

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322-1
(Shoreham Nuclear Power Station,	)	(OL)
Unit 1)	)	

AFFIDAVIT OF CARL H. BERLINGER

I, Carl H. Berlinger, being duly sworn, state as follows:

1. I am employed by the U.S. Nuclear Regulatory Commission and I am currently assigned as the Manager of the TDI Project Group in the Division of Licensing. A copy of my professional qualifications has been previously provided.

2. The purpose of this affidavit is to provide information concerning matters raised by Suffolk County in their filing dated June 11, 1984, concerning litigation of emergency diesel generator contentions.

3. Specifically, I will address the issue of the level of effort made by the staff to secure information on the operating history of TDI diesels.

4. As a consequence of the crankshaft failure at Shoreham (August 1983) and based on its assessment of operating experience records at both nuclear and non-nuclear TDI installations and the results of its vendor inspection findings of quality assurance problems at TDI, the staff has

undertaken an evaluation of the reliability of TDI diesel generators for nuclear service.

5. In its review of TDI diesel generator reliability the staff has utilized TDI operating experience information from several sources. The nuclear experience data has been provided from licensee event reports, 10 CFR Part 21 deficiency reports, inspection reports, personal observations, and communications with non-U.S. reactor operators. The non-nuclear operating experience considered has included information provided by TDI, the TDI Owners Group, Suffolk County and from personal observations and communications with TDI diesel engine owners/operators.

6. The staff has visited and discussed TDI operating experience at the Kuosheng Nuclear Power Station (Taiwan Power Company).

7. Several TDI Owners that Suffolk County has asked the staff to contact in their May 30, 1984 letter have previously provided information that has been reported and used by the TDI Owners Group in their analyses.

These include the State of Alaska, United States Steel Corporation, Falcon Shipping Group, Kodiak Electrical Association, Anamax Mining Company, and The Village of Mora and Taipower.

8. The staff has communicated with the management of the Falcon Shipping Group and has visited and discussed operating problems with the Chief Engineer on the Star of Texas.

9. These sources have contributed in varying degrees to the identification of specific problems and/or concerns with the TDI diesel engines.

9. These sources have contributed in varying degrees to the identification of specific problems and/or concerns with the TDI diesel engines.

10. The staff has reviewed available reports relative to problems identified from these sources and has concluded that although the information available from non-nuclear applications is useful, it tends to be cumulative and has not identified additional significant problems which are not already being considered within its ongoing review of TDI engine reliability.

11. The requirements to maintain detailed documentation of operating experience at nuclear installations are far in excess of those routinely utilized at non-nuclear facilities. Although records may be maintained at non-nuclear installations, discussions with experienced individuals indicate that the information generally available is inadequate for determining the root cause of failures and the applicability of the problems to diesels in nuclear service.

12. Even in those instances where adequate records are maintained and failure analysis reports are available, determining the relevance of non-nuclear TDI diesel experience to nuclear applications is complicated. For example, the use of different design standards for specific engine applications is commonplace. Problems experienced with TDI diesels in applications having diverse operating conditions, service requirements, fuel quality specifications, individualized engine maintenance programs and procedures are further complicated by diverse training requirements and the level of competence of responsible personnel.

13. The staff and its consultants believe that determining the relevance of non-nuclear TDI operating experience to nuclear applications would be complicated at best and would require that a complete failure analysis for each significant problem be conducted if this information is to be useful. Clearly those major failures which have been reviewed by

the staff have been useful but their relevance has not been confirmed. For example, the cylinder head and valve problems experienced by the Star of Texas, Pride of Texas and the Gott have been attributed to fuel quality and maintenance problems which are common problems in marine applications.

14. Exhaustive investigations of non-nuclear TDI operating problems might provide useful information but the staff and its consultants do not believe such an effort is necessary in order to make a determination regarding the reliability of TDI diesel engines for nuclear service.

