UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	§	
	§	
HOUSTON LIGHTING & POWER COMPANY	§	
	§	Docket No. 50-466
	§	
(Allens Creek Nuclear Generating Station, Unit No. 1)	§	
	§	
	§	

AFFIDAVIT OF DR. JAMES R. SUMPTER

My name is James R. Sumpter. I am employed by Houston Lighting & Power Company as Manager, Nuclear Department. I have been so employed for eight years. I hold a Ph.D degree in nuclear engineering from Texas A&M University. I have supervised the licensing, nuclear engineering, and health physics of two nuclear power plants, and I have kept abreast of matters relating to the safety and licensing of such plants. A fuller statement of my background and qualifications is attached as Exhibit 1.

This affidavit addresses TexPirg's Motion for Summary Disposition of TexPirg Additional Contention 50, the contention that Allens Creek Nuclear Generating Station (ACNGS) will be a hazard because its radioactive emissions will confuse the electronic guidance systems of aircraft that fly nearby, due to the so-called phenomenon of "latching." In this affidavit, I will review and comment upon the numbered assertions in TexPirg's motion under the title, "Statement of Material Facts." TexPirg appears to be saying in these assertions that ACNGS will emit enough airborne radiation to degrade the performance of some or all semiconductors, transistor crystal materials, and metal-oxide semiconductor materials on aircraft and that this degradation will cause airplanes to crash. This general proposition is, as I stated in my earlier affidavit on "latching,"1/ unsupported by any persuasive scientific evidence. If "latching" operated in the way suggested by TexPirg, it is reasonable to assume that one or more aircraft would have crashed in the past as a result of this phenomenon, and that the technical literature would have recognized the existence of the problem. In fact, no such crashes have been documented, and there have been no publications in the technical literature, to the best of my knowledge, on this issue.

1. <u>ACNGS will emit large amounts of radioactivity in to [sic] the air.</u>

This assertion lacks both accuracy and the precision necessary for meaningful scientific discourse.

1/ "Affidavit of Dr. James R. Sumpter," supporting "Applicant's Motion for Summary Disposition of TexPirg Additional Contention 50" (August 4, 1980).

I assume, in light of assertions 2 and 3, that this assertion refers to normal operation of the plant. The emissions standards for all operating nuclear power plants are set out by the NRC. If TexPirg is asserting here that ACNGS will exceed these limits, then TexPirg is wrong. ACNGS under normal operation conditions will emit a calculated gamma dose in air of 0.59 millirads/year and a beta dose of 0.35 millirads/year at the site boundary at ground level.[2/] The doses at normal flight elevations will be much lower. Normal emissions most certainly will not cause aircraft to crash through the causal mechanism suggested by TexPirg, as will be discussed below.

2. During accidents, upsets, and incidents, ACNGS would emit even more radioactivity into the air.

The operating history of nuclear power plants clearly shows that, "accidents, upsets, and incidents" are not always accompanied by radiation leakage. If TexPirg is saying that "accidents, upsets, and incidents" *may* result in greater than normal emissions, then the critical question is, "how much greater?" This is something that TexPirg has not quantified.

2/ PSAR Table 11A.2-7, page 112A-21.

The fact is that the largest offsite doses postulated for any design basis accident at ACNGS are anticipated for a loss-of-coolant accident.[3/] The PSAR[4/] indicates that expected doses from such an accident at ACNGS are thyroid exposures of 150 rem/2 hours at the exclusion distance of 1,323 meters from the reactor and 72 rem/30 days at the low population zone 5,632 meters away, and whole body exposures of 4.9 rem/2 hours at the exclusion distance and 1.5 rem/30 days at the low population zone. All these exposures are at ground level. The exposures at normal flight elevations will be much lower.

These exposures, too, are insufficient to cause aircraft to crash through the casual mechanism suggested by TexPirg, as will be discussed below.

3. <u>During class 9 accidents, huge amounts of radiation can travel large distances in the air as shown in the Atomic Energy Commission study, WASH-740 at page 62.</u>

It is my understanding that class 9 accidents need not be considered in the licensing of ACNGS. Nevertheless, I will note that, once again, TexPirg's assertion is virtually meaningless. "Huge amounts" and "large distances" are not scientific terms. Furthermore, the reference to WASH-740[5/]

3/ SER Table 15-1.

