Memorandum

Florida Department of Environmental Protection

TO: Michael G. Cooke

THRU: Trina Vielhauer
J. K. Pennington

FROM: Michael P. Halpin

DATE: March 18, 2005

SUBJECT: Gulf Power Company
Crist Unit 5 – Mercury Research Center (MerRC)

Attached for approval and signature is a construction permit for the subject facility. The permit provides an authorization of a temporary research center for evaluating mercury (Hg) emission reduction techniques. This is an existing facility and neither a PSD Review nor a new determination of Best Available Control Technology (BACT) was required as a result of this request.

The project was noticed in the Pensacola News Journal on March 3, 2005 and no comments were received.

I recommend your approval and signature.

Attachments

/mph

Jeb Bush
Governor

Department of Environmental Protection

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Colleen M. Castille
Secretary

March 18, 2005

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Gene L. Ussery
V.P. Power Generation
Gulf Power Company
One Energy Place
Pensacola, Florida 32520-0110

File No. 0330045-011-AC
SIC No. 4911
Expires: April 1, 2010

Re: Crist Mercury Research Center (MerRC)

Dear Mr. Ussery:

The Department has reviewed the request from Gulf Power received on January 25, 2005 concerning the construction of a temporary research center for evaluating mercury (Hg) emission reduction techniques. As indicated in the application, research has shown that pollution control technologies designed to control NO_x, SO_2, and PM can affect overall Hg performance. In order to investigate these relationships, Gulf Power is planning a 5 MW equivalent slip-stream facility equipped with a complete system of flue gas cleanup technologies at Crist Unit 5, located in Escambia County, Florida. The proposed slip-stream facility will incorporate a Selective Catalytic Reduction (SCR) system, a rotary air-heater, an electrostatic precipitator (ESP), a baghouse (BH), and a wet flue gas desulphurization (FGD) system. Based upon information provided by the applicant and pursuant to the applicant's request, the Department has determined that there is a satisfactory showing that all test information should be kept confidential as "secret processes", in accordance with Section 403.111, Florida Statutes. Accordingly, all documents or information submitted or disclosed to the Department as confidential related to tests conducted and test results shall be maintained as confidential, pursuant to applicable Florida law.

According to the application, no increase of pollutants above PSD thresholds is anticipated. Therefore, you are hereby authorized to construct the aforementioned slipstream, and conduct performance tests in accordance with the included conditions. All conditions of existing permits related to air pollution emission limits and control equipment remain in force.

The project shall be subject to the following conditions:

1. The permittee shall notify the DEP Northwest District and the Bureau of Air Regulation, in writing, at least seven days prior to beginning construction. Notification shall also occur within seven days, in writing, of completion of construction activities. An "as-built" drawing, including all actual equipment specifications shall also be provided.
2. For the duration of the project, once the permittee has established any test program (or granted a 3rd party the rights to do such test program) a Scope of Work shall be sent by fax to the DEP Northwest District Office as soon as possible and in advance of the planned commencement of the test program. This Scope of Work will give *general* descriptions of processes, work planned, dates of the tests and general objectives of the tests. Proprietary or confidential data, documents or information submitted or disclosed to FDEP shall be identified as such by the Permittee and shall be maintained as such pursuant to applicable Florida law.
3. Beginning June 30, 2006, the permittee shall be responsible for submitting semi-annual summary reports. These reports will outline each test program conducted and outline each test program results. Proprietary or

confidential data, documents or information submitted or disclosed to FDEP shall be identified as such by the Permittee and shall be maintained as such pursuant to applicable Florida law. The semi-annual summary reports will be sent to the DEP Northwest District Office and the Bureau of Air Regulation. The first summary will be due June 30, 2006 and will cover all tests and the results from such tests conducted between July 1, 2005 and December 31, 2005. In a like manner, a similar summary shall be submitted for each 180 day period thereafter.

4. At the end of each calendar year, the permittee shall include on the Annual Operating Report (AOR) a calculation of Crist Unit 5 emission increases/decreases as a result of the slipstream. Any deviation from the permittee's original estimates (that no PSD Significant Emission Rate thresholds will be crossed) shall be brought to the Department's attention immediately.

