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EISENHUT,D.G. Division of Licensing

SUBJECT: Forwards processed marine seismic reflection lines.Lines developed from data collected during Jul 1981 seismic reflection survey.

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P.O. BOX 529100 MIAMI, FL 33152

FLORIDA POWER & LIGHT COMPANY

April 9, 1982
L-82-143

Mr. D. G. Eisenhut
Director of Licensing
Division of Licensing
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Eisenhut:

Re: St. Lucie Unit No. 2
Docket No. 50-389
Processed Marine Seismic Reflection Lines

Attached please find one set of processed marine seismic reflection lines. These lines have been developed from the data collected during a seismic reflection survey performed in July 1981.

The data has been processed in response to NRC staff concerns noted in the St. Lucie Unit 2 SER Section 2.5.3.

Also attached you will find technical information and back up documentation that will assist the staff in interpreting the processed marine seismic reflection lines.

Very truly yours,

J A De Mastry for

Robert E. Uhrig
Vice President
Advanced Systems and Technology

REU/RAK/ga

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Attachments

cc: Mr. James P. O'Reilly, Region II
Harold F. Reis, Esquire

Background and Technical Information Related to the 1981-82 Marine Seismic Study at St. Lucie Unit 2

In July 1981, a seismic reflection survey was performed on the Intracoastal Waterway and the Atlantic Ocean adjacent to Hutchinson Island and south of the Florida Power and Light Company St. Lucie Nuclear Power Plant. The purpose of the survey was to determine the existence of a fault postulated by Mr. John Armstrong in a masters thesis at Florida State University. The field survey, consisting of 10 east-west lines and 2 north-south lines, was performed by Weston Geophysical under the direction of Law Engineering personnel. The data was acquired using a 1 cubic inch airgun and a multi-element, single-channel hydrophone array. The data was recorded with an EPC electrostatic printer. In addition, eight of the twelve lines and a portion of the ninth, were recorded on magnetic tape before the tape drive malfunctioned.

The seismic reflection lines were correlated with available well logs and an earlier seismic reflection survey performed for the St. Lucie Project in 1974. The time profiles from the reflection data were interpreted and converted into depth profiles using a velocity function calculated from correlations with well logs. No faulting was observed on the reflection lines.

After presentation of the reflection profiles to the Nuclear Regulatory Commission (NRC), the NRC staff raised questions related to the quality of the data. Due to shallow water bottom and the airgun energy source, the NRC felt that the reflection records contained a significant amount of "ringing". The NRC felt that this obscured the reflecting horizons and limited the interpretability of the data.

The outcome of these discussions between EBASCO, FP&L, the NRC and Law Engineering was a decision to process the reflection data.

Processing

The processing sequence was outlined in a meeting with the NRC on November 9, 1981 as follows:

(1) Convert data from analog to digital.

(2) Fathometer records will be used to assist in designing a deconvolution filter for removing resonance or "ringing" in the reflection data.

(3) Auto-correlation will be performed on traces at intervals of approximately 150 traces. This operation should reveal the presence and period of multiples and of resonance.

(4) Using information from (1) and (2), a deconvolution operator, which can vary over the length of the profile, will be designed and used to remove the resonance and and multiples present.

(5) A frequency analysis of the deconvolved traces at intervals of approximately 150 traces will be performed to determine if the reflection profiles can be improved through selective filtering.

(6) Prints of the deconvolved and filtered seismic reflection sections will then be furnished.

It was determined after a review of the fathometer records that there was not enough variation in water depths to require static corrections or to use the fathometer records in filter design. Auto-correlation was performed only on selected traces from Line 4 and the selected deconvolution operator was then used for processing all the seismic reflection lines. Also, the frequency analysis was performed only on portions of Line 4.1.

Analog/Digital Conversion (Weston Geophysical)

The first step in processing the data was to convert the analog data recorded on magnetic tape in the field to digital format stored on magnetic tape in a Society of Exploration Geophysicists "Y" format, a standardized data storage system. Weston Geophysical first developed a test tape and submitted it to Evergreen Geophysical Associates (the consultant contracted to process the data) to check for compatibility with their system. After the format compatibility was determined to be acceptable, Weston performed the conversion on all nine lines.