4/ PSAR Table 15.A-2.

5/ "Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants," WASH-740 (March, 1957).

is completely misplaced. The page cited by TexPirg is absolutely irrelevant to exposure of passing aircraft to radiation. The drawing on that page shows the theoretical deposition pattern of radioactive materials on the earth's surface under certain stated conditions. Among these conditions is a postulated cloud height of zero. (See WASH-740, at p. 62).

4. Most airplanes have large amounts of electronic equipment made with semiconductors, transister crystal materials, and metal-oxide semiconductor (MOS) materials.

The content of this assertion--that aircraft do or do not carry these materials in "large amounts"--is outside my area of expertise. However, I will again point out that "most airplanes" and "large amounts" are not precise, scientific language. One is left, once again, to guess at meanings.

Furthermore, TexPirg fails to provide any logical link between the presence of these materials aboard aircraft and the in-flight safety of the craft. TexPirg apparently assumes that all these named materials on each aircraft are critical for safety, so that the failure or degradation of any one component might cause a crash. It seems more reasonable, however, that not all of these materials would be so so critical. TexPirg fails to identify them, tell where they are located, describe their functions, or explain how their failures would cause a crash.

5. These semiconductor materials and their devices are very sensitive to radiation. Page 10 of the General Electric Transistor Manual states. [sic] "Transistor crystal material is very sensitive to radiation." Chapter 13 of the Introduction to Solid State Physics by Kittel shows that radiation can even cause the conductivity type of the semi-conductor to change. At page 380, it states ". . . it is possible to convert the conductivity type of an n-type specimen to p-type by a low concentration of radiation-induced defects."

It is true that radiation can affect the performance of certain of the materials discussed by TexPirg. But the real question is not whether such effects are possible but how much radiation is necessary to produce them. TexPirg, once again, avoids quantification in favor of generalized statements about materials that are "very" sensitive.

In fact, very large radiation doses, compared to those expected from ACNGS, are required to change the voltage and current characteristics of semiconductor devices. This is clearly shown by one of Intervenor's own cited references[6/], which states: "Generally speaking, surface effects become noticable [sic] at radiation doses [about] 10^3 rads . . . as compared to [about] 10^7 rads for bulk effects."[7/] These

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6/ J. P. Mitchell & D. K. Wilson, "Surface Effects of Radiation on Semiconductor Devices," Bell System Technical Journal, Vol. 46, page 1 (Jan., 1967), miscited by TexPirg as Bell System Technology [sic] Journal.

7/ Id. at 20.

figures indicate that before radiation will affect the performance of a semiconductor device, the dose must be at least one million times greater than the gamma dose of 0.59 millirads/year expected at the site boundary during normal operation of ACNGS. In other words, an aircraft could park at the site boundary during the entire normal operational life of ACNGS without absorbing even a significant fraction of the radiation necessary to interfere with the performance of these semiconductor materials.

Even during a loss-of-coolant accident, when emissions are postulated to be higher than during normal operation, the levels of radiation will not approach the levels necessary to affect semiconductor performance. Making the reasonable assumption that for human tissue, one rad is about equal to one rem,[8/] the two-hour whole body dose at the exclusion boundary is about five rads. Again, based on the article cited by TexPirg, this exposure is about 200 times lower than the dosage necessary to affect semiconductor performance. To even approach the threshhold exposures for possible semiconductor damage, therefore,

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8/ This assumes a Quality Factor of one for gamma rays. Other types of radiation would have a Quality Factor equal to or greater than one, producing a smaller value in rads. See, Foster & Wright, Basic Nuclear Engineering, page 127 (1973).

aircraft would need to park at the site boundary for an extended period. Aircraft passing quickly overhead would not even approach this threshhold.

These comparisons are, in fact, quite conservative. The same article cited by TexPirg shows that, although radiation-induced surface effects may be noticeable at 10^3 rads, many semiconductor devices can withstand much more radiation without significantly affecting device characteristics.[9/]

Furthermore, another article cited by TexPirg states that metal-oxide-silicon capacitors and transistors had an absorbed dose rate of about 5 X 10^3 rads/second in silicon,[10/] far greater than can be expected from ACNGS.

