HMM Associates
336 Baker Avenue
Concord, Massachusetts 01742
(617) 371 1692

May 10, 1985

Nuclear Regulatory Commission, Region 1
Nuclear Materials Section B
631 Park Avenue
King of Prussia, PA 19406

Attn: Dr. John Glenn, Chief

Dear Dr. Glenn:

This is in reference to license #20 20795-01 which was issued to HMM Associates on April 18, 1985. The issuance of this license was contingent upon several items including HMM's commitment to monitor drums for contamination prior to shipment to a burial facility. The monitoring equipment must be capable of detecting tritium.

In a letter to you dated March 14, 1985, we indicated that, upon granting of the license, HMM would purchase a Berthold LB6255/LB1210B tritium surface contamination monitor in order to satisfy the monitoring requirement. Since that time, we have learned of another suitable piece of equipment which would also offer us several operational advantages over the Berthold. The Whitlock Tritium Meter, a plastic scintillation detector, is somewhat more sophisticated than the Berthold and offers these major advantages:

1. Switched energy discriminators allow the ability to distinguish between lower and higher energy isotopes (tritium and Carbon-14 for example).

2. Switched 1, 10, or 100 second pre-set counting intervals. This allows the counting of lower activity samples for a longer period of time thereby reducing the likelihood of false negative counting results due to statistical variation in the background count rate.

3. No gas supply lines or wires to complicate the use of the instrument.

4. Digital display of counts for the pre-set counting interval.

HMM Associates has contacted George Washington University and Stanford University (both facilities have purchased the Whitlock for use in their Radiation Study Programs) concerning the adequacy and reliability of the Whitlock meter for smear test counting and direct surface counting. Radiation Safety Officers at both facilities have expressed satisfaction with the instrument and its performance.

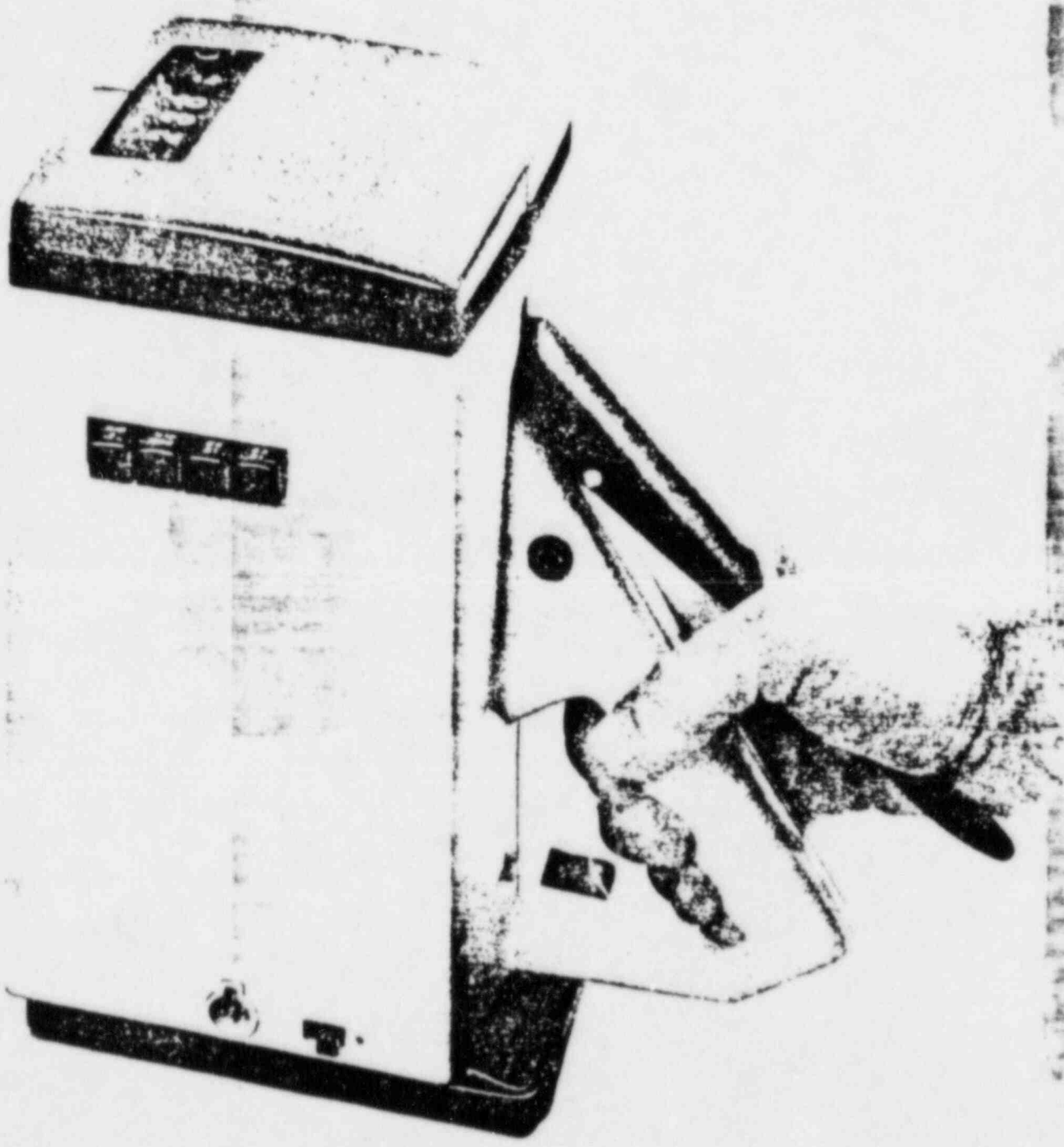
Because of the advantages indicated above, we intend to purchase a Whitlock Tritium Meter for surface contamination monitoring. Literature on this instrument is enclosed for your information.