In the field, a key pulse in the reflection system triggers the airgun causing it to fire at 1-second intervals. The key pulse, which is recorded on tape, also triggers the recording system, which records signals from the hydrophone array for 0.5 seconds after triggering. The operator records position mark numbers on a voice track for navigation purposes. Using the voice track and a stopwatch, Weston Geophysical was able to determine the number of traces on each line and correlate trace numbers to the position mark numbers. The key pulse was used to trigger the digitizing of each trace.

The digitizing interval was set at 0.25 milliseconds so that the analog data would be faithfully reproduced in digital form. An oscillator in the computer system was used to measure the digitizing interval. The oscillator was set to a frequency of 4096 cycles/second, thus 2048 samples would be taken for each 0.5 seconds of recorded data. This gives a digitizing interval of 0.244 milliseconds instead of 0.250 milliseconds. This was determined to be acceptable.

At each interval, the analog/digital converter read the voltage recorded on the analog tape and transformed it to a 12-bit binary number. The voltage number was ±2.5 volts and the numerical range was ±2048. The converted data was then stored in the proper format.

Processing (Evergreen Geophysical)

Line 4 was the first seismic reflection line to be received by Evergreen Geophysical and was the test line used to determine the processing sequence and procedures.

As a first step, the data was edited to remove traces that contained no signal or excessive noise. This was followed by scaling to compensate for the fact that less energy is reflected from deeper horizons. The decrease in reflected energy is due to spherical spreading of source energy from the source location and to the reflection of energy upward from shallower horizons. The scaling is performed by moving an averaging window with a length of 125 milliseconds over the 500-millisecond record length. Digitized amplitudes within the averaging window are normalized with the median amplitude given an arbitrary value.

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[illegible]

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After scaling, the data was mixed to remove the effects of editing out bad traces and to enhance coherent signals. The mixing was performed on every trace by adding 40 percent of the previous trace, 50 percent of the current trace and 40 percent of the following trace. Since at average boat speeds, a trace was recorded approximately every 3 feet, this process decreases the horizontal resolution from 3 feet to about 9 feet. This does not have a significant effect on the resolution of the survey.

Deconvolution testing was performed to determine the operator best able to remove the "ringing" from the recorded data. As a first step, a few traces from Line 4 were selected and their auto-correlation functions and amplitude spectra were calculated. The auto-correlation function provides a measure of the repetitiveness of a signal and the amplitude spectra shows the frequency content of the signal's energy. As could be expected from the "ringing", there was a significant amount of repetitiveness in the traces. The energy was spread fairly evenly over the recording frequency bandwidth although there was a slight decrease at higher frequencies.

A spiking operator with a length of 25 milliseconds was chosen and tested on the sample traces at various white noise levels. A spiking operator is a type of digital filter which, when applied to a signal, decreases the time length of the signal with optimum conditions, the signal is transformed to a single short spike. The white noise levels are changed to find the optimum level for flattening the amplitude spectrum within the recording bandwidth. A predictive deconvolution

operator with a 25-millisecond length was also tested. After the operators were applied to the test traces, the auto-correlation functions and amplitude spectra were recalculated and it was determined that the 25-millisecond spiking operator with a 5 percent white noise level was the most effective at removing the "ringing", and was used in processing the other lines.

The final procedure was testing Line 4 with various frequency filters to determine their effects on the data. It was determined that frequency filtering would have no beneficial effect on the data.

The sequence of processing for the remainder of the lines was as follows:

1. Editing
2. Scaling
3. Mixing
4. Deconvolution

The processed lines were then printed at a horizontal scale of 50 traces/inch and a vertical scale of 0.025 seconds/inch.

Preliminary Review of the Processed Data

A preliminary review of the processed reflection profiles indicated that there were no significant changes between the interpretation of the processed data and Law's previous interpretation of the unprocessed data. There is no faulting evident on the profiles and the approximate position of the reflecting horizons remained the same. There appears to have been some shift in the depth of the horizons, which will require interpretation and redrafting of the depth sections.

During the preliminary review of the processed reflection lines two features on Line 3 between position marks 41 and 43, were noted. One feature is a buried channel just below water

bottom between position marks 39 and 41 which has obscured the reflecting horizon below. In addition, between marks 41 and 43, there exists a trough in the reflectors below 0.20 seconds which becomes more pronounced with increasing time (depth). There is no causal relationship between the obscured reflectors and the trough.