5. Stack emissions shall not exceed any limit within existing permits.

6. All stack performance tests shall be conducted using EPA Reference Methods, as contained in 40 CFR 60 (Standards of Performance for New Stationary Sources), 40 CFR 61 (National Emission Standards for Hazardous Air Pollutants), and 40 CFR 266, Appendix IX (Multi-metals), or any other method approved by the Department, in writing, in accordance with Chapter 62-297, F.A.C. [NOTE: this permit condition is only applicable to any stack testing conducted on Crist Unit 5 pursuant to and during the test programs.]

7. Daily records of the slipstream operation (i.e. insertion of and/or removal of equipment from service as well as records of tests performed) shall be maintained on site and available for Department inspection.

8. The project shall not result in the release of objectionable odors pursuant to Rule 62-296.320(2). F.A.C.

9. Performance testing shall cease as soon as possible if the boiler operations are not in accordance with the conditions within existing permits, or this authorization protocol. Performance testing shall not resume until appropriate measures to correct the problem(s) have been implemented.

10. This Department action is only to authorize the MerRC construction and operation. Notification shall occur within 45 days, in writing, upon completion of the final test. Prior to December 31, 2009 the permittee shall provide the DEP Northwest District Office and the Bureau of Air Regulation with its plans to disassemble and remove all slipstream components, returning the unit back to its original condition. Such plans shall be completely executed by April 1, 2010.

11. Unless otherwise specified herein, the preliminary test matrix submitted by the applicant, and received by FDEP via e-mail on February 3, 2005, is acceptable and incorporated herein as Attachment "A".

This letter must be attached to permit No. 0330045-009-AV and shall become a part of the permit. This permit modification is issued pursuant to Chapter 403, Florida Statutes.

Any party to this order (permit modification) has the right to seek judicial review of it under Section 120.68, F.S., by filing a notice of appeal under Rule 9.110 of the Florida Rules of Appellate Procedure with the clerk of the Department of Environmental Protection in the Office of General Counsel, Mail Station #35, 3900 Commonwealth Boulevard, Tallahassee, Florida, 32399-3000, and by filing a copy of the notice of appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The notice must be filed within thirty days after this order is filed with the clerk of the Department.

Executed in Tallahassee, Florida.

[signature]
Michael G. Cooke, Director
Division of Air Resource
Management

CERTIFICATE OF SERVICE

The undersigned duly designated deputy agency clerk hereby certifies that this permit modification was sent by certified mail (*) and copies were mailed by U.S. Mail before the close of business on 3/25/05 to the person(s) listed:

Gene L. Ussery, Gulf Power *
G. Dwain Waters, Gulf Power
Gregory N. Terry, P.E., Gulf Power
Gregg Worley, EPA
John Bunyak, NPS
Sandra Veazey, NWD

Clerk Stamp

FILING AND ACKNOWLEDGMENT FILED, on this date, pursuant to §120.52, Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

[signature] 3/25/05
(Clerk) (Date)

ATTACHMENT "A" – Preliminary Test Matrix

Optimization of process parameters for TOXECON

TOXECON is the EPRI patented technology that captures Hg by injected activated carbon into the flue gas downstream of an existing ESP into a high-ratio fabric filter (baghouse). This approach allows operators to preserve ash sales and minimize the effect of ACI on the existing ESP, while effectively reducing Hg emissions due to long residence times and effective mass transfer between flue gas and AC at the bag surface. To date, several evaluations of TOXECON's performance have funded through the DOE. However, little work to optimize baghouse design and carbon injection control schemes has been undertaken.

This test program will investigate different baghouse sizes (air to cloth ratios) as well as different schemes for activated carbon injection. Typically, Hg in flue gas will be measured along with appropriate process parameters to evaluate an optimum operating condition. Following parametric testing, a long term test will be performed to evaluate balance of plant issues with the chosen optimum.

Effects of selective catalytic reduction (SCR) on Hg chemistry

It is well known that SCR systems can significantly affect Hg chemistry in flue gas, thereby affecting overall system Hg control performance. However, little is understood about the fundamental chemistry that drives this effect, or how this affect changes as SCR catalysts age. These issues will significantly affect how SCR catalyst management programs are implemented in the future.

