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 O.L.
(Shoreham Nuclear Power Station, Unit 1)	)	

DIRECT TFSTIMONY OF MARC W. GOLDSMITH

ON BEHALF OF SUFFOLK COUNTY REGARDING

SUFFOLK COUNTY CONTENTION NO. 5 - LOOSE PARTS MONITORING

April 13, 1982

SUMMARY OUTLINE OF SUFFOLK COUNTY

CONTENTION 5 TESTIMONY*

Suffolk County contends that Shoreham's loose parts monitoring system (LPMS) could produce a large number of spurious (unwanted) alarms which, if not readily identified or explained would diminish operator performance and overall plant safety.

A loose part in the primary system can contribute to component damage and material wear by frequent impacting with other parts in the system. Early detection could prevent serious economic damage and avert a health or safety accident. The function of a LPMS includes: detecting and alarming the presence of unexplained impacts occurring within the reactor pressure boundary; and possibly determining the probable size and location of the impacting object.

The specific concerns relative to Shoreham's LPMS include the following: Shoreham's LPMS lacks sufficient capabilities in order to discriminate, locate, and evaluate a loose part in the reactor pressure vessel; LILCO has not demonstrated that Shoreham's LPMS will minimize spurious alarms; LILCO has not demonstrated the precise procedures an operator will follow upon a LPMS alarm; and the NRC has not adequately reviewed Shoreham's LPMS in order to determine whether Shoreham's LPMS capabilities are adequate.

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*/ ASLB Memorandum and Order, March 15, 1982, p. 30.

This testimony discusses the importance of the loose parts monitoring system, inadequacies in the Shoreham system, and recommendations as to what is necessary to make Shoreham's system adequate.

Recommendations to make Shoreham's system adequate include documentation by LILCO that: its LPMS is capable of discriminating, locating and evaluating a loose part in the reactor pressure vessel; and its operator training program will provide adequate instruction in equipment operation and evaluation. Lastly, the NRC staff should conduct a comprehensive review of Shoreham's loose part monitoring system's capabilities.

Exhibits*/

1. Addendum No. 1 and Specification for Loose Parts Monitoring System, Shoreham Nuclear Power Station - Unit 1, Spec. No. SH1-461, August 29, 1979, Stone & Webster Engineering Corporation, Boston, MA. - Cover page and page 1-7.
2. TEC Proposal No. P-80-003, Long Island Lighting Invitation No. TM-9-515, Loose Parts Monitoring System for the Shoreham Nuclear Power Station Unit 1, prepared by Technology for Energy Corporation, January 9, 1980.
3. Long Island Lighting Company's Response to NRC Inspection No. 82-02, dated March 11, 1982.

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*/ ASLB Memorandum and Order, March 15, 1982, p. 30.

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LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322 O.L.
(Shoreham Nuclear Power Station, Unit 1)	)	
	)	

DIRECT TESTIMONY OF MARC W. GOLDSMITH

REGARDING SUFFOLK COUNTY CONTENTION 5 -

LOOSE PARTS MONITORING

Q Please state your name, address, occupation and qualifications.

A My name is Marc W. Goldsmith, and my business address is 400-1 Totten Pond Road, Waltham, Massachusetts. I am the President of Energy Research Group, Inc. My qualifications have been submitted to this Board separately.

Q Would you please state the contention on which you are testifying?

A Suffolk County Contention 5 reads as follows:

> Suffolk County contends that Shoreham's Loose Parts Monitoring System could produce a large number of spurious (unwanted) alarms which, if not readily identified or explained, could diminish operator performance and overall plant safety. This would violate 10 CFR 50, Appendix A, GDC 1 and 13, as well as 10 CFR 20.1(c), and 10 CFR 50.36(c)(2), (3) and (5).

Q What is the purpose of your testimony?

A The purpose of my testimony is to discuss concerns relative to Shoreham's loose parts monitoring system. It is to discuss the importance of the loose parts monitoring system (LPMS), inadequacies in the Shoreham system, and recommendations as to what is still necessary to make the system adequate.

Q Why do you think a loose parts monitoring system is important?

A A loose parts monitoring system is important to provide operators with the ability to readily identify and properly react to a loose part in the primary system.

According to Regulatory Guide 1.133, "Loose-part Detection Program for the Primary System Light-Water-Cooled Reactors", September 1977, the presence of a loose (i.e. disengaged and/or broken) object in the primary coolant system can be indicative of degraded reactor safety resulting from failure or weakening of a safety-related component. A loose part, whether it be from a failed or weakened component or from an item inadvertently left in the primary system during construction, refueling, or maintenance[1/], can contribute to component damage and

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1/ While significant steps have been taken to mitigate this problem, an LPMS system would provide an additional safeguard. Materials left in the reactor vessel could damage fuel leading to higher than normal gaseous releases by either mechanical damage or creating a hot spot.

material wear by frequent impacting with other parts in the system.[2/] A loose part can pose a serious threat of partial flow blockage with attendant departure from nucleate boiling (DNB) which could result in failure of fuel cladding. In addition, a loose part increases the potential for control-rod jamming and for accumulation of increased levels of radioactive crud in the primary system.[3/]

Failed or loosened parts can vibrate providing in some cases early detection of a potential problem. Early detection could prevent more serious economic damage and avert a health or safety accident. There have been several incidents of tools or equipment being left in the primary system during construction, maintenance or refueling.

Partial flow blockage has occurred in the past (Fermi Nuclear Plant) as a result of a loose part in the primary system. The Fermi case is significantly different than that found at Shoreham. The Fermi reactor was a liquid-metal-cooled fast reactor with a flat core

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2/ A loose part in the primary system contributes to material wear by frequent impacting which could result in the formation of crevices along the surface of the component. These crevices increase the surface area where radioactive crud could potentially accumulate. A loose part could create damage, requiring maintenance. In addition, the material eroded from the surface could be carried through the core creating additional activation products. Both effects increase the potential plant personnel doses directly. Doses would be indirectly increased by any additional maintenance resulting from loose part caused damage.

3/ In the event a loose part, (for example, a nut or bolt) becomes lodged inside the control rod drive housing, the control rod could jam preventing insertion. Other active components, such as valves and pumps, could also be susceptible to jamming or damage preventing proper functioning.

support plate. This reactor had a different fuel and internal design than Shoreham. However, it serves to demonstrate the impact of an unaccounted for loose part. The mechanical design of fuel assemblies has since been changed to preclude this specific blockage problem. A loose parts monitoring system should be able to detect a part large enough to cause flow blockage prior to its occurrence.

The primary function of a loose-part monitoring system would be to detect and alarm the presence of unexplained impacts occurring within the reactor pressure boundary. A second, more demanding function of the LPMS would be to determine, to the extent possible, the probable size and location of the impacting object. A serious problem encountered in the use of loose-parts monitoring systems has been an unacceptable occurrence of false (spurious) alarms. According to NUREG/CR-0524, "Characteristics and Performance Experience of Loose-Part Monitoring Systems in U.S. Commercial Power Reactors," this has resulted in either a gradual loss of confidence in the system (in some cases, a total disregard for all LPMS alarm signals) or a compensatory upward readjustment of alarm level setpoints. In the past, false alarms seem to have resulted from generally low signal-to-noise ratios, from specific transient signals, improper LPMS installation, poor choices of sensor locations and from mountings having poor acoustic coupling to the NSSS structures.

Once a loose part is detected in the primary system, an evaluation of its safety significance is required. Plant shutdown, followed by location and visual identification of the loose part, is one candidate method for such evaluation and has the advantage of usually (but not invariably) providing the clearest and least ambiguous information about the loose part (including its likely origin). However, there is strong incentive to derive diagnostic information from the LPMS, since this approach offers a potential for shortening, delaying, and/or avoiding entirely a plant shutdown. There is an increased probability for the introduction of still more loose parts

during retrieval operations with the vessel head removed, if the sole purpose was a loose part retrieval. Therefore, a capability for estimating these characteristics on-line is desired.

Presently, operating systems usually only record impact signals on magnetic tape and any analysis for characterization purposes is done by the operator. Considerable effort must be expended by the plant staff in manually comparing LPMS alarms with control room logs to account for alarms induced by true (but innocuous) sonic disturbances resulting from equipment operation. The current practice of LPMS manufacturers is to compare impact signals of an unknown nature against categorized impact patterns (baseline signatures) obtained during a scheduled plant outage by using a calibrated impacting device at likely points of impact. Then, based on the similarity (in terms of peak amplitude, frequency content, and duration) of the signals of unknown origin to those available in the baseline library, an "educated guess" as to the nature of the loose part can often be made. The accuracy to which mass, shape, material hardness, and other distinguishing properties can be estimated in practice is thus largely a matter of the availability and extensiveness of a categorized impact pattern library that is known to be applicable to the plant in question. Therefore, due to the considerable time involved with analysing diagnostic information, an operator may disregard many LPMS alarm signals. The occurrence of numerous spurious alarms would further compel the operator to disregard a LPMS alarm, possibly a real (not spurious) alarm.

Q What are the specific concerns relative to Shoreham's loose parts monitoring system?

A The specific concerns relative to Shoreham's Loose Parts Monitoring System (LPMS) include the following: Shoreham's LPMS lacks sufficient capabilities in order to discriminate, locate, and

evaluate a loose part in the reactor pressure vessel; LILCO has not demonstrated that Shoreham's LPMS will minimize spurious alarms; LILCO has not demonstrated the precise procedures an operator will follow upon a LPMS alarm; and the NRC has not adequately reviewed Shoreham's LPMS in order to determine whether Shoreham's LPMS capabilities are adequate.