An analogy can be stated to define what is meant by "useful" and "necessary." Having a third arm may be useful but not necessary to lead a successful life. The staff and its consultants believe that the TDI Owners Group program plan constitutes an acceptable approach. The combination of the Phase I (16 generic issues) and Phase II (DR/QR) programs with expanded inspections and testing and enhanced maintenance and periodic surveillance programs is believed to be a much more comprehensive and direct approach to evaluating the reliability of these TDI diesels for nuclear service than would be a comprehensive investigation of past failures.

15. While the staff and its consultants believe that additional data from non-nuclear installations may be useful, it is not considered necessary for reaching a conclusion regarding TDI diesel engine reliability. Based on our evaluation of non-nuclear experience already considered in our review and the knowledge and expertise of our consultants familiar with non-nuclear TDI installations, we have concluded that an exhaustive review of TDI non-nuclear operating experience would have limited value and is not necessary. The opinions of our staff consultants, B. J. Kirkwood, Paul Louzecky and Adam Henricksen, are attached for your information.

16. The staff review of the Owners Group Program is continuing. All but one of the Phase I reports have been submitted for review. The outstanding report which will be submitted by June 22, 1984, will address the engine block and cylinder liner. All of these reports are applicable to Shoreham. The Phase II (DR/QK) report will be submitted by June 29, 1984.

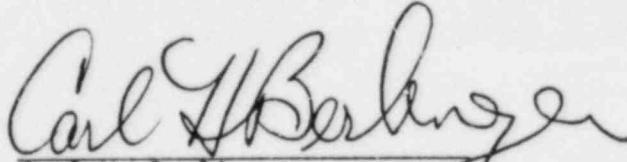
17. The NRC and Contractor comments and questions on the Phase I reports have been provided to the Owners Group on all reports submitted with the exception of the cylinder head, piston skirt and turbocharger reports. These additional comments/questions will be provided to the Owners Group for discussion at the next NRC/Owners Group working meeting scheduled for June 29, 1984, at the Shoreham site.

18. Outstanding issues which remained unresolved after the previous meeting (May 24, 1984) were scheduled for discussion amongst the respective technical staffs. Those issues relative to the Stone & Webster reports were resolved via teleconference and the Owners Group will be submitting a supplemental report documenting those discussions. A meeting has been scheduled on June 22, 1984, at FaAA offices in Palo Alto, California.

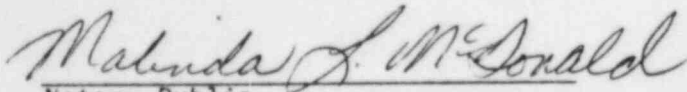
That meeting, which will be transcribed, will address outstanding issues relative to the FaAA reports.

19. The staff plans to issue an evaluation of the Phase I program by August 17, 1984. The Phase II evaluation would be issued by August 30, 1984. Both these schedules assume that all open issues can be resolved expeditiously.

20. The staff plans to issue an evaluation of the TDI Owners Group Program Plan by June 29, 1984, assuming that our contractor Technical Evaluation Report is received by June 22, 1984.

  
Carl H. Berlinger

Subscribed and sworn to before me  
this 21<sup>st</sup> day of June 1981.

  
Notary Public

My Commission expires: 7/1/86.

7731 N. Fairchild Road  
Fox Point, Wisconsin  
53217

June 19, 1984

Mr. Carl Berlinger  
Division of Licensing  
Office of Nuclear Reactor Regulation  
U. S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Berlinger:


SUBJECT: SUFFOLK COUNTY'S FILING CONCERNING LITIGATION OF EMERGENCY  
DIESEL GENERATOR CONTENTIONS before the Atomic Safety and  
Licensing Board, dated June 11, 1984

After reviewing the subject document and referring to pages 33 and 34 therein, the following observations may be made: Although undeniably additional information from the field, nuclear or otherwise, may be helpful in evaluating the TDI engines, it is at this stage not regarded as essential in arriving at the final determination as to the fitness of the engines for nuclear power plant standby service. Unfortunately, most information from the field is very poorly documented. Seldom or never are failures reported from the field accompanied by a failure analysis, essential for taking corrective action. Likely all that research among TDI customers would tell us would be the number of failures of the various parts with no explanation or reason for the failures and corrective action taken. That type of information will almost certainly have to be furnished by TDI since most customers would not have the kind of personnel necessary to make that kind of determination. Furthermore a lot of the failures reported would be of no value for further study as they reflect failures of parts having been replaced by parts either modified or redesigned. I therefore feel that an effort to seek information in this area would be an exercise in futility and would not yield enough useful information to make the project worthwhile.