As for the change in conductivity type discussed by TexPirg, again, the critical question is not whether such changes occur but how much radiation is necessary to induce them. TexPirg, as usual, uses words rather than numbers.

TexPirg quotes physicist Charles Kittel to the effect that a change in conductivity type may result from "a <u>low concentration</u> of radiation-induced defects." (emphasis

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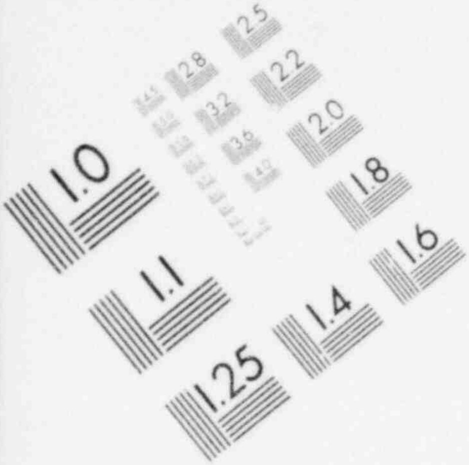
9/ Mitchell & Wilson, <u>supra</u>, at figures 17 & 27.

10/ A. S. Grove & E. H. Snow, "A Model for Radiation Damage in Metal-Oxide-Semiconductor Structures," <u>Proceedings of the IEEE</u>, volume 54, page 894 (June, 1966).



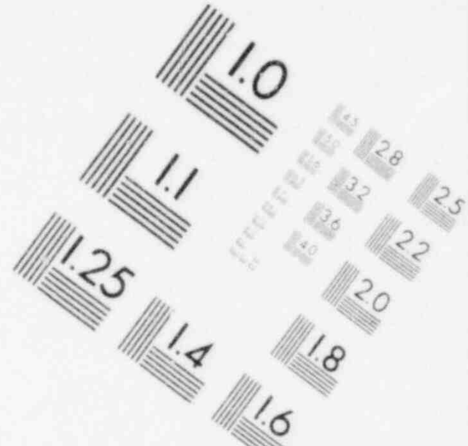
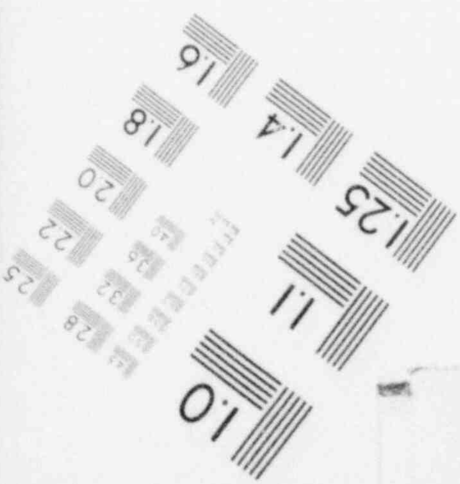
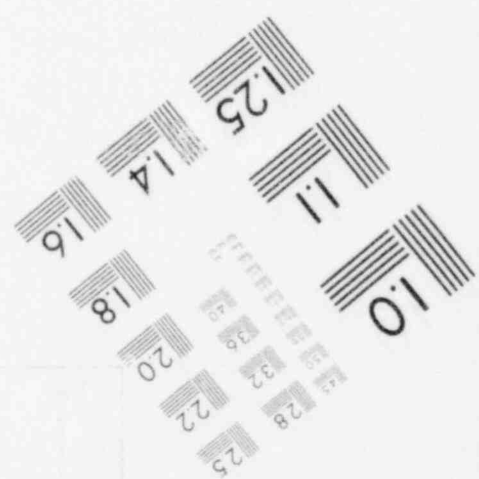


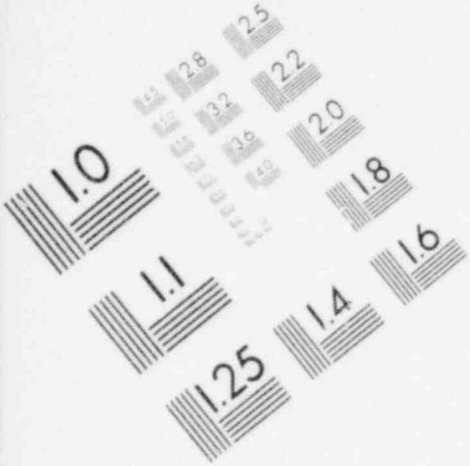
IMAGE EVALUATION
TEST TARGET (MT-3)