Q Why do you believe Shoreham's LPMS lacks sufficient capabilities to discriminate, locate, and evaluate a loose part in the reactor pressure vessel?

A Present-day loose part monitoring systems attempt to achieve their functional objectives by continuously monitoring the sonic outputs from sensors installed at a number of locations on the external surfaces of the nuclear steam supply system (NSSS) components and piping. According to NUERG/CR-0524, "An effective LPMS must have an adequate number of properly deployed sensors. The number and location of sensors will depend on the functional requirements placed on the LPMS. . ."

In LILCO's Technical and Performance Requirement Specification (see Exhibit 1) for Shoreham's loose parts monitoring system dated August 29, 1979, LILCO stated, "The Bidder (for the LPMS) shall recommend in his proposal the number and location of sensor channels which would comprise the minimum configuration required by that Bidder's LPMS in order to meet the requirements of Regulatory Guide 1.133. . ." LILCO also stated "The Bidder shall recommend in his proposal the number and location of sensor channels which would be considered optional but desirable due to improved system capability for discriminating, locating, and evaluating loose parts in the reactor. In response, see Exhibit 2, TEC proposed the location of the minimum (4) sensors. Two of these four sensors were recommended to be located at the feedwater inlets and the remaining two sensors were recommended to be located on the control rod drive housing. The two optional sensors, were recommended to be located in recirculation suction A

and B to improve the system's capability for discriminating, locating and evaluating loose parts in the pressure vessel. LILCO purchased a LPMS system from Technology for Energy Corporation which comprised only the minimum number of sensor channels (four sensors) in order to comply with Regulatory Guide 1.133. LILCO did not install the two optional sensors which would improve the system's capability for discriminating, locating and evaluating loose parts in the reactor. According to NUREG/CR-0524, the simplest LPMS will comprise 4-8 sensor locations, but for reasons of sensor redundancy or diagnostic capability, better quality systems will often have 10-18 loose-part sensors. Therefore, it appears LILCO purchased the lowest grade system which lacks sufficient capability to discriminate, locate, and evaluate a loose part in the reactor.

Q Why do you think spurious alarms will not be minimized at Shoreham?

A The Technology for Energy Corporation (TEC) loose parts monitoring proposal (Response of LILCO to Suffolk County's Request for Production of Documents, pg. 6, March 26, 1982) states the TEC system's expected number of annual false (spurious) alarms is three. However, in the proposal, TEC agrees to pay a penalty of $67.00 to LILCO for each estimated annual false alarm occurrence.[4/] This sum will not exceed a maximum penalty of $24,500.00. Simple arithmetic indicates TEC is willing to be penalized for up to 365 spurious alarms per year. TEC claims that a false alarm history is included in their proposal. However, no reference is made to other plants' spurious alarm experience utilizing the TEC system. As a result, it has not been demonstrated that spurious alarms will be minimized at Shoreham.

In addition, as stated previously, past spurious alarms may have resulted from improper LPMS installation. Regulatory Guide 1.133 specifies that instrument channels be physically separated where inaccessible during full power operation. However, according to

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[4/] See Exhibit 2.

LILCO's response to NRC Inspection Number 82-02, dated March 11, 1982, ". . .instrument cables for different channels were not physically separated inside the drywell in that they were run in the same conduits and they utilized the same electrical penetration."[5/] It is not clear whether cabling from the sensors and preamplifiers have been incorrectly routed in trays that also included power cables for high-current electromagnetic actuators used elsewhere in the plant. According to NUREG/CR-0524, this could subject the LPMS to high levels of electrical interference, resulting in unwanted alarms. If this is the case at Shoreham, spurious alarms will not be minimized.

Q What is your specific concern relative to operator procedures following a loose part monitoring system alarm?

A It is essential that operating personnel have the ability to make effective use of the equipment for the detection of loose parts. As discussed previously, once a loose part is detected in the primary system, an operator evaluation of its safety significance is required. This evaluation consists of comparing impact signals of an unknown nature against categorized impact patterns. Then, based on the similarity of the patterns, the operator usually makes an "educated guess" as to the nature of the loose part, based on past impact patterns. The operator then determines whether the LPMS alarm was false or not and what the next step of action should be if the alarm is real. Therefore, it is imperative that the operator know the capabilities of the LPMS system and the diagnostic procedures involved.

According to NUREG/CR-0524, (LPMS). . ."operating personnel generally seem ill-informed or confused about the quantitative capability of their systems. . ." LILCO's response to Suffolk County interrogatory number 50, dated March 26, 1982, states, "Procedures to be followed by operators concerning the use of the (Shoreham) LPMS will

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[5/] Attached as Exhibit 3 hereto.

be issued after an LPMS start-up training program has been established."[6/] Therefore, no assurance is presently provided as to whether an operator will be able to accurately detect a loose-part in the primary system at Shoreham and react properly before damage occurs.

Q Why do you believe the NRC has not adequately reviewed Shoreham's LPMS in order to determine whether Shoreham's loose part monitoring system's capabilities are adequate?

A The NRC requires all plants currently being licensed to install loose part monitoring systems. Plants at the OL level are required to provide a detailed system description. However, Shoreham's Final Safety Analysis Report does not provide a complete description of how Shoreham's LPMS complies with Regulatory Guide 1.133. A short description of the LPMS is given, including the number and locations of sensors, but a description of system sensitivity, alert levels, data acquisition system, etc. is not included. Therefore, it appears that NRC has not adequately reviewed Shoreham's LPMS in order to determine whether Shoreham's LPMS capabilities are adequate.

Q What regulations do you feel the Shoreham LPMS does not meet?

A LILCO has not complied with 10 CFR 50, Appendix A, GDC 1 and 13, as well as 10 CFR 20.1 (c) and 10 CFR 50.36 (c)(2), (3) and (5).

General Design Criteria 1, "Quality standard and records", states:

> "Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed."

It is clear from previous discussion that the loose-part monitoring system is important to assuring safe reactor and fuel operation. Therefore, Shoreham's LPMS should be classified as important to

6/Response of Long Island Lighting Company to Suffolk County Interrogatories and to Suffolk County Second Set of Interrogatories, March 26, 1982, p. 21.

safety. LILCO's Technical and Performance Requirement Specification for Shoreham's loose-parts monitoring system dated August 29, 1979, stated; "The Bidder (for the LPMS) shall recommend in his proposal the number and location of sensor channels which would comprise the minimum configuration required by that Bidder's LPMS in order to meet the requirements of Regulatory Guide 1.133. . ."

General Design Criterion 13, "Instrumentation and control" states:

> "Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems."

Shoreham's LPMS lacks adequate capabilities relative to discriminating, locating, and evaluating loose parts in the reactor. Shoreham's LPMS may also have the potential for electrical interference resulting in spurious alarms. Therefore if a loose part remains undetected within the primary system at Shoreham, the integrity of the primary system components could be adversely affected.

10 CFR 20.1(c) states:

> ". . .persons engaged in activities under licenses issued by the Nuclear Regulatory Commission. . .should. . .make every reasonable effort to maintain radiation exposures, and releases of radoiactive materials in effluents to unrestricted areas, as low as is reasonably achievable."

As stated previously, a loose part increases levels of radioactive crud in the primary system. If efforts are not made to detect loose parts in the primary system at Shoreham, a loose part could potentially increase levels of radioactive crud. In addition, a loose part that is detected early and removed will not erode or damage equipment requiring maintenance that leads to occupational exposure and may prevent accidents which also would lead to exposures. As a result, LILCO would not be making every reasonable effort to maintain occupational radiation exposures as low as reasonably achievable.

Section 50.36 "Technical Specifications" of 10 CFR Part 50, requires an applicant for a facility operating license to provide proposed technical specifications. Shoreham's loose part monitoring system or program is not described or included in Shoreham's Technical Specification of February 1, 1982.

10 CFR 50.36(c)(2) "Limiting Conditions for Operation" states:

> "Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. . ." A limiting condition requiring the loose-part detection system to be operable during startup and power operation has not been described or included in Shoreham's Technical Specifications.

10 CFR 50.36(c)(3) "Surveillance Requirements" states:

> "Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within the safety limits, and that the limiting conditions of operation will be met." Loose parts monitoring channel operability by channel checks, channel functional tests and calibration tests have not been described or included in Shoreham's Technical Specifications.

10 CFR 50.36(c)(5), "Administrative controls", states:

"Administrative controls are the provisions relating. . .to reporting necessary to assure operation of the facility in a safe manner." Procedures for commission notification in the event the presence of a loose part is confirmed, have not been described or included in Shoreham's Technical Specification.

Therefore, LILCO violates 10 CFR 50.36 (c)(2), (3) and (5).

Q What would satisfy the concerns you have expressed relative to Shoreham's loose-part monitoring system?

A The following would satisfy the concerns relative to Shoreham's loose-part monitoring system:

1. LILCO should provide documentation that its loose parts monitoring system is capable of discriminating, locating and evaluating a loose part in the reactor pressure vessel. In the event Shoreham's LPMS is incapable of the above, LILCO should upgrade its existing LPMS.

2. LILCO should provide documentation that Shoreham's operator training program will provide adequate instruction in:
   A. the operation of Shoreham's LPMS; and,
   B. the evaluation of LPMS alarms.

Q What should NRC Staff do to evaluate Shoreham's loose-part monitoring system's capabilities.

A NRC should conduct a comprehensive review of Shoreham's loose part monitoring system's capabilities by evaluating Shoreham's LPMS relative to the system's (including the operator) ability to detect, identify and respond to a loose part.

EXHIBIT 1

Addendum No. 1 and Specification for Loose Parts Monitoring System, Shoreham Nuclear Power Station - Unit 1, Spec. No. 5H1-461, August 29, 1979, Stone & Webster Engineering Corporation, Boston, MA. - Cover page and page 1-7.