The trough occurs at the base of a monoclinal fold and may be related to the fold. However the increase of the slope of the trough with increasing time (depth) and its constant width indicates that it may be a result of either multiples or a velocity anomaly in the upper sediments (Hawthorne Formation). When migrated, the trough broadens and the slopes become less steep. Also, the vertical exaggeration of the reflection profile is approximately 8:1, which makes the slopes appear much steeper than is actually the case. Law Engineering has stated that, based on their analysis, they do not believe that the trough feature is related to faulting.

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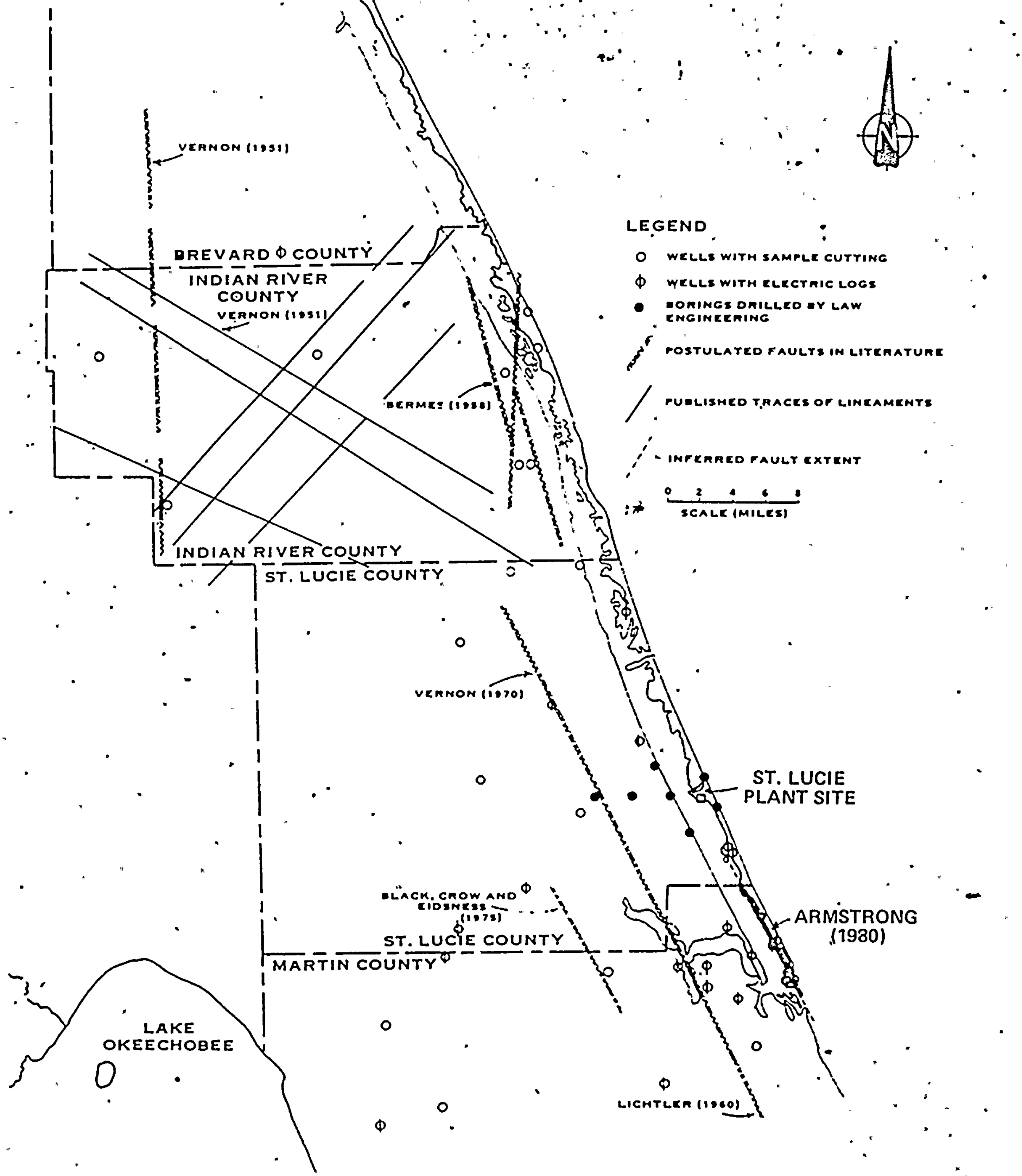