In order to better understand the chemistry, a program to parametrically investigate different catalyst designs and flue gas conditions will be performed. This program will investigate the affects of NH_3 injection, SCR temperature, space-velocity, catalyst formulation, along with other process parameters to identify optimum design for both NO_x and Hg control.

Effects of flue gas chemistry on Hg control in FGD systems

Because flue gas desulphurization (FGD) systems will be widely used to achieve necessary Hg emission reductions, it is imperative that the mechanisms driving absorption into the scrubber slurry are understood. The effect of scrubber chemistry on Hg control will be investigated in the 1 MW FGD with various configurations of the upstream process equipment (SCR, ESP, and BH).

A test program of this nature is most likely a long term parametric investigation, with mostly shift work due to the nature of the pilot FGD (they are difficult to run for extended periods of time uninterrupted). This is also the most cost effective approach to investigate the multitude of scrubber chemistries that could be encountered.

Optimization of Hg control efficiency for typical units with SCR/ESP/FGD combinations

The utility industry will rely heavily on the co-benefits realized from previously installed NO_x, Particulate, and SO_2 control equipment. The lowest cost overall compliance strategy will require that these combinations of systems be optimized for all Hg control, as well as the other pollutants. Because of the MerRC's unique combination of equipment, it will allow for parametric testing of each system to achieve this goal.

Development of Sulfuric Acid control technologies

As the utility industry begins to install its second fleet of scrubbers, the cost competitiveness of high sulfur coals will begin to improve. The higher sulfur coal will influence the level of sulfuric acid emissions from these facilities, particularly the plants with SCR installations. Currently, there are few demonstrated control technologies that achieve meaningful reductions in acid emissions. Alkaline injection systems are currently the state of the art in sulfuric acid control, but a thorough test program to understand the performance and balance of plant impacts is warranted.

A test program of this nature is likely to be a series of parametric evaluations followed by long term testing to evaluate optimum conditions and any balance of plant problems generated by the technology candidates. For a given alkaline injection technology, a 1 week parametric test program followed by a long term evaluation is probable.

Hg Sorbent development

Activated carbon injection is currently the state of the art in Hg control technology. Once the base injection systems are installed, the choice of sorbent is based on the cost/performance curve of the material in question. For that reason, it is necessary to develop and evaluate the latest developments in sorbent technologies. As these new and improved sorbents come to market, test programs to demonstrate their effectiveness are required.

Any number of test programs in this model could be envisioned and proposed by control equipment vendors and 3rd party researchers. A typical evaluation would consist of 1-2 weeks of parametric testing, followed by a of long term evaluation to understand balance of plant impacts. Typical process parameters to be optimized include: injection concentration, Hg control efficiency, ESP/Baghouse performance during injection, and possible implications to ash sales.

Gulf Power Proposed Mercury Research Center (MerRC)

In March 2005, the U.S. EPA is scheduled to promulgate rules that will require utilities to significantly reduce their Hg emissions. Currently, there are no commercially available Hg control technologies with documented long term performance on coal flue gas. Because of the lack of experience, Hg chemistry in flue gas is not very well understood. However, research performed over the past couple of years has shown that pollution control technologies designed to control NO_x, SO_2, and PM can significantly affect overall Hg performance. In order to investigate these relationships, Gulf Power is planning a 5 MW equivalent slip-stream facility equipped with a complete system of flue gas cleanup technologies.

System Description

The proposed slip-stream facility will incorporate a Selective Catalytic Reduction (SCR) system, rotary air-preheater, Electrostatic Precipitator (ESP), baghouse (BH), and wet Flue Gas Desulphurization (wFGD). Each system will be designed with the appropriate level of functionality so that a large number of existing plants can be represented. Because of the complex interactions of Hg with various surfaces in flue gas, it is difficult to generate representative data for full scale installations at the pilot scale. However, the 5 MW scale is sufficiently large enough to provide the appropriate surface to volume ratios to gather representative data. Figure 1 shows a schematic for the proposed system.