J.O. No. 11600.02
W080-48923
Spec. No. SH1-461

August 29, 1979

Addendum No. 1 and

Specification for

LOOSE PARTS MONITORING SYSTEM

Shoreham Nuclear Power Station - Unit 1
Long Island Lighting Company
Brookhaven Township, Long Island, New York

Technology for Energy
Corporation

P.O. 310971

CONTROLLED

APPROVED		
	Name	Date
Preparer	[signature]	8/28/79
Lead Engr	[signature]	8/27/79
Specialist	[signature]	8/28/79
Proj Engr	[signature]	8/29/79
Qual Assur	[signature]	8/28/79
Mat'ls Engg	[signature]	8/29/79
Const Dept	NR [signature]	8/28/79

II

TECHNICAL AND PERFORMANCE REQUIREMENTS 6.18

The Bidders are to furnish technical data sheets identifying 6.21
pertinent characteristics of the system's components with
their proposals. 6.22

1. Number and Location of Sensors 6.24

The Bidder shall recommend in his proposal the number and 6.26
location of sensor channels which:

a. Would comprise the minimum configuration required 6.28
by that Bidder's LPMS in order to meet the
requirements of Regulatory Guide 1.133 for the 6.29
Purchaser's boiling water reactor.

b. Would be considered optional but desirable due to 6.30
improved system capability for discriminating,
locating, and evaluating loose parts in the 6.31
reactor.

The incremental cost to the Purchaser of the optional 6.33
sensors in b above, including all associated signal
tramsmission and signal conditioning equipment, shall be 6.34
separately stated by the Bidder in his proposal.

The Bidder shall also indicate in his proposal the number of 6.35
spare channels available in his LPMS for future system
expansion. 6.36

2. Sensors 6.41

All sensors shall be accelerometer type transducers capable 6.43
of detecting acoustic/mechanical vibrations associated with 6.44
loose parts impacting within the primary coolant system 6.46
within the sensitivity requirements of Regulatory
Guide 1.133.

3. Sensor Mounting 6.50

Sensor mountings shall be supplied by the Seller. The 6.53
number and type of mounting shall be submitted to the
Engineers by the Seller for approval. The Seller shall 6.55
demonstrate to the Engineers that the mountings will ensure
the integrity and operability of the sensors under the 6.56
specified environmental conditions (e.g., use of waveguide
tube mountings to reduce temperature or lead shielding to 6.57
reduce radiation exposure). The mountings shall be designed 6.58
so as not to compromise the integrity of the component on
which they are mounted. Direct stud mounting or welding of 6.59
the sensors to the reactor vessel or other component of the
reactor coolant pressure boundary shall not be permitted. 7.1

EXHIBIT 2

TEC Proposal No. P-80-003, Long Island Lighting Invitation No. TM-9-515, Loose Parts Monitoring System for the Shoreham Nuclear Power Station Unit 1, prepared by Technology for Energy Corporation, January 9, 1980.

TEC PROPOSAL NO. P-80-003

LONG ISLAND LIGHTING
INVITATION NO. TM-9-515

LOOSE PARTS MONITORING SYSTEM

FOR THE SHOREHAM NUCLEAR POWER STATION

UNIT 1

Technology for Energy Corporation
10770 Dutchtown Road
Knoxville, Tennessee 37922

January 9, 1980

1C10040

PREFACE

Technology for Energy Corporation (TEC) offers this proposal in response to LILCo Specification SH1-461 W.O. 80-48923. Our proposal is valid for 60 days from January 10, 1980.

TEC agrees to receive the Buyer's representative for inspecting TEC's manufacture of the system, when deemed necessary by the Buyer, provided that one-week notice is given TEC.

Upon receipt of an order, purchaser shall have the right to reproduce drawings or prints submitted by TEC.

Prices:	Total System -	$50,291
	Options:	
	Two extra channels -	$ 7,890
	Locator -	$12,600
	Impact Calibrators - (6 channels)	$ 9,400

Engineering Services: Labor Rates attached.

Terms of Payment: 1/2-10 or net 30

LABOR COST SHEET

Request for Proposal: P-80-003

Name of Proposer: Technology for Energy Corporation

Address: 10770 Dutchtown Road, Knoxville, Tennessee 37922

Contract Administrator: R. D. Brenner

Labor Category	Direct Labor Rate
Level I	$20.00/hr.
Level II	$37.00/hr.
Level III	$55.00/hr.
Level IV	$70.00/hr.

The rates quoted above are firm for the period March 1, 1980 thru December 31, 1980.

TEC LABOR CATEGORIES

LEVEL I (Engineer Aide/Specialist): Personnel in this category provide general technical support and have a background generally characterized by a specialized training in a limited technical area with a range from limited to considerable working experience. Work is performed under the direct supervision of Level III or above personnel.

LEVEL II (Associate Engineer/Designer): Personnel in this category have a technical background generally characterized by senior technical support experience, a B.S. degree and up to seven years' experience, or an M.S. degree and up to three years. Work is performed under project managment direction.

LEVEL III (Engineer): Personnel in this category have a technical background generally characterized by an M.S. or B.S. degree with considerable technical experience or a Ph.D. degree with limited experience. Work is usually performed under general management direction with technical responsibility for one or more tasks and with some project management responsibility.

LEVEL IV (Senior Engineer): Personnel in this category have a technical background generally characterized by an advanced degree with many year's experience and are recognized as a leader in one or more areas of technical expertise. Work is generally performed in the project manager role or in providing technical guidance or performing advanced technical activities with responsibility for the overall technical quality of the work performed on a project.

Submitted by Technology for Energy Corporation

Date January 9, 1980

Long Island Lighting Company
175 East Old Country Road
Hicksville, NY 11801

PROPOSAL FOR: Shoreham Nuclear Power Station - Unit 1
Loose Parts Monitoring System
Invitation No. TM-9-515
Specification SH1-461, W.O. 80-48923
Proposal Due Date: January 10, 1980

The undersigned hereby offers to furnish and deliver The Loose Parts Monitoring System for Shoreham Nuclear Power Station, Unit No. 1, in strict accordance with LILCO Invitation to Bid No. TM-9-515, dated December 4, 1979 and its incorporated Specification SH1-461 dated August 29, 1979, except as detailed below:

Exceptions to Invitation:

1. List all variations
2. If necessary, use additional paper
3. If no exceptions are taken, please so state. (NO EXCEPTIONS)

Submitted By Technology for Energy Corporation

TM-9-515

Date January 9, 1980

A. 1. Firm Lump Sum Price for furnishing and delivering the loose parts monitoring system as specified in Specification SH1-461, F.O.B. jobsite, Shoreham, Long Island, New York, in accordance with delivery schedule shown on Attachment "1" $ 50,291.00

2. Amount included in above firm lump sum price for freight (for tax purposes only). $ 300.00

B. 1. Firm unit price for additional channels beyond the minimum as specified in the specification. total 2 $ 3,945.00 each

2. Amount included in above firm unit price for freight (for tax purposes only). $ 75.00 each

C. Firm lump sum price for fragility testing. $ Not included

D. False alarm potential factor equals $67.00 (N)

N= Expected Number of Annual False Alarms

Expected Number of Annual False Alarms Equals 3

NOTE: The penalty of $67.00 applied to each estimated annual false alarm occurrence, will not exceed a maximum penalty of $24,455.00

E. Number of calendar days required to submit complete complete detail drawings for approval after an award. 10 Days

F. Number of weeks after approval of such detail drawings to make complete delivery at the project site. 15 Weeks

Associated Proposal No. P-80-003

Specific Proposal References:

False Alarm History Page No. 2-5, 2-6, 2-9, 2-10, 2-11

Terms of Payment Page No. i

F.O.B. Page No. i

Price Policy (for required delivery) Page No. i

Warranty — Page No. 2-12

Drawing Information — Page No. Preface

Delivery — Page No. 4-2

List of Recommended Spare Parts and Associated Prices — Page No. Provided ARO

List of Special Tools Required — Page No. None

It is understood that:

1. Unless written exceptions are attached or noted herein, the stated requirements of LILCO's Invitation to Bid No. TM-9-515 are incorporated in this proposal.

2. All prices included in this proposal are firm, based on the required delivery except as specifically stated within this proposal and where prices are not firm, the proposal includes a definitive formula for arriving at price adjustments with a maximum limit for price increase, based on the required delivery date.

3. This proposal is valid for acceptance within ninety (~~90~~ 60) days.

4. LILCO reserves the right of rejecting any or all proposals and of waiving technical irregularities.

Date January 9, 1980

Technology for Energy Corporation

Legal Name of Firm or Corporation

By [signature]

Title Vice President, Finance

THIS PROPOSAL IS RETURNED IN SEXTUPLICATE WITH DETAILED PROPOSAL

1. INTRODUCTION

Technology for Energy Corporation (TEC) has prepared this proposal in response to LILCo's Bid Request No.: TM-9-515, "Loose Parts Monitoring System for the Shoreham Nuclear Power Station - Unit 1." Section 1 contains general background information on loose parts monitoring (LPM) and a brief discussion of TEC's capabilities. A technical description of the proposed LPM system is given in Section 2.

1.1 Background Information

In recent years, the use of electronic monitoring and surveillance has taken on new and expanded roles in the nuclear energy industry. In addition to vibration analysis of machinery, one area of surveillance presently receiving considerable attention by both industry and regulatory agencies is loose parts monitoring. Unfortunately, the consequences of implementing an inadequate LPM System on a NSSS can be worse than not having a system at all. If alarm warnings are given without enough information to evaluate the nature of the event, the result can be detrimental to plant availability, personnel exposure and safety.