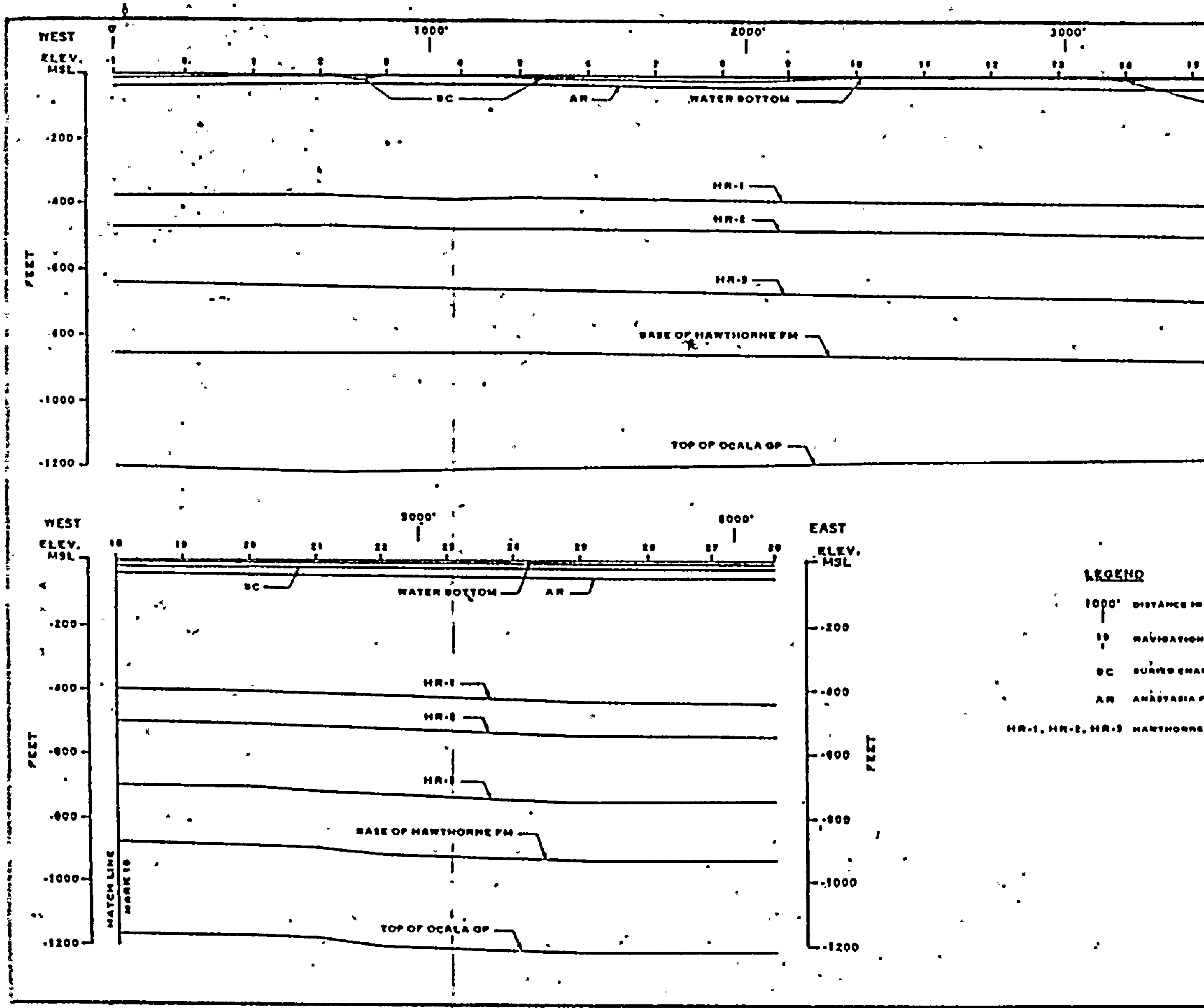

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SEISMIC PROFILE - LINE 4, AIRGUN ENERGY SOURCE

FIGURE 2.5-42dd