6″

MICROCOPY RESOLUTION TEST CHART







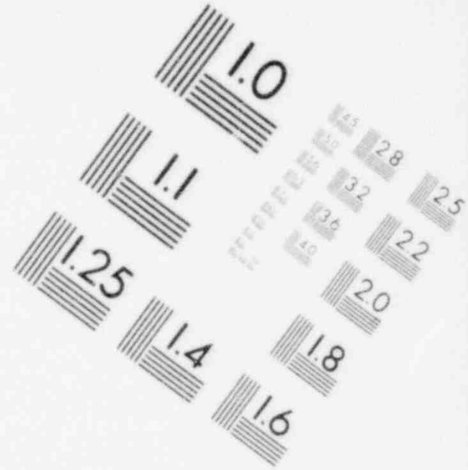
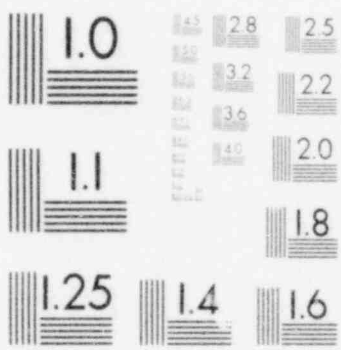


IMAGE EVALUATION
TEST TARGET (MT-3)



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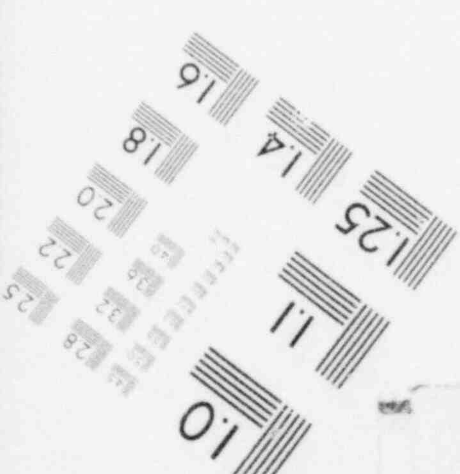
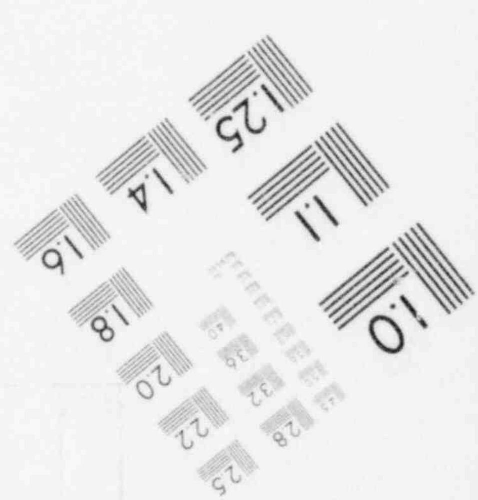
MICROCOPY RESOLUTION TEST CHART





in TexPirg quotation).[11] I note that this statement refers, not to a low concentration of radiation, but to a low concentration of defects. TexPirg, again, does not say what exposure is necessary to induce these defects. As I discussed earlier a great deal more radiation exposure than can be expected from ACNGS during normal operations or during a loss-of-coolant accident is necessary to induce such defects.

> 6. <u>Semiconductor electronic devices depend on p-n junctions for their correct operation. If the p-type change to n-type or the other way around, the p-n junction becomes a short circuit thereby preventing the semiconductor device and the equipment in which it is located from operating correctly.</u>

I note that this assertion is unsupported by TexPirg.

> 7. <u>In MOS devices (many are in modern planes), the radiation can cause a space-charge build-up in the silicon dioxide film which can prevent the device from operating correctly. See Bell System Technology [sic] Journal, Vol. 46, Page 1 (1967) and Proc. IEEE, Vol. 54, Page 894.</u>

11/ TexPirg cites this quotation as C. Kittel, <u>Introduction to Solid State Physics</u>, page 380. This citation lacks both a year and an edition number. The fifth edition of that textbook contains no such quote. Some earlier editions do. The second edition (1956), for example, says at page 380:

> It has been found that the effect of irradiation in germanium is dominated by the acceptors produced, so that it is possible to convert the conductivity type of an *n*-type specimen to *p*-type by a low concentration ([about] $1:10^7$, depending on the specimen) of radiation-induced defects.