A survey of the status of field operational loose parts monitoring systems revealed the need for decreased false alarms and improved characterization of impacting events (i.e., estimating their location, rate and energy) in addition to detection.[1] NRC Regulatory Guide 1.133, "Loose Part Detection Program for the Primary System of Light-Water-Cooled Reactors," emphasizes this need,

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[1] R. C. Kryter, C. W. Ricker, and J. E. Jones, Loose Parts Monitoring: Present Status of the Technology, Its Implementation in U.S. Reactors, and Some Recommendations for Achieving Improved Performance, Progress in Nuclear Energy, Vol. 1, pp. 667-672, Pergamon Press, 1977.

emphasizes this need, stating that a well-developed system should enable discrimination of the signals induced by the impact of a loose part from those signals caused by normal plant manuevers, and that there should be diagnostic procedures to determine the significance of a loose part. The NRC Guide 1.133 describes programmatic methods for detecting and evaluating a potentially safety-related loose part during "preoperational testing and the startup and power operation modes." Besides recommended system characteristics, including sensor requirements, sensitivity and data acquisition modes, the guide discusses the formulation of a loose parts detection program for submittal to the Commission. Among other things, the program should contain a summary of the available diagnostic procedures, a description of a surveillance requirement ensuring channel operability, and guidelines for the report to be submitted to the NRC within two weeks of the initial notification of the presence of a loose part. Obviously, these requirements reflect the basic need to establish an LPM surveillance and diagnostics program built and supported with state-of-the-art technology.

1.2 TEC's Capabilities

Technology for Energy Corporation (TEC) personnel are recognized internationally as leaders in the development of surveillance and diagnostic technology for power plant applications. TEC's surveillance and diagnostic experiences have included: core internals vibration monitoring, pump vibration monitoring, diagnosis of loose parts data, valve surveillance and rotating machinery surveillance. A highlight of some of TEC's ongoing projects provide credentials relevant to the effort proposed herein.

TEC is assisting Mississippi Power and Light Company in the design, development, testing and operation of a computerized system which monitors the vibrational characteristics of the turbine and many of the pumps at the Grand Gulf BWR Power Station. This is the most comprehensive rotating machinery monitoring program to be used in any power plant to date.

TEC Model 1400 Microprocessor-Controlled Surveillance System is being used at Philadelphia Electric Company's Peach Bottom BWR Power Station to continuously monitor, for leakage, all main steam safety/relief valves. The system has been in operation for over two years and is the basis of the most dedicated valve surveillance program in the nuclear industry.

TEC has been contracted to provide Acoustic Valve-Position Indication Systems for the following customers:

Boston Edison's Pilgrim Nuclear Station
TVA's Sequoyah Units 1 and 2 and Browns Ferry Units 1, 2 and 3
Duke Power's Oconee Units 1, 2 and 3, McGuire Units 1 and 2
Portland Electric's Trojan Station
Florida Power and Light's Turkey Point Units 3 and 4 and St. Lucie Unit 1
Consolidated Edison's Indian Point Unit 2
Omaha Public Powers' Ft. Calhoun Plant
Indiana and Michigan Electric's Cook Units 1 and 2
Power Authority of New York's Indian Point Unit 3
Baltimore Gas and Electric's Calvert Cliffs Units 1 and 2
Toledo Edison's Davis Besse Plant
Sacramento Municipal Utility District's Racho Seco Plant.

TEC has supplied the Vibration and Loose Parts Monitoring Systems for the Sequoyah Nuclear Station, Units 1 and 2, the Watts Bar Nuclear Station, Units 1 and 2 and the Bellefonte Stations, Units 1 and 2. TEC is presently manufacturing a loose parts monitoring system for supply to the Turkey Point Nuclear Station, Unit 3.

TEC has developed both analog-based and digital controlled LPM systems (see Exhibit 1). Our analog-based LPM system is described in Section 2 of this proposal. TEC's digital system, which is described in Section 5, features microprocessor-controlled trend analysis. The TEC analog LPM system is a prerequisite for assembly of the complete digital system. We recommend that the buyer consider later expansion of the proposed system to a TEC digital controlled system for the reasons stated in Section 5 of this proposal. The price for the digital option is not contained in the schedule of prices. TEC's loose parts monitoring systems meet the regulatory requirements of NRC Regulatory Guide 1.133. TEC's modular systems contain complete signal conditioning and data processing instrumentation needed for a fully qualified loose part detection program. As required, fully qualified TEC personnel are available to assist in prompt analyses and reporting of loose parts data. TEC will also prepare licensing support in preparing responses to NRC inquiries about the Loose Parts Detection Program as requested.

1.3 Summary of Proposed System

In Section 2.1, we propose an analog-based LPM system per LILCo's specification. The system will meet the requirements of Regulatory Guide 1.133. The proposed system will contain four (4) channels of monitoring and data processing, with immediate expansion capability to optionally recommended six (6) channels.

2. TECHNICAL DESCRIPTION OF LPM SYSTEM

The technical description of the proposed Loose Parts Monitoring (LPM) System includes a description of the components of the basic system, and a discussion of the proposed options.

2.1 Components of LPM System

The basic system consists of front-end items which are installed within containment and instrumentation which is to be located outside containment. A block diagram of the instrumentation is given as Exhibit 2.

2.1.1 Sensors, Mounts, Cables and Charge Converters

The LPM sensors will be high-temperature (700°F) isolated accelerometers with mineral insulation cable (see data sheets, Exhibit 3). These devices are suitable for continuous operation under the conditions of service described in lines 5.50 - 6.13 of the Specification. The accelerometers will be mounted on 10-32 studs and sealed with a seal wire to mounting blocks. Examples of mountings are shown in Exhibits 4 and 5.

TEC recommends that the accelerometers be mounted the following locations:

Sensor No.	Component*	Azimuth*	Approx. Elevation from RPV base (feet)*
1	CRD 46-43	135	-2
2	CRD 06-11	315	-2
3	FW Inlet	45	40
4	FW Inlet	225	40
5 (opt.)	Recirc. Suction A	0	14
6 (opt.)	Recirc. Suction B	180	14

* Based on GE's locations for typical RPV. After receipt of RPV drawings, TEC will submit drawings and details of several recommended sensor installation techniques for approval.

The charge converters will be TEC type 500 (see Exhibit 6). Each sensor will be enclosed in a J box, as will the charge converter (see Exhibit 7). Each sensor is connected by a 36-inch hard-line cable which mates to a flexible special cable to the charge converter. The special cable satisfies environmental requirements.

The unit shall have four (4) sensor assemblies, which will be wired by the Buyer to separate terminal blocks in the data acquisition cabinet.

2.1.2 LPM Differential Amplifier

The TEC 932 differential amplifier provides calibrated gain steps to a total gain of 1,000 with a frequency response commensurate with the most commonly used impact detection range. Each amplifier provides a current-regulated voltage for powering the remote charge converters. Output signals are taken directly through the back-plane connector to the impact detector module. A front-panel-mounted connector is provided for convenient access to the conditioned signal for viewing on oscilloscopes, spectrum analyzers, or, for external analog recording. The 932's low-pass filter aids in attenuating any spurious electrical spikes which contribute to false LPM alarms. The technical specifications of the 932 are given in Exhibit 8.

2.1.3 TEC 1432 Impact Detector

The TEC 1432 Impact Detector Module performs the necessary signal processing needed to recognize signals which are caused by impacting. The 1432 receives the RMS signal from the 932 and feeds this signal to a baseline restorer which measures and separates the long and short term RMS signal components, and transmits the results to a comparator circuit. Internal

switch-selectable time constants are provided for optimizing impact thresholds relative to the long term background noise variations. A convenient signal LED indicator light provides a constant display of channel status.

The 1432 accommodates the changing background noise associated with operating conditions. In contrast to the fixed alert level detection methods which compare absolute signal levels to a fixed reference, the 1432 automatically adjusts its alert threshold above the background noise thereby detecting only those signals which rise above the changing average. This feature is consistent with the recommendation of Sect. 2c of the Regulatory Guide 1.133. The proper functioning of the TEC LPM system during plant startup, when background conditions are varying, is achievable because of the capabilities of the impact detector. Unambiguous impact detection is clearly enhanced by the 1432.

Two front-panel-mounted BNC's are provided for convenient monitoring of the TEC-1432 analog outputs.

a. BACKGROUND - This is the long-term-average rms over a time selected by the internal switches.

b. Δ SIGNAL - This is the short-term rms minus the background.

The alert output of the 1432 module is a digital signal indicating an impact. This signal is derived by comparing the "Δ signal" output with the "background" output. To indicate an alert the "Δ signal" voltage must exceed the background voltage multiplied by a factor of "K". For steady non-fluctuating signals, the "Δ signal" output is at 0 volts and a sudden increase or burst of signals will cause the "Δ signal level" to go positive. The important parameter "K" is

controlled by a potentiometer that is accessed by inserting a screw driver through the small hole in the 1432 front panel. This is to prevent it from being tampered with once a system is calibrated. For operator convenience, a momentary contact toggle switch is provided on the 1432 front panel. When this switch is depressed to the "BKGND" position, the background signal voltage (+ rms) is put onto a meter located on the audio/switch panel. Similarly, when this switch is depressed to the "THRESHOLD" position, a voltage (- rms) equal to the alert level is put onto the meter. This monitoring capability gives the operator an easy way to check the background level and the alert level without having to enter the circuitry with test equipment.