Very truly yours,

Robert J. Merlino

RJM:cs

OVERHOFF & ASSOCIATES, INC.
P.O. BOX 8091
CINCINNATI, OHIO 45208



WHITLOCK TRITIUM METER

THE WHITLOCK TRI[illegible]M METER FOR RADIOLOGICAL PROT[illegible]TION

MEASURES

[illegible] controlled conditions [illegible]
by the operator or his peers
Tritium surface contamination of 10^{-4} μCi/cm² /cm² in [illegible]
Other radio isotopes, e.g. ^{14}C, ^{35}S, ^{32}P at 10^{-4} μCi/cm² [illegible]
Smears of walls, floors, ceilings or glassware
in the laboratory
or on site
Planchets
Paper and activated charcoal air filter [illegible]
Potentially volatile tritium fractions

FEATURES

Large area detector of 100cm² [illegible]
Digital display of count
Pushbutton discriminators [illegible]
Pushbutton selection of 1 second [illegible]
Portable
Easily decontaminated
Rechargeable batteries
Unaffected by scintillation fluorescence or [illegible]
No wires or gas supply lines
Not affected by dust particles

[illegible]

The instrument is placed on the [illegible] and a half [illegible]
chamber by releasing the lever [illegible] a single action manually operated [illegible]
External light is excluded and light photons generated by nuclear [illegible]
total internal reflection and viewed by two photomultipliers. Coincidence events are discriminated, amplified, counted for a preset time and digitally displayed [illegible] the vacuum and the instrument is moved to a new position on the surface. The measurement cycle is repeated.

Only the disposable vacuum seal is in contact with the surface so that no contamination of the instrument [illegible]

EVALUATED, PROVED AND ACCEPTED BY

[illegible]

International Radiological
Protection Organisations

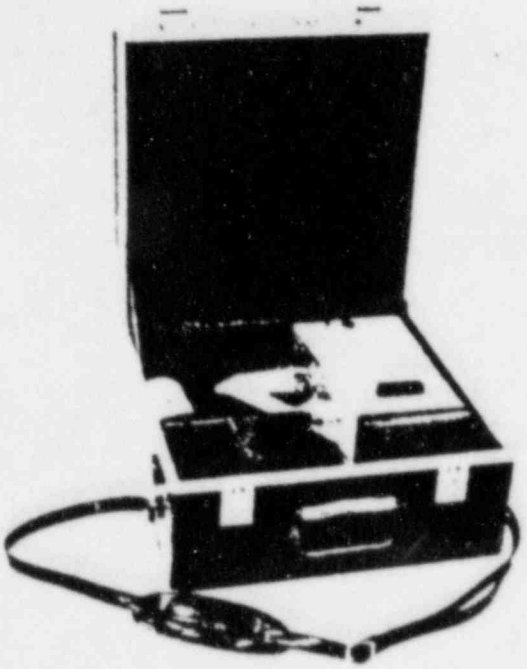
Medical Research

[illegible]

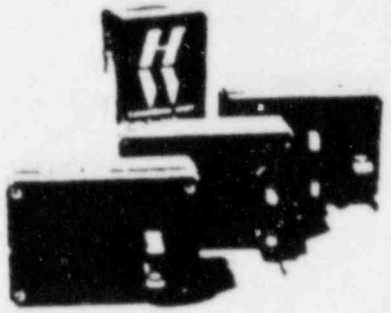
Universities

[illegible]

Luminising Plants

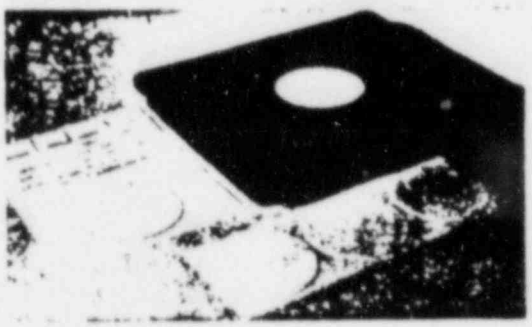


Transit Case embodying advanced principles of packing technology to withstand the rigours of