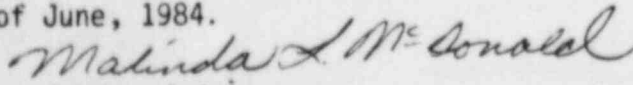
On the other hand I feel confident that when the TDI Owners' group program plan is finalized, it will be comprehensive enough and technical enough so that when properly executed, it will give the TDI units the necessary confidence level to be accepted as nuclear standby units. The lead engine concept should also eventually lead to all parts being tested to such a level that the engine may not be considered prototype or unproven.

Adam J Henriksen  
Consultant

Adam Henriksen, being duly sworn atests  
that he has read the above and that it  
is true and correct to the best of his  
knowledge.

  
Adam J. Henriksen

Subscribed and sworn to  
before me this 21st day  
of June, 1984.

  
NOTARIAL PUBLIC  
My Commission Expires July 1, 1986

ENGINE  
SYSTEM  
ANALYSTS

ENGINEERED APPLICATIONS CORPORATION  
ENGINEERING AND DESIGN CONSULTANTS  
1674 Witherbee Road, Troy, Michigan 48084  
Phone 313-646-6439

ENGINE  
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SPECIALISTS

June 15, 1984

Mr. Carl Berlinger  
Division of Licensing  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Subject: Docket No. 50-322-OL  
Suffolk County's Filing Concerning  
Litigation of Emergency Diesel Generator  
Contentions in the matter of the  
Shoreham Nuclear Power Station and  
Attachments.

Dear Mr. Berlinger:

In reply to the reference deposition and attachment, I would like to address my comments as follows:

All engine people and operators desire trouble free operation; however, engine failures occur. The first human reaction is to blame the engine builder.

The engine builder starts an investigation of the problem, assembling the facts as best he can to determine the actual cause of the trouble.

Because it is difficult to discuss many of the engine problems and the reported failures without having more complete information, I will review some of these problems with the information at hand.

1. CYLINDER HEADS

a. General

I have heard of a number of cylinder head problems but, as yet, I have not seen a cracked or leaking cylinder head at engine overhauls. I have seen a number of heads from two different Shoreham engines, a number of heads from one Catawba engine and a number of heads from Unit 1 at Grand Gulf. Of all these heads I have only seen a photograph of a hair line crack in a Grand Gulf head. The crack was across the stellite valve seat. The crack, I was told, was about .001" wide by .003" deep and was not expected to cause operating trouble. At the next overhaul, which will be after about 200 running hours,



the head will be inspected again.

b. Visit to Delaval Engine Plant

Because of the reports of cylinder head problems, I went out of my way to discuss the problems with the Delaval people during a visit with the PNL people, to T.D.I. in Oakland, California.

The cylinder heads are steel castings for greater thermal stability and physical strength. The heads are cast from an electric furnace melt that is checked spectrographically for its chemical composition before pouring. I did not see any heads cast but I did see castings that had come from molds with their gates and risers. The heads have machining pads on the firing deck to control their thickness. We then saw the inspection procedure for cracks and then went to the station where the stellite valve facing was done. We noted the welding and stress relieving procedure. The welding is done hot at about 700°F. in order to minimize possible head distortion and weld cracking. The carbon content of the steel is .24 - .30%, which is within the range that the welding could be done at room temperature.

The cylinder heads are identified and a record kept of each head from the casting to the finished product.

In order to get even more detailed information on the cylinder heads I discussed the metallurgy with the steel melting foreman and their metallurgist. I also asked my tour guide questions on the heads, their problems and on the amount of testing done to prove a design. He said they not only had many hours of testing but the engine loads were higher than the commercial rating. It seems that the head cracking problem is mostly one originating from the stellite seat cracks that progress till they break through the water jacket. If the engine was running when the crack occurred, the crack would probably not shut the engine down but it would have to be replaced before the engine could run again. Cracking of this nature generally occurs when the engine is stopped and cools down. Therefore, it is recommended to crank the engine once or twice while it is cooling and then once every 24 hours thereafter. The cranking will show up water leaks.