The status LED located on the 1432 front panel is another operator convenience. This LED will glow "green" indicating normal operation, and glows "red" when the 1432 module indicates an "alert", a possible loose part. It will return to green after depressing the reset switch on the speaker-relay panel. If the background level is too low due to insufficient system gain or a defective sensor, the status LED will blink "red". Likewise, if the background level is abnormally high, the status LED will also blink "red". The blinking red condition overrides the alert indication and indicates a problem that needs attention. The 1432 Impact Detector module is a TEC standard "single width" module. All signals are connected through the P.C. board edge fingers to prevent the need for cabling to the front panel. The front panel has two BNC outputs: "Background" and "Δ signal" for monitoring or subsequent processing. It is recommended that the "Δ signal" output is recorded on the strip chart recorder.

Specifications of the 1432 Impact Detector Module are given in Exhibit 9.

2.1.4 <u>TEC Model 1433-P Alarm Module and Model 133A Annunciator Module</u>

The TEC Model 1433 Alarm Logic provides a third method of reducing false loose parts alarms. The TEC system has an alert level and an alarm criterion. The TEC alarms criterion provides a greater capability of enhancing reliable detection of loose parts and reducing false alarms. The 1432 impact detector informs the 1433 module when the RMS ratio set point has been exceeded. This is classified as an "alert".

Initiation of the alarm requires satisfaction of the alarm criterion which defines a minimum rate at which alerts must occur. This alarm logic feature has two salient advantages:

1. The detector discriminator can be operated much closer to the noise level, increasing sensitivity; and

2. Mean time between alarms can be greatly increased, reducing the probability of false alarms.

The alarm criterion consists of an accumulation time and a selected number of alerts. Accumulation time is set by the Auto Reset control on the 1433 front panel. In the DISABLE position, an internally selected 1-15 second interval restricts the time in which ALERTS are accumulated. If, after the duration of this interval, the number of alerts has not reached the preset value (alarm criterion setting), the accumulator is reset and the timer restored. If, however, the criterion setting is reached, an alarm status is determined.

The value of the alarm criterion's requirement of repetitive impacting can be illustrated by the following statistical fact regarding spurious alerts: if the average rate of random alerts at a given system sensitivity is

0.1 alerts/second (an abnormally high rate), an alert would be generated every ten (10) seconds with a criterion setting of one (1) and an accumulation time of ten (10) seconds. However, without changing the system sensitivity, if the criterion setting is increased to eight (8), the mean time between alarms increases to seven days. The advantages are obvious. For realistic random alert rates, it is possible to eliminate false alarms.

An LED display on the 1433 module will indicate the identity of the first channel which initiated the alarm. The identities of the other involved channels can be seen by noting the latched condition of their activity lights on their 1432 module.

The 133A annunciator module activates two relay contacts (alarm annunciators) corresponding to an alarm. It also activates a front panel "SONALERT" audible alarm. Annunciator Controls provide alarm annunciator control, namely; inhibition of alarms, testing of alarms without interfering with the normal operation of the system, and resetting the alarm annunciators.

2.1.5 TEC Model 1439 Audio Monitor/Simulator Module

The audio/simulator module contains a system test circuit and an audio channel select switch (6 positions + external) with speaker, volume and tone controls.

The Audio Monitor Controls provide unit and channel selection, audio amplifier frequency bandpass and gain levels. Simulator Controls provide for the insertion of accelerometer simulation signals into the 932 amplifiers for testing the system.

A meter, reading in volts RMS, is located on the panel above the amplifier rack. Switching the background signal or the alert level for any channel into the meter is achieved by depressing a toggle switch on the 1432 panel of that channel.

2.1.6 TEC-1434C Deliberate Plant Manuever Detector

The Reg. Guide 1.133 on Loose Part Detection states that "administrative procedures may be used by control room personnel in lieu of automatic procedures to identify and make allowance for alert signals caused by plant manuevers". Although this is an acceptable procedure, it certainly is not desirable, and, it is expected that plant operators would prefer a more efficient method.

The TEC Model 1434C Deliberate Plant Manuever Detector is used to inhibit the TEC 1430 Loose Parts Monitor from generating loose part alarms during plant manuevers. The Model 1434C has an optically isolated plant manuever input. The 1434C inhibits the LPM system for the duration of the plant manuever as well as a two-second period after completion of the plant manuever. A light emitting diode on the front panel indicates a system inhibit due to a plant manuever. Also, a front panel toggle switch is included to allow the 1434C system inhibit function to be enabled or disabled.

2.1.7 Tape Recorder

A 4-channel reel-to-reel tape recorder shall be provided with the system. The recorder will be a Racal 4DS, and will be controlled by a TEC model 1436 recorder control module.

The specifications of the Racal recorder are given in Exhibit 10.

2.1.8 System Configuration

The LPM system instrumentation will be configured as shown in Exhibit 11. It will be located in a cabinet having the dimensions shown in Exhibit 12. The cabinet will meet Nema 12 standards. The cabinet will contain an isolation transformer and will be provided with cable entrances at the bottom of the cabinet.

2.1.9 Calibration, Performance Checks and Functional Test

2.1.9.1 Calibration. For initial calibration, TEC will provide an adjustable, spring-loaded, hand-held impacting device, which has been calibrated under laboratory conditions to generate an impact signal, as detected by an LPM accelerometer, having a peak amplitude equivalent to that produced by a 0.5 lb. steel object falling through one foot onto a steel surface. Using this device and a documented procedure, all channels may be calibrated in conformance with the Regulatory Guide 1.133.

2.1.9.2 Performance Checks. The Regulatory Guide for the Loose Part Detection Program requires that qualitative assessment of each channel's behavior be performed at least once per 24 hours. At the least, this requires that audio monitoring of every channel be briefly performed. This will suffice to ensure that the sensor-to-amplifier configuration is functional. However, with little additional time, considerably more valuable information can be obtained, together with increased reliability of loose part detection. The following Performance Check procedure is recommended:

1. Record the date and time of the check, together with the operator's name (his audiogram should be on file).
2. Check that all lights are the proper colors. If any gain adjustments are made, record new settings.

3. Select each channel in turn for audio monitoring. Listen for each channel for approximately 30 seconds. Measure and record both the background and alert level for each channel.
4. Enable the simulator and check that all channels latch and the alarm functions. (Once a week, do this with the tape auto-start enabled and assure that the automatic recording feature is working properly.)

2.1.9.3 Channel Functional Test. The Regulatory Guide requires that a channel functional test be performed at least once per 31 days. If the optional (see Sect. 2.2.2) remotely-controlled impacting calibrators are installed, performance of this test is simple. Without the calibration devices, a plant maneuver noise, such as those associated with control rod stepping or similar operations, can be used as an impact-like noise source. It may be necessary to increase the channel gain or to reduce the alert level in order to utilize the maneuver noise as a stimulus. It will also be necessary to inhibit the deliberate plant maneuver detector. Since the daily Performance Check verifies system operation from the amplifiers to the alarm functions, the channel Functional Test need only show that the sensor detected the maneuver noise. This is done by observing that the channel's 1432 light latches red when the maneuver occurs.

2.1.10 Loose Part Detection in the Presence of Background Noise

Detection of loose parts by acoustical monitoring requires a thorough characterization of the intrinsic noise phenomenon peculiar to the reactor under surveillance. Pertinent parameters such as frequency spectral content, energy

level, and rate of occurence are collectively used to detect a loose part. The role of these parameters depends on such practical considerations as mechanical resonances, reactor operating conditions, background noise, etc. It is desirable that the loose part detection criteria be sufficiently flexible to accommodate the various conditions under which loose parts must be detected.

The impact signals received from the accelerometer sensors can be too small to be directly useful in the LPM processing electronics. Given an impact noise, the signal-to-noise (S/N) ratio can be inadequate for reliable signal separation. Therefore, signal amplification and S/N enhancement are major functions of the loose parts detection system.

Figure 2.1 shows a spectrum of background noise on a main steam line of a BWR plant during maximum power production. The frequencies below 1 kHz predominate. (Actually, increasing system gain results in displaying energy at all frequencies, but the spectrum as shown details the regions of large energy.) Figure 2.2 shows the spectrum of a metal-to-metal impact detected by the same accelerometer several seconds after the time corresponding to the spectrum of Fig. 2.1. No changes have been made in channel sensitivity or in the settings of the spectrum analyzer. Several important observations can be drawn from comparing the two spectra:

<u>Observation 1</u>. There is little change in the signal content below 1 kHz. Therefore, 1 kHz is a good candidate for a low frequency cutoff value.

<u>Observation 2</u>. Using a standard peak threshold in the bandwidth 4-20 kHz would not easily allow for detection of the impact signal (the peak at 10 kHz for the backgroud is about the same as the peak for the impact signal).

Observation 3. Over the frequency range 1-20 kHz, detection can be unequivocally made if one uses a measure of the total energy of the signal. This could be done by performing RMS conversion of the analog signal.

The main feature of the TEC LPM system is based on an extension of Observation 3. Not only does RMS conversion improve signal recognition, but it can actually optimize detection sensitivity. The TEC 1432 Impact Detector Module subtracts the long-term averaged RMS value from the short-term averaged RMS value. The difference is then compared to the long term value as a "floating threshold", permitting optimum detection in the presence of changing background noise.

2.2 Optional Components of Analog Systems

2.2.1 Loose Parts Locator (optional)

The TEC Model 1435 Loose Parts Locator is a module containing a microprocessor, which provides on a paper tape printer the history, in milliseconds, of the sequence of channel alerts and the real time of the initial alarm (A). Whenever no channel alerts for a front-panel selected time interval, the 1435 resets itself.