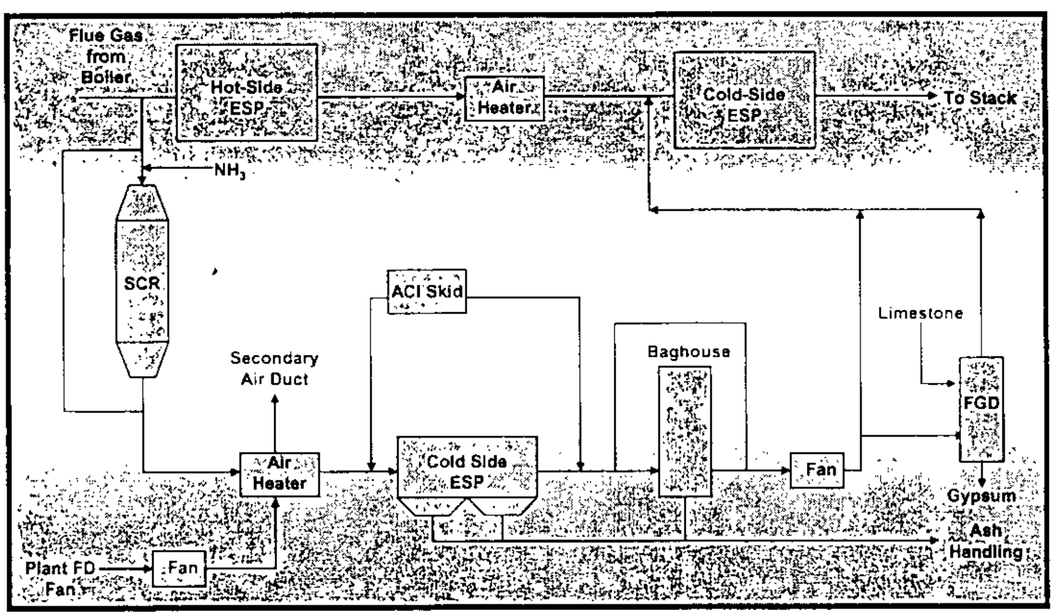


Figure 1: MerRC proposed schematic.

Host Facility

Because of its history with research facilities of this magnitude, Plant Crist Unit 5 was chosen as the host plant for the slip-stream facility. Crist Unit 5 is a wall fired PC boiler burning low-sulfur bituminous coals and is equipped with hot and cold side ESPs arranged in series. The process gas supplied to the MerRC will be drawn from the inlet of the hot-ESP. The typical flue gas characteristics for this gas stream are presented in Table 1.

Table 1: Typical flue gas characteristics for MerRC inlet.

	Value	Units
Temperature	600	°F
Pressure	-6	inches H_2O
N_2	80	%
CO_2	15	%
O_2	3	%
SO_2	0.6-2.4	lb/mmBtu
NO_x	0.5-0.7	lb/mmBtu
Particulate	7	lb/mmBtu
Hg	6	lb/tBtu
MerRC System Flow	25,000	wacfm

Flue Gas Temperature Control

Because Hg chemistry has been shown to be temperature dependent, temperature control at the inlet of the research facility is crucial. This will be accomplished by using a combination of an economizer bypass line, providing ~ 900°F gas to the facility, or a flue gas heater. The heater will be sized to allow for a wide range of operating temperatures, up to and including 750°F. The heaters will be simple resistance type and will not introduce any additional compounds to the process gas. Typical heater characteristics are presented in Table 2.

Table 2: Flue gas heater parameters.

Heater Type	Electric Resistance heater	
Inlet Temp	600	°F
Max Outlet Temp	750	°F
Heat Input Requirement	3.5	mmBtu/hr
Power Requirement	600	kW

Selective Catalytic Reduction (SCR) system

SCR for NO_x control has been widely incorporated throughout the world and is well understood. However, there is little known on the details of Hg chemistry in the SCR. The SCR designed for MerRC will resemble a typical full scale system installed at any number of plants. The scale of MerRC will allow for the use of full scale catalyst modules, with the cross section designed to achieve representative space velocities for the system. Typical SCR design points are shown in Table 3. The SCR will be equipped with 3 catalyst layers, which will allow for greater than 80% control of NO_x and a maximum pressure drop of 6 in. H_2O.

Table 3: Typical SCR system design points.