Texpirg misquotes by omitting the parenthetical materials.

It is outside my expertise to comment on whether there are many metal-oxide-silicon (MOS) devices in modern airplanes, however, the assertion on that point by TexPirg is unsubstantiated.

Once more, the issue is not whether radiation can cause defective performance of MOS devices, but how much radiation is necessary to do so. TexPirg, once again, fails to supply an answer.

As explained in my discussion of assertion 5, above, the radiation necesary to cause the space-charge effect mentioned is several orders of magnitude greater than the radiation levels anticipated at the site boundary for ACNGS. No effects on semiconductor devices have been documented for the levels of radiation expected from ACNGS.

8. Defective semiconductor electronic equipment would increase the probability, of the plane carrying it, of crashing somewhere and perhaps into the nuclear plant itself.

Defective equipment of any kind, if critical to plane safety, could increase the possibility of a crash. But TexPirg has failed to identify any critical electronic gear or show that it could be degraded by plant emissions from ACNGS. Therefore, this assertion stands unsupported.

TexPirg's assertions, furthermore, give no reason for believing the probability of an air crash into ACNGS (as opposed to any other given site) is enhanced by the so-called phenomenon of "latching." As shown by my previous discussion, the operation of ACNGS or even a loss-of-coolant accident will not expose passing aircraft to sufficient radiation to degrade any transisters or other solid state devices or materials. Hence ACNGS will not increase the probability of air crashes resulting from such degradation.

DH:4:D

EXHIBIT I

PROFESSIONAL QUALIFICATIONS

JAMES R. SUMPTER

Title:	Manager-Nuclear Department-Houston Lighting & Power Company
Responsibility:	Nuclear System design and engineering, and the safety analysis, nuclear licensing, and radiation protection aspects of HL&P's nuclear power plant projects.
Employment History with Company:	Joined HL&P as Nuclear Engineer, August 1972 Promoted to Supervising Engineer, Nuclear Safeguards & Licensing, March 1973 Promoted to Manager, Nuclear Department, February 1975
Education:	B.S., Penn State University, Engineering Science, 6/65 M.S., University of Michigan, Nuclear Engineering, 12/67 Ph.D., Texas A&M University, Nuclear Engineering, 12/70
Civic & Professional Affiliations:	Registered Professional Engineer, State of Texas American Nuclear Society, South Texas Section Program Co-Chairman, 1977; Treasurer, 1978-80; Vice President, 1981 Secretary, American National Standards Institute (ANSI) Standard on Nuclear Power Plant Air Cleaning Units & Components, N509, 1972-75 Lecturer for International Atomic Energy Agency (IAEA) Nuclear Power Projects Course 1976, 1977 Atomic Industrial Forum (AIF) Steering Committee on Reactor Licensing & Safety, 1975-78 American National Standards Institute (ANSI) Steering Committee on Nuclear Power Plant Fire Protection, 1976-78

Chairman, Technical Session on New Developments in Radwaste Management, ASME Joint Power Generation Conference, 1978
Member, Industrial Representatives Committee, Doctor of Engineering Program, Texas A&M, 1977
Member, Gas Cooled Reactor Associates Direct Cycle Technical Advisory Committee, 1977
Member, Technical Program Committee, ANS Reactor Operating Experience Conference, 1979
Member, Utility Occupational Radiation Standards Groups, 1978
Member, Edison Electric Institute, Nuclear Power Subcommittee, 1979
Sierra Club, 1973
Chairman, HL&P Three Mile Island Task Force, 1979
Member, Advisory Committee on Nuclear Energy, Texas Energy & Natural Resources Advisory Council, 1980
Lecturer, 23rd Petroleum Institute for Educators, 1980
Lecturer, Institute on Energy, Economics, and the Environment, U of H, Clear Lake City, 1979, 1980
Co-Chairman, Topical Session on Human Factors, ANS Reactor Operating Experience Conference, 1981