2.2.2 Optional Impacting Calibrators

An optional calibration procedure requires the installation of remotely-controlled impacting calibrators. These units can be calibrated against a standard drop-weight test in the laboratory. After installation, calibration can be performed not only during cold shutdown, but also during power operation. TEC can provide one "Impact Calibrator" for each LPM sensor. The Impact Calibrators have been successfully used for several years within

containment of a BWR nuclear powerplant. A TEC power and control unit is used to manually activate the calibrators. These devices are ideal for performing the NRC-required channel operability tests. We quote these devices as options.

2.3 Warranty

TEC guarantees the performance of the system for a period of six months following delivery. TEC will not be responsible for consequential damages or for any costs of dismantling or reassembly necessary to obtain access to the equipment.

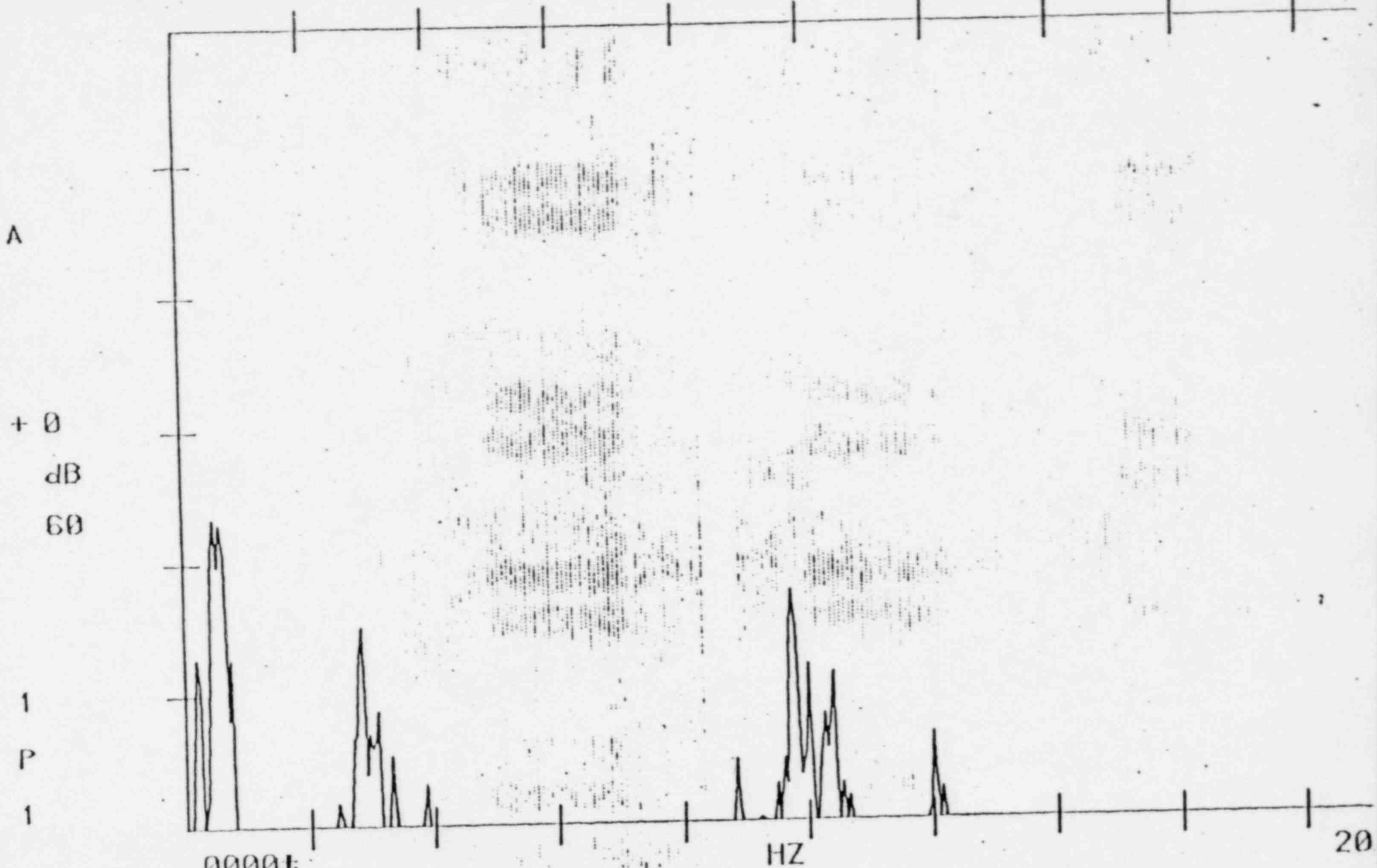

Figure 2.1- Frequency Spectrum of Background Noise on a mainsteam line of an 1100 MW BWR Plant.

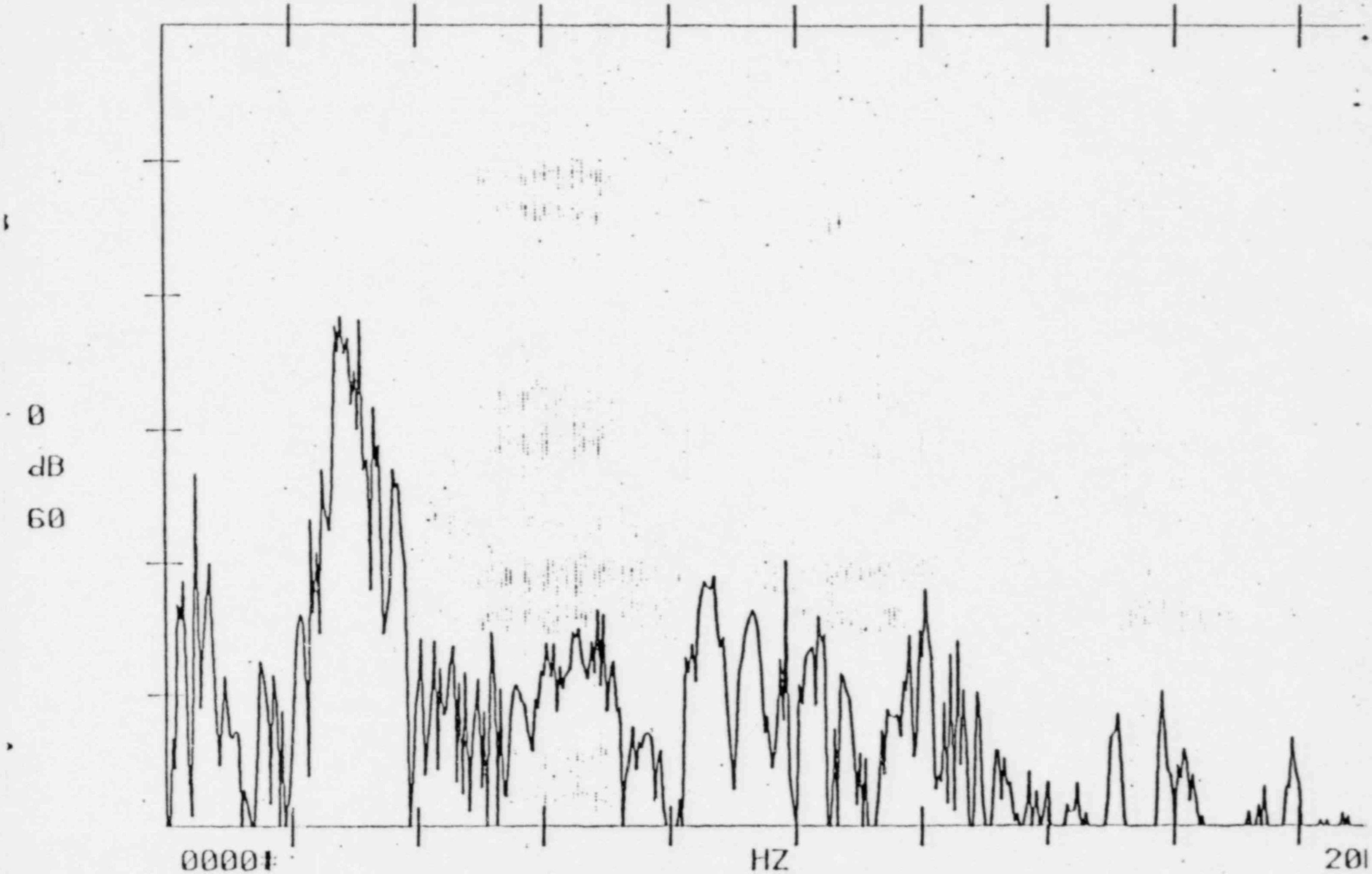

Figure 2.2- Transient-Captured Spectrum of Metal-to-Metal Impact signal seconds after the time corresponding to the Spectrum of Fip¨re 2.1

3. TRAINING AND TECHNICAL SERVICES

3.1 Included in Bid Price

The following TEC services will be provided on a time and expenses basis:

a) Guidance and inspection of the installation of accelerometers and instrumentation. Verification that such installations and their calibrations are in accordance with the TEC requirements for conformance to the Regulatory Guide 1.133. Technical guidance for start-up and acceptance testing of the VLPM systems (approximately four days at site).

b) Training relating to the theory of operation, maintenance, calibration, etc., as necessary to reasonably prepare for the implementation of the "Loose Part Detection Program", which TEC will provide the buyer. (Outline of training course given below.)

c) Training relating to vibration monitoring (included in course outline below).

Training Course

The following outline represents material which can be adequately covered in a 20-hour course. The course is to be conducted in three full days.

