to Nibco (an iron foundry in Arkansas) where it is currently being prepared to operate. There will be contacts made with foundries in the area to ascertain interest while in Arkansas.

FOR PERIOD JUNE 25, 1994 THROUGH JULY 25, 1994

July Activity The unit has completed sand reclamation testing at NIBCO in Blytheville, Arkansas. It is currently enroute to Atchison Castings with a projected start date of August 1, 1994. Currently, we are also investigating an air quality permit modification or variance to allow operation at a brass alloy foundry in the State of Iowa. The variance appears to be viable on the condition that an exhaust stack study be conducted while in operation at a brass foundry. An experimental permit is also being sought in order to reclaim what the EPA considers a hazardous material (system sand).

FOR PERIOD JULY 25, 1994 THROUGH AUGUST 25, 1995

August Activity The unit is currently at Atchison Castings in Atchison, Kansas. It is presently broken down due to a rebuild requirement needed for the auger feed gearbox. This rebuild will cost about one week of operating time. The unit is also scheduled to move to Mercury Marine Foundry in Fond Du Lac, Wisconsin on August 24, 1994. However, acquiring a permit to operate at Mercury Marine may postpone operation at that site. The variance needed to operate at A.Y. McDonald Foundry and treat what is considered a hazardous material is still being sought. We are currently pursuing a research, development, and demonstration permit through the EPA, Region VII, Iowa Section, Waste Management authority

FOR PERIOD AUGUST 25, 1994 THROUGH SEPTEMBER 25, 1994

September Activity The unit is still at Atchison Castings in Atchison, Kansas. The control unit for the auger feed also had to be replaced. The MCC received a letter from EPA Region VII, Iowa Section that a permit for operation of the unit at the two brass foundries (which contain lead in their metal) in Dubuque, Iowa will not be required due to the experimental nature of the project. A copy of the letter is in the possession of the University attorney for review.

FOR PERIOD SEPTEMBER 25, 1994 THROUGH OCTOBER 25, 1994

October Activity The unit is currently at Mercury Marine in Fond du Lac, Wisconsin. Maintenance on the cartridge collector, duct work, gear box, and nozzles was conducted at a site located in Denver, Iowa during the movement from Atchison Castings. The unit will operate at Mercury Marine for approximately 2 weeks.

FOR PERIOD OCTOBER 25, 1994 THROUGH NOVEMBER 25, 1994

November Activity The unit is currently at the A.Y. McDonald facility. All maintenance on the unit has been completed. The unit is currently heating up, and the start-up for reclamation experiments is scheduled to begin on November 21, 1994.

FOR PERIOD NOVEMBER 25, 1994 THROUGH DECEMBER 25, 1994

December Activity The unit has been relocated to UNI, and has complete sand reclamation experiments using sand provided by Max-Cast. The final report has been initiated, and will be completed and submitted prior to the 60 days following the project period date.