The heads I saw at Delaval were Series III, which are the current heads.

c. Grand Gulf Cylinder Heads

The heads I saw at Grand Gulf were probably Series I, which I was told had been run for about 1400 hours. However, I understand a number of heads were returned to Delaval because they showed rust in the valve seat area.

The heads were not pressure tested before returning to Delaval, so possibly some were not cracked. It must be remembered that these engines were about 6 years old and no information was made available on how the engines were protected during the delay from receipt to operation.

d. Cylinder Head Cracking Problem

A number of cylinder head cracking problems were reported on non-nuclear installations. The type of crack, or its extent, was only reported in a few cases. Therefore, it appears that an investigation of this problem could turn out to be a statistical summary of number of heads cracked to total heads in service, or number of hours of engine operation till failure occurred. (if the information is available,) Also, I would suspect that the type of heads used on many of these installations would not apply to the nuclear power plants.

The deposition mentions a number of cases where a considerable number of heads failed on an engine. In cases like this I would suspect engine operation. If the improper water is used for cooling engine, scale forms inside the head which impairs the cooling and the heads crack.

Cracking of heads were reported but did the people owning the engines investigate the cause? Was a failure analysis made? It is easy to blame the manufacturer but why did the heads crack? Just to see the heads or hear about the cracking is not enough. An investigation must be made to determine the cause. Cut the crack out, open the head and look inside.

Besides preventing scale formation an additive is added to the cooling water to inhibit rust formation and or catalytic corrosion. Was this practice followed in the reported engines?

Besides the cooling and rust inhibitor problems, how was the engine operated and how many operating hours did the heads have when trouble developed? We need to know the past history that led up to the failure.

When the cracks occurred what problems were created? How long did the engine run after a crack was suspected?

Therefore, in order to study this problem more specific details are required.

Therefore, to the best of my knowledge the Delaval cylinder head cracking problem has not been as serious as implied and even if a head should crack during emergency operation, it would probably not shut the engine down.

However, in order to prevent such an occurrence a procedure has been recommended for the emergency power units to identify just such a problem and to prevent it by proper monitoring of the engines.

## 2. PISTON CROWNS AND SKIRTS

In the case of the piston crown and skirts, I think we should limit the problem to the A.E. pistons. I think most of the engines will use these pistons.

## 3. CYLINDER BLOCK CRACKING

The cracking of the cylinder block, as at Shoreham, is in the cylinder stud area and appears to be caused by a very tight liner flange fit in the block. I have not seen any such problems at Grand Gulf or Catawba.

## 4. CRANKSHAFT BEARING PROBLEMS

With the new crankshafts at Shoreham, I think the bearing cracking problems are behind us.

## 5. CRANKSHAFTS

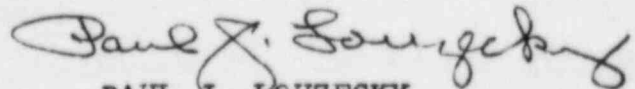
I understand that the engines at Shoreham were tested extensively at Delaval before delivery, yet the crankshafts broke. The new crankshafts are larger, made from better material and have shot peened fillets. The calculations and tests on these new shafts show that they will perform satisfactorily.

## 7. CYLINDER BLOCK

At Shoreham most of the problems have been or are being corrected with the exception of the cracked cylinder block. The cracked block will probably be replaced with the No. 5 series, which is better and has been tested by Delaval at higher load and speed than the No. 4 blocks.

Therefore, based on the above, I do not see the value of making an investigation into the non-nuclear engine part failures of the Delaval Model R engines. From past experience, the information available on the failure will be sketchy and incomplete and the value derived from such an investigation will, therefore, be questionable.

Sincerely yours,

  
PAUL J. LOUZECKY

*Linda G. Smith*

LINDA G. SMITH  
Notary Public, Macomb County, Michigan  
Acting in Oakland County  
My Commission Expires January 26, 1988

*Paul J. Louzecky*

Paul J. Louzecky

Subscribed and sworn to  
before me this 16<sup>th</sup> day  
of June, 1984.

## Covenant Engineering

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P.O. Box 788  
BUENA VISTA, COLORADO 81211  
303-395-6056

June 18, 1984

Dr. Carl Berlinger  
US Nuclear Regulatory Comm  
7920 Norfolk Ave.  
Bethesda, MD 20015

Re: TDI Engines in Standby Nuclear Service  
Significance of Unit and Component Experience  
from Non-nuclear Applications

The contention of TDI/EDG inadequacy for the intended service reflects various specific experiences. Some are nuclear-based (eg, Shoreham's broken shafts); others are from non-nuclear installations (principally certain marine users); all of which already represent some extent of survey of TDI records and of TDI users.

Having identified the generic issues of moment, the TDI/OG has undertaken a comprehensive program to identify root causes and appropriate correction via the DR/QR analyses, coupled with extensive, expanded inspection, testing and subsequent enhanced maintenance and surveillance.

In view of this comprehensive program, it is problematical if an extensive survey of all users would, at this date, add anything meaningful to the process of evaluation, correction and surveillance.

In part this is because much of the data potentially available from these non-nuclear sources would be of questionable content and significance unless and until it was extensively evaluated. In the largely-municipal domestic stationary-diesel generator field, data on service problems, and operations relevant thereto, is not kept in the depth of detail that would allow simple surveying techniques. Indeed, it would require comprehensive review of maintenance logs or diaries, review of manifold daily operating logs, and probably on-site interviews with operating and maintenance personnel. Furthermore, correlation of engine parts of the eras of those problems with the parts at nuclear installations might defy reliable tracing.

Considering the work already done to identify the 16 generic issues; considering the already-proceeding program of DR/QR far beyond the generic issues; considering the planned programs of expanded inspection and testing -- it is doubtful that such a survey would provide meaningful new revelations.

At best, it probably would yield a truer perspective of how widespread the known problems really are; whether indeed they were/are of such universality as to warrant concern on the EDG units. Even at that, if the whole replacement/DRQR/inspection/testing program results in a new vintage of parts, etc, these statistics then become moot.

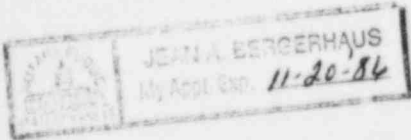
If done, though, such an investigation would have to thoroughly annotate and carefully correlate such matters as loading conditions, fuels used, maintenance practices, outage-cause investigation results, etc. Otherwise, such data might well be misleading.

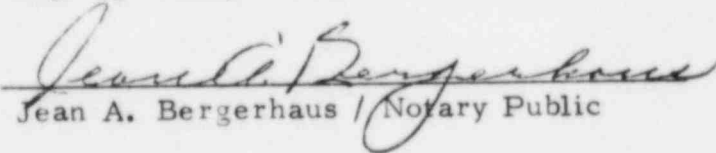
COVENANT ENGINEERING

  
B. J. Kirkwood, PE

State of Kansas ) ss.  
County of Johnson )

Subscribed before me this the 18th  
day of June, 1984.



  
Jean A. Bergerhaus / Notary Public

DRAFT

Signed Copy Will Follow

Mr. Carl Berlinger  
Division of Licensing  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

June 20, 1984

Dear Mr. Berlinger:

SUBJECT: OPERATING HISTORY OF TRANSAMERICA DELAVAL, INC. DIESEL ENGINES  
IN NON-NUCLEAR APPLICATIONS: RELEVANCE FOR RESOLUTION OF KNOWN  
PROBLEMS

Summarized in this letter are PNL's comments on the penultimate paragraph of Section IV, "ADDITIONAL INFORMATION," in "SUFFOLK COUNTY'S FILING CONCERNING LITIGATION OF EMERGENCY DIESEL GENERATOR CONTENTIONS" dated June 11, 1984. The filing is before the Atomic Safety and Licensing Board in the matter of Long Island Lighting Company's Shoreham Nuclear Power Station, Unit 1, Docket No. 50-322-OL.

Suffolk County's filing includes the following statement in the paragraph referenced above: "The Staff's consultants testified in a deposition on May 23 that marine diesel experience would be useful information, but that Pacific Northwest Laboratory (the Staff's contractor) is not directly obtaining information on TDI diesel problems in marine and other non-nuclear applications." In response to this comment, it is pertinent to elaborate on the approach that PNL is taking to review and evaluate the TDI Diesel Generator Owners' Group Program Plan and related information submitted by the Owners' Group to NRC.

PNL is relying heavily on the experience and expertise of consultants in diesel engine technology who are under subcontract to the Laboratory to participate in providing technical support to the NRC Staff. To date, eight consultants have assisted in various aspects of this work. Each of the consultants has extensive experience in the design, testing, installation, and/or field engineering of diesel engines similar in size to those installed at nuclear power stations by members of the TDI Diesel Generator Owners' Group. The consultants gained their experience in diesel engine technology for non-nuclear applications, including diesel-electric power generation and ship propulsion.

The experience of PNL's consultants encompasses diesel engine technology as it has been developed in European countries as well as in the United States. Of the consultants who have participated to date, one is a Professor of Internal Combustion Engines at the Norwegian Institute of Technology, and a second is on the staff of an internationally-known engineering firm located in West Sussex, England.

With the advice and counsel of the consultants, PNL is reviewing reports submitted by the Owners' Group on known problems in the context of the overall effort for establishing the adequacy of TDI diesels for nuclear applications. Analyses submitted by the Owners' Group in support of design changes are a key aspect of this effort, but are not sufficient to establish that problems are resolved. Other key aspects include verification of corrective actions (e.g., through engine testing, which is

a major element of the Owners' Group Program Plan), enhanced engine surveillance and maintenance, and the implementation of an effective quality assurance program to ensure that new engines and replacement parts meet established requirements.

Because diesel engine problems and appropriate corrective actions are closely related to the conditions under which the engines are operated (e.g., load, speed, and fuel used), PNL's reviews of the TDI Diesel Generator Owners' Group Program Plan and related submittals are focusing on operating experience, tests and inspections of TDI engines in nuclear service. Through on-site examinations of components during engine disassemblies at nuclear power stations, PNL's consultants are able to observe directly how engine components have performed under the conditions to which they have been exposed. This information is, of course, highly relevant to PNL's evaluations of the problems being addressed by the Owners' Group that would affect the reliability and operability of TDI engines in nuclear service.

Nothing in the data on non-nuclear applications already available to PNL through the Owners' Group suggests that a comprehensive effort to acquire additional, non-nuclear data is justified. In separate correspondence to NRC, PNL's consultants who participated in the deposition taken by Suffolk County on May 23, 1984 are providing their own views on this issue.

Sincerely,

W. W. Laity  
PNL Project Manager

Sworn to before me this \_\_\_\_ day of June 1984.

\_\_\_\_\_  
\_\_\_\_\_

My commission expires the \_\_\_\_ day of \_\_\_\_ 19\_\_.

cc: M. Plahuta, DOE-RL  
M. Carrington, NRC (2)  
K. Trickett, DOE-HQ



UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of )  
LONG ISLAND LIGHTING COMPANY ) Docket No. 50-322-1  
(Shoreham Nuclear Power Station, ) (OL)  
Unit 1) )

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF RESPONSE TO 'SUFFOLK COUNTY'S FILING CONCERNING LITIGATION OF EMERGENCY DIESEL GENERATOR CONTENTIONS,'" ATTESTED STATEMENTS OF "CARL H. BERLINGER," "ADAM J. HENRIKSEN," "PAUL J. LONZECHY," AND "JEAN A. BERGERHAUS" AND UNATTESTED STATEMENT OF "W. W. LAITY" in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class, or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mail system, this 21st day of June, 1984:

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

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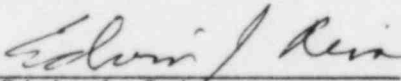
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