1. History of LPM in U. S. Reactors
   - 1.1 Opinions of NRC and ACRS
   - 1.2 Present Status of the Technology

1.3 ORNL Recommendations for Achieving Improved Performance

1.4 Introduction to Regulatory Guide 1.133

2. Methods of Impact Detection

2.1 Definition of Impact Energy

2.2 Wave Propagation and Attenuation

2.3 Detection of Impact Signal by Mounted Accelerometers

2.4 Typical BWR Plant Noise

2.5 Methods of Detecting Impact Signals in the Presence of Varying Background Noise

3. Formulation of a Loose Part Detection Program

3.1 Compliance with NRC Reg. Guide 1.133

3.2 Optimizing Benefits to Plant

3.2.1 LPM as a Surveillance and Diagnostic Tool

3.2.2 Relationship to Plant Availability

4. The TEC LPM System

4.1 General Description

4.1.1 Sensors, Cables and Charge Converters

4.1.2 Modules and Controls

4.2 Theory of Operation

4.2.1 Impact Detection

4.2.2 Alarm Logic

4.2.3 Functional Description

4.3 Operating Procedures

4.3.1 Installation

4.3.2 Calibration Procedure

4.3.3 System Initialization

4.3.3.1 Startup Mode

4.3.3.2 Power Operation Mode

4.3.4 Performance Checks

4.3.5 Response to Loose Part Alarm

4.3.6 Evaluation of Loose Part Data

5. Vibration Monitoring Program

5.1 Theory of Operation

5.2 Operating Procedures

3.2 "On-Call" Maintenance Package

For a period of one year starting at the successful completion of the acceptance tests, TEC will provide an "on-call" maintenance package consisting of the following:

1. 24-hour response to request for service.
2. travel expenses to be billed at cost.
3. field engineering labor to be charged at TEC labor rates, including travel time.
4. parts to be charged at price listed in priced parts lists.
5. no charge for labor or parts if warranty applies.

4. SCHEDULE OF PERFORMANCE

Following this page is Buyer's Attachment 1 "Schedule" which has been completed by TEC (Bidder).

SCHEDULE

ırchaser	Long Island Lighting Company	Date 1/9/80
roject	Shoreham Nuclear Power Station - Unit 1	J.O. No. 11600.02
pec. Title	Loose Parts Monitoring System - SH1-461	WO80-48923
pec. Date	August 29, 1979	

n the premise that:

1. The Purchase Order will be mailed not later than February 14, 1980.
2. When drawings or documents are submitted to the Engineers for approval, they will be mailed within 21 business days after the receipt of the drawings or documents.

he Seller, by accepting the purchase order, shall agree as follows:

1. To mail, ship, or complete as committed below.
2. As a prerequisite for payment, to submit a copy of this schedule with each invoice, showing by the entries in Column C that all mailings, shipments, or completions due as of the date of the invoice have been made.

	Column A Committed Mailing, Shipping, or Completion Date	Column B Estimated Transit Time to Boston Jobsite or Fabricator*	Column C Actual Mailing, Shipping, or Completion Date #
Equipment Outline & Wiring Drawings	March 18, 1980	Mar 18 1980	
Spare Part Lists	April 31, 1980	Apr 31 1980	
Installation Instructions	July 11, 1980	July 11 1980	
Documentation for Approval	April 31, 1980	April 31 1980	
Shipment of Equipment	August 8, 1980	Aug 8, 1980	

Seller to provide installation and start-up support within two weeks of notification by purchaser.

To be filled in by the Seller for submittal with his invoice. Mailing, shipping, or completion of all items due by the date of the invoice is prerequisite for payment of the invoice.

* To be filled in by Bidder.

5. LPM DIGITAL-CONTROLLED CAPABILITY

The TEC LPM system described in Section 2 contains the interface points for upgrading the basic LPM to a fully computer-controlled LPM.

5.1 Microprocessor, Floppy Disk and CRT Display

Many desirable features of a Loose Parts Monitoring System are optimized by using digital data acquisition, processing, analysis and storage. These features include: first events capture, direct measurement of event characteristics, large dynamic range, capability of real-time trend analysis, instant access to selected data, and simplicity of data storage. TEC's LPM System reads the outputs of the impact detectors into a microprocessor, stores recent information in circular memory, and subsequently enters it onto a floppy diskette.

All data records (time, number of events, peak amplitudes, rms levels, etc.) are stored on a floppy diskette that can be periodically removed, filed and replaced with a new diskette. This procedure takes about one minute. Under normal conditions (no loose parts), the diskette would require replacement about every three months. By using this simple and inexpensive method, a permanent history of the plant's LPM program is maintained in a compact form. A visual display of the recorded data for each channel is obtained by entering the channel number and activity number of interest on the keyboard. The information is automatically displayed on the CRT.

5.2 Deliberate Plant Manuever Monitor (TEC Model 1434)

The Deliberate Plant Manuever Monitor (DPMM) is an advanced version of the DPMD described in Section 2.1.6. Whereas the DPMD only detects that some manuever has occured, the DPMM provides for individual recognition of 16

deliberate plant manuevers (DPM). If a larger number of DPMs is to be considered, any number of single DPM signals can be ganged into one channel of the DPMM. It is important to realized that all system measurement capabilities can be active during a DPM, but the alarm is disabled. This means that the acoustic signals associated with these normal menuevers can be measured and their main characteristics can be ganged into one channel of the DPMM. For certain selected logged on disk. Everytime a DPM occurs, the microprocessor routes the following data set to temporary memory and to disk:

1. the date and time of the DPM
2. the type of DPM (1 thru 16)
3. the channel(s) affected,
4. the short-term rms peak for the channel(s),
5. the most recent value of the long-term rms for the channel(s).

Since the most acoustic characterization of many routine manuevers becomes permanently stored on disk, this data can be used to check that certain manuevers are occurring without abnormal behavior. (This becomes very helpful when, in fact, the presence of a loose part is confirmed.) Certain DPMs can be used for "channel checks" (NRC Reg. Guide 1.133: "... the qualitative assessment of channel behavior during operation, including, where possible, comparison of the channel indication or status with other indications or status derived from independent instrument channels measuring the same parameter). An example of a channel check is: During stepping of control rods (DPM type), check that the number of events for each of certain channels is greater than some predetermined value. It is possible for some DPMs to be used for "channel functional tests" (NRC: "... the injection of a simulated signal into the

channel as close to the primary sensor as practicable to verify operability including alarm functions"). Any DPM causing a disturbance which satisfies the alarm criteria (as defined below) can be routinely and automatically used as a channel(s) functional test(s).

The DPM is addressable from the keyboard. Any number of the 16 alarm inhibit commands can be activated or disabled manually in a few seconds. This is convenient for adjusting the system's behavior during early use (learning mode with respect to DPM-induced signals).

5.3 Software

The software which will be provided with the digital LPM system controls the data acquisition, recognizes the alarm criteria and assists in the diagnostics. Here, we give some examples of the available data displays.

5.3.1 Automatic Regular Scan

The system samples the long-term rms values for all channels. For each channel, the hourly average is computed and stored in memory. (Whenever a coded DPM occurs, values at that time are not entered into the computation of the average of the long-term rms). For each channel, the microprocessor's circular memory holds, for display upon request, the last 168 hours of record (one week) as well as the last 60 minutes of record (one hour).

5.3.2 Alert - Triggered Scan

Whenever the short-term rms value of any channel exceeds the detect level, the following information is stored in temporary memory and on disk:

1. the date and time of the alert
2. the channel of the alert

3. the short-term rms peak for that channel

4. the most recent value of the long-term rms for that channel.

The last ten Alert Scan data sets are instantly available upon keyboard address. All data sets are available from disk.

5.4 Impact Calibrators

TEC recommends the use of TEC's optional software-controlled impact calibrators. These high-temperature solenoid-activated devices will automatically perform channel checks every 24 hours, in accordance with Regulatory Guide 1.133.

5.5 Special Diagnostics

TEC's special diagnostic features include an advanced locator.

Computation of the probable location of an impact is based on both the arrival sequence at the affected sensors and relative amplitude analysis. The TEC Locator Software will compute the location of each impact relative to the first sensor activated. It uses the data from the activity scans to compute the impact site. If only two sensors are activated, an approximate location is assigned along the line (on the vessel's surface) connecting the two sensors' locations. However, not all impacts can be located, even approximately, because of the complex acoustic paths along the reactor internals. TEC's software can recognize when the data is ambiguous.

For each impact, which is assigned a location, an estimated impact energy can be obtained. This is possible because once the impact site relative to the first-hit sensor is known, the sensor's corresponding (rms)max value is related to the impact energy. When the locations and corresponding estimates of impact

energies for many impacts have been obtained, averaging the impact energy values, for impacts in certain regions of known flow velocities, permits estimates of the size of the loose part. Note: It is very important to understand that without the capability of loose parts location, estimates of size or mass cannot be properly made. Furthermore, without data from multiple impacts of clearly the same loose part, statistical averaging techniques cannot be used, and any size estimates would be unreliable. It is for this reason that the assessment of safety implications for a loose part which impacts many times is often easier than for the case of a loose part which impacts a few times and is never heard from again.

5.6 Identification of a Loose Part

The procedure of identifying or characterizing a loose part depends on the features of the system. First, in order to confirm that the detected impact noises were caused by a "loose part" (detached and drifting) it is best to be able to observe that the impacts are not all occurring at the same place. Sometimes, one can infer this from the audio output. However, if a loose part locator is being used, it first serves the fundamental need of being able to recognize that the impacts are produced by a "loose-part."

Second, ability to estimate where the part began its journey often helps in reducing the number of possible identities. In the general system, the "first-hit indication" helps in estimating where the part comes from.