SCR System Inlet NO_x	0.7 lb/mmBtu
Expected SCR Performance	90%
Typical SCR Outlet	0.07 lb/mmBtu
Number of Catalyst Layers	3
Typical Maximum NH_3 slip	5 ppm_{vd} @ 3% O_2

The research facility will also incorporate a SCR reactor by-pass to allow for testing of alternate designs. Although research has shown that SCRs do not control Hg, data has shown it can significantly affect the chemistry of downstream devices, which could significantly change the performance of those systems. The ability to operate with and without SCR in service is a necessary requirement in order to investigate seasonal operation as well as alternate plant configurations.

In order to achieve NO_x reductions within the SCR, ammonia must be fed as a reagent to react with NO and NO_2 per the following equations.

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$
$$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$$

Typically 95% of NO_x in the flue gas stream is NO, with the remainder NO_2. At these ratios, an ammonia flow rate of ~25 lb/hr to the SCR can be expected in order to achieve the stated NO_x reduction goals. At these rates, an ammonia slip of less than 5 ppm (0.065 lb/hr) is expected. However, during some research programs, this value could be exceeded for short periods of time.

Air Pre-heater (APH)

In order to mimic the time-temperature profile of a full scale system, the MerRC will incorporate a rotary type APH for flue gas cooling. The APH will cool the flue gas from ~700°F to 300°F before sending it to the downstream air pollution control equipment. In order to reject the heat transferred from the flue gas, a cooling air fan will be installed. The cooling air fan will provide ambient air supplied from the plant forced draft fan to the APH and, after heating, will force the air back into the plant secondary air duct in order to minimize the efficiency impacts of the MerRC. Table 5 presents pertinent APH design information.

Table 5: APH typical design criteria.

APH Type	Rotary (Lungstrom)
Heat load	5.5 mmBtu/hr
Flue Gas inlet Temp	700 °F
Air inlet Temp	72 °F
Flue Gas outlet	300 °F
Air Outlet	550 °F

Electrostatic Precipitator (ESP)

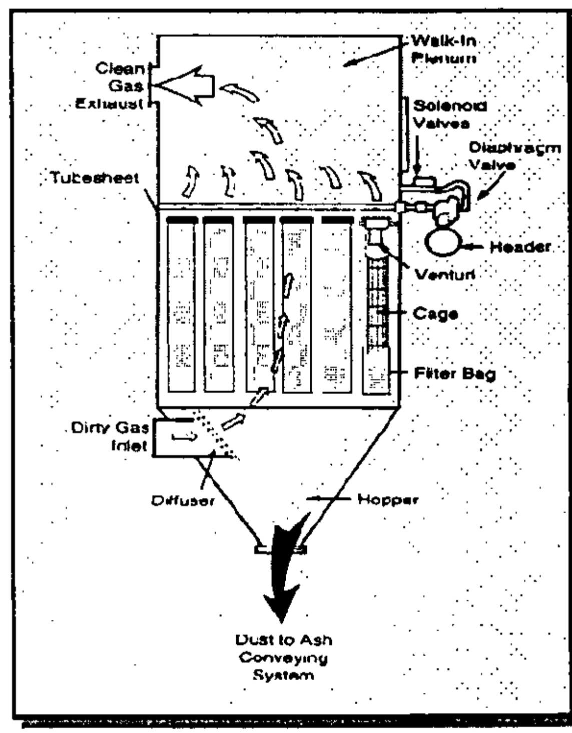
The utility industry has operated ESPs for several decades. However, in the future, more stringent particulate emission requirements will force operators to make incremental improvements in performance. Additionally, the co-benefit of Hg removal in these ESPs could play a significant role in achieving least cost compliance. The ESP installed in the MerRC will be designed as a single casing 4 field unit, able to achieve >99% removal efficiency of particulate matter. Typical design data are listed in Table 6.

Table 6: Typical ESP design data.

Number of fields	4
Field Length	5 ft
Field Height	12 ft
SCA (ft^2/1000acfm)	225
Efficiency	>99%

Baghouse

Currently, the most mature Hg control technology is TOXECON™. TOXECON™ is an EPRI patented technology that incorporates a high (air to cloth) ratio fabric filter downstream of an ESP, with activated carbon injection (ACI) between. The high ratio baghouse, or COHPAC baghouse, is designed to minimize conserve footprint while weighing increased pressure drop due to higher bag face velocities. There are only a handful of installations of this technology in the industry, and 2 of them are located at Alabama Power's Plant Gaston near Birmingham, AL. Southern Company has significantly contributed to the development, and would be able to continue this development at the MerRC. The baghouse will be designed to allow for multiple bag configurations, bag types, and inlet loadings so that critical parameters for long term performance of these systems can be investigated. Figure 2 shows a schematic for a typical COHPAC baghouse.