Awards, Honors:

Sigma Pi Sigma (Physics)
Psi Chi (Psychology)
NSF, AEC Traineeships at college

Publications:

"BWR Liquid Radwaste System Optimization Studies" 1975 Winter Meeting of American Nuclear Society, "ANS Transactions," 22, 542 (1975)
"Nuclear Power Plant Fire Protection-Status"- AIF Conference on Reactor Licensing & Safety, February, 1977
"Impact of Nuclear Regulatory Commission Regulations on Fire Protection for Nuclear Plants" - American Power Conference, March, 1977
"Proceedings of the American Power Conference," 39, 127 (1977)

DH:04:I

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	§	
	§	
HOUSTON LIGHTING & POWER COMPANY	§	Docket No. 50-466
	§	
(Allens Creek Nuclear Generating Station, Unit No. 1)	§	

AFFIDAVIT OF JAMES R. SUMPTER

STATE OF TEXAS §
§
COUNTY OF HARRIS §

I, James R. Sumpter, Manager, Nuclear Department, Houston Lighting & Power Co., first being duly sworn, upon my oath certify that I have reviewed and am thoroughly familiar with the statements contained in the attached affidavit addressing Intervenor TexPirg's Additional Contention 50 on "latching" and that all my statements contained therein are true and correct to the best of my knowledge and belief.

James R. Sumpter

James R. Sumpter

Subscribed and sworn to before me by the said James R. Sumpter on this 11th day of September, 1980.

Angela Nichols Smith

Notary Public in and for
Harris County, Texas

ANGELA NICHOLS SMITH
Notary Public in Harris County, Texas
My Commission Expires October 18, 1980

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	§	
	§	
HOUSTON LIGHTING & POWER COMPANY	§	Docket No. 50-466
	§	
(Allens Creek Nuclear Generating	§	
Station, Unit 1)	§	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing Applicant's Response to TexPirg's Motion for Summary Disposition and Applicant's Cross-Motion for Summary Disposition of TexPirg's Additional Contention 50 ("Latching") in the above-captioned proceeding were served on the following by deposit in the United States mail, postage prepaid, or by hand-delivery this 2nd day of October, 1980.

Sheldon J. Wolfe, Esq., Chairman
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. E. Leonard Cheatum
Route 3, Box 350A
Watkinsville, Georgia 30677

Mr. Gustave A. Linenberger
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. Chase R. Stephens
Docketing and Service Section
Office of the Secretary
of the Commission
Washington, D. C. 20555

Susan Plettman
David Preister
Texas Attorney General's Office
P. O. Box 12548, Capitol Station
Austin, Texas 78711

Hon. Charles J. Dusek
Mayor, City of Wallis
P. O. Box 312
Wallis, Texas 77485

Hon. Leroy H. Grebe
County Judge, Austin County
P. O. Box 99
Bellville, Texas 77418

Atomic Safety and Licensing
Appeal Board
U.S. Nuclear Regulatory
Commission
Washington, D. C. 20555

Atomic Safety and Licensing
Appeal Board
U.S. Nuclear Regulatory
Commission
Washington, D. C. 20555

Richard Black
Staff Counsel
U.S. Nuclear Regulatory
Commission
Washington, D. C. 20555

Bryan L. Baker
1118 Montrose
Houston, Texas 77019

J. Morgan Bishop
11418 Oak Spring
Houston, Texas 77043

Stephen A. Doggett
P. O. Box 592
Rosenberg, Texas 77471

John F. Doherty
4327 Alconbury
Houston, Texas 77021

Carro Hinderstein
609 Fannin, Suite 521
Houston, Texas 77002

D. Marrack
420 Mulberry Lane
Bellaire, Texas 77401

Brenda McCorkle
6140 Darnell
Houston, Texas 77074

W. Matthew Perrenod
4070 Merrick
Houston, Texas 77025

F. H. [illegible]thoff
7200 Shady Villa, No. 110
Houston, Texas 77055

Wayne E. Rentfro
P. O. Box 1335
Rosenberg, Texas 77471

William Schuessler
5810 Darnell
Houston, Texas 77074

James M. Scott
13935 Ivy Mount
Sugar Land, Texas 77478

J. Gregory Copeland

J. Gregory Copeland