5.6.1 Assessment of Severity. Once the presence of a loose part has been confirmed, there are two sources of data for use in the process of assessing the severity of impacting, with respect to safety implications. One source is the LPM system records and diagnostics, the other is supplemental plant data,

including closer scrutiny of certain process or control signals. Here, we address only the former source of data. The procedures for the latter source are as varied as the possible types of loose parts. The Regulatory Guide, 1.133, points out some of the potential degradations of reactor safety associated or caused by loose part(s). If any of these are highly suspected because of interpretation of the loose part data, then specific scrutiny of plant data can be performed, until the suspicions are affirmed or abandoned. (One motivation for having comprehensive LPM data is to be able to methodically and quickly proceed with preparation of the follow-up report which the NRC requires within two weeks of the initial notification of a loose part.)

Types of Safety-Related Loose Parts: (paraphrasing NRC)

1. "A loose part can be indicative of failure or weakening of a safety-related component"

   Relevant Questions by TEC: Is the part truly loose and drifting? Where did it come from? Is it big or small?

2. "A loose part can contribute to component damages and material wear by frequent impacting"

   Relevant Questions by TEC: How often does it impact? Where does it impact? What are its impact energies at the various points of impact?

3. "A loose part can cause partial flow blockage"

   Relevant Questions by TEC: Has the part become lodged? Where was it last detected? (The answers to these questions are useless unless they are obtained very quickly.)

4. "A loose part increase the potential for control-rod jamming and for generation of increased levels of radioactive crud" Relevant Questions by TEC: Where is it impacting? How often? What is its probable size?

The TEC digital LPM system provides quick answers to all of the above questions. In fact, we posed these "relevant questions" and designed the TEC system to give the answers. Furthermore, TEC's system is designed to require only very simple and standardized operator interaction to acquire and utilize the LPM data.

EXHIBIT 3

Long Island Lighting Company's Response to NRC Inspection No. 82-02, dated March 11, 1982

MAR. 1 9 1982

LILCO

LONG ISLAND LIGHTING COMPANY

175 EAST OLD COUNTRY ROAD · HICKSVILLE, NEW YORK 11801

MILLARD S. POLLOCK
VICE PRESIDENT-NUCLEAR

SNRC-677

March 11, 1982

Mr. Richard W. Starostecki, Director
Division of Resident and Project Inspection
U. S. Nuclear Regulatory Commission, Region I
631 Park Avenue
King of Prussia, PA 19406

NRC Inspection No. 82-02
Shoreham Nuclear Power Station, Unit No. 1
Docket No. 50-322

Dear Mr. Starostecki:

This letter responds to your letter of February 2, 1982, which forwarded the report of the routine inspection of activities authorized by NRC License CPPR-95, conducted by Mr. Higgins of your office on January 1-31, 1982. Your letter stated that it appeared that one of our activities was not conducted in full compliance with NRC requirements, and that one other activity appeared to be a deviation from FSAR commitments. Our response to the apparent non-compliance was provided in our letter SNRC-674. The deviation and our response follow:

APPARENT DEVIATION FROM COMMITMENT MADE
IN THE SHOREHAM FSAR, PARAGRAPH 4.4.6
THAT THE LOOSE PARTS MONITORING SYSTEM
MEETS THE REQUIREMENTS OF REGULATORY GUIDE 1.133

1. Regulatory Guide 1.133, Paragraph C.1.c specifies that instrument channels be physically separated where inaccessible during full power operation.

   Contrary to that requirement, as of January 13, 1982, instrument cables for different channels were not physically separated inside the drywell (which is inaccessible during full power operation) in that they were run in the same conduits and they utilized the same electrical penetration.

2. Regulatory Guide 1.133, Paragraph C.1.d specifies that an audible or visual alarm should alert control room personnel when the alert level is reached.

2. Cont'd.

Contrary to that requirement by system design, as of January 13, 1982, there was no alarm or annunciator from the loose parts monitoring panel to audibly or visually alert control room personnel that the alert level had been reached.

CORRECTIVE ACTION AND RESULTS

1. The loose parts monitoring system is not, nor is it required to be, a safety-related system. As such, Class IE criteria do not apply to the design and installation of this system. Regulatory Guide 1.133, Paragraph C.1.c, however, does recommend physical separation of the two sensors at each natural collection region from the sensor itself to a point in the plant that is always accessible for maintenance during full power operation. It should be noted that, as the purpose of having two sensors is to provide "broad coverage" of the collection region, these two sensors are not redundant.

   The functional reason for separation is not explicit in the regulatory guide; however, it is stated that "it is desirable that the loose part detection system be designed to function following all seismic events that do not require plant shutdown." It is our interpretation, therefore, that the purpose of separation for this system is to protect non-accessible components of at least one of the two channels serving the same natural collection region from mechanical damage precipitated by an operating basis earthquake. In this regard we state the following:

   a. The loose parts monitoring system is designed in accordance with R.G. 1.133 to operate to Operating Basis Earthquake (OBE) criteria. As such, the existing cabling in primary containment, which is installed to Design Basis Earthquake (DBE) levels plus Mark II hydrodynamic load criteria, is qualified significantly beyond the qualification of the loose parts monitoring system.

   b. Although the existing cables are in the same penetration, the penetration is qualified to safety grade standards and exceeds loose parts monitoring system requirements.

   c. Within the biological shield, separation is maintained up to a common junction box located at the biological shield penetration. From this junction box a common cable is run through conduit and trays to the primary

c. Cont'd.

containment penetration, all of which are designed and supported to withstand DBE. The conduit and cable tray provide mechanical protection to the cabling within the primary containment. Structures and equipment within the primary containment are also designed and installed to DBE levels plus Mark II hydrodynamic load criteria; therefore, any seismic event of sufficient magnitude to damage common channel cables or the penetration would exceed the design basis of the loose parts monitoring system as recommended by Regulatory Guide 1.133.

Although we do not believe separation for fire protection is intended by the regulatory guide, we further note that Shoreham's inerted containment will prevent the outbreak of fire. Also, the cable will carry only low energy signals (50Vmax AC and DC), for which the voltage and current handling capacity of the safety grade cabling will far exceed even the short circuit output of the loose parts monitoring system electronics.

Therefore, we believe that the intent, as well as the functional requirements, of Regulatory Guide 1.133 were met by the current design and installation, although the literal interpretation was not. Paragraph 4.4.6 of the Shoreham FSAR will be revised to explicitly state the above interpretation.

2. Visual indication of a loose part "alert" is provided at the loose parts monitoring panel at the main control room; however, the lack of spare annunciator windows at the main control board resulted in an alarm not being provided. Both an audible and an external visual alarm will be added at the loose parts monitoring system panel in the main control room to alert control room personnel that an alert level has been reached or exceeded. In addition, this alarm will be designed to remain functional following an OBE event as recommended by Paragraph C.1.g.

STEPS TAKEN TO PREVENT RECURRENCE

As stated above, we believe both the intent and the functional requirements of Regulatory Guide 1.133 were achieved without incorporation of electrical separation as recommended by the Regulatory Guide, therefore we feel no corrective action is required. Regarding the loose parts alert signal, the audible and visual signals as described above will be added to the loose parts monitoring panel.

With respect to the implementation of corrective actions associated with overall management control systems as they apply to the FSAR, in a meeting held on November 12, 1981 with the Resident Inspector, Region I Management, NRC Licensing Project Management, Stone & Webster Engineering Corporation, and LILCO Management, a number of similar inspection item findings were discussed both separately and in light of how they related to the overall question of FSAR conformance. As a result of an extensive evaluation performed by our Architect Engineer, it has been our conclusion that there have been no significant or generic differences between the licensing and design documents, that would warrant substantive changes to the in-place FSAR control mechanisms. As documented in Inspection Report 81-20, the NRC in general agreed with that conclusion, but nevertheless believed that the number of discrepancies between the as-built plant and the licensing document required an additional LILCO review to compare the as-built plant to the FSAR.

As a result of this meeting, we have initiated a formal Shoreham Configuration Review Program which involves a documented detailed comparison of the as-constructed configuration of major plant safety systems to the applicable FSAR descriptions. This review compares the systems to the FSAR, formally documents any discrepancies found, and initiates corrective actions/dispositions, as appropriate. We feel confident that the existing FSAR update and control mechanisms, coupled with the FSAR configuration review program will provide adequate and effective management controls to assure that FSAR conformance is maintained.

DATE WHEN FULL COMPLIANCE WILL BE ACHIEVED

With respect to the loose parts monitoring audible and visual signals, full compliance will be achieved by June 30, 1982. With respect to the Shoreham Configuration Review Program, we anticipate completion by fuel load.

Very truly yours,

M. S. Pollock

M. S. Pollock
Vice President-Nuclear

STATE OF NEW YORK)
: ss.:
COUNTY OF NASSAU)

MILLARD S. POLLOCK, being duly sworn, deposes and says that I am a Vice President of Long Island Lighting Company, the owner of the facility described in the caption above. I have read the Notice of Deviation attached to NRC Inspection Report 82-02 and also the response thereto prepared under my direction dated March 11, 1982. The facts set forth in said response are based upon reports and information provided to me by the employees, agents, and representatives of Long Island Lighting Company responsible for the activities described in said Notice of Violation and in said response. I believe the facts set forth in said response are true.

Millard S. Pollock

MILLARD S. POLLOCK

Sworn to before me this
11th day of March, 1982.

Rosa Lee Oliveira

[illegible]
Notary Public, State of New York
No. [illegible]
Qualified in [illegible] County
Commission expires Mar. 30, 19 84

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

PREPARED DIRECT TESTIMONY OF MARC W. GOLDSMITH, SUSAN J. HARWOOD, RICHARD B. HUBBARD AND GREGORY C. MINOR ON BEHALF OF SUFFOLK COUNTY AND THE SHOREHAM OPPONENTS COALITION

REGARDING

CONTENTION 7B

April 13, 1982