Activated Carbon Injection (ACI)

As stated above, the most mature Hg control technology is TOXECON (ACI into COHPAC baghouse). Significant work has been performed by Southern Company and others to investigate ACI into existing ESPs. Although results from these programs show promising Hg control results, there is concern that the additional solids loading to the ESP will degrade the particulate removal performance. In order to understand long term performance and BOP issues of both of these control concepts, the MerRC will incorporate a carbon injection skid. The skid will be designed with enough variability to allow for both injection schemes. Typical injection rates for ACI into ESPs vary from 5-20 lbs Carbon/mmacf (5-20 lbs/hr) of flue gas, and for TOXECON from 0.5-2 lbs/mmacf (0.5-2 lbs/hr). As the art of ACI matures over time, the MerRC will also provide a testing ground for the latest innovation in sorbents. Assuming an annual capacity factor of 10% for ESP injection, you could expect ~7.5 tons of activated carbon, and ~0.5 tons of activated carbon for the TOXECON injection case.

Wet Flue-gas Desulphurization

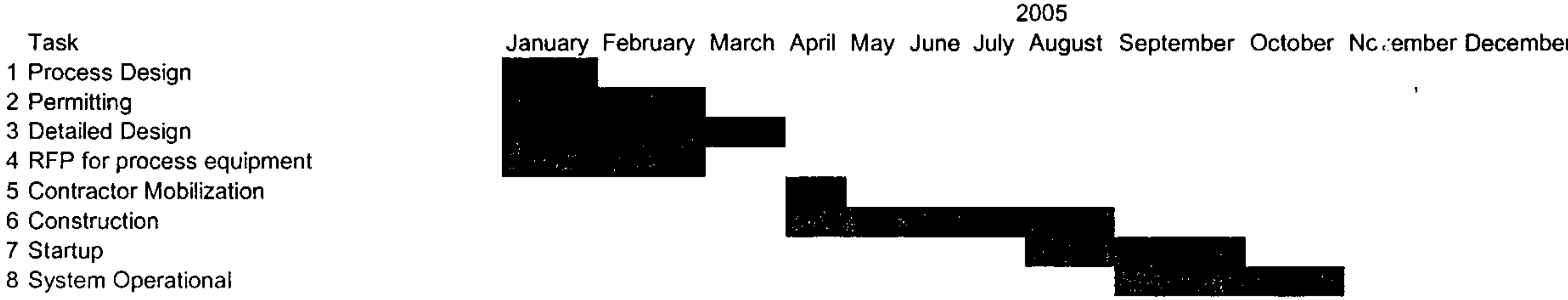
Over the next decade, Southern Company will be installing a large number of FGD systems throughout its fleet, including some of Gulf Power's units. In order to achieve the lowest cost Hg compliance, it will be paramount that these systems be optimized for Hg removal efficiency. Tests have shown that wet FGD systems can efficiently capture oxidized Hg. However, little about Hg chemistry in the FGD is understood. Research to uncover the critical factors affecting these chemical processes is needed.

Southern Company currently owns a 1 MW scale pilot wet FGD system. This system will be incorporated into the MerRC to study the effects described above. The FGD will require a limestone feed for SO_2 control, and will produce a gypsum byproduct. Typical process flows are presented in Table 7. Applying an annual capacity factor of 20% to the FGD projects an annual gypsum production of ~45 tons.

Table 7: Typical stream flows for FGD pilot.

System Flow	3000 acfm @ 300°F
SO_2 Concentration	1100 ppm_v
SO_2 Feed (lb/hr)	24
Limestone Feed (lb/hr)	37.5
Gypsum Draw off (lb/hr)	51

Crist Mercury Research Center



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Mr. Gene L. Ussery
V.P. Power Generation
Gulf Power Company
One Energy Place
Pensacola, Florida 32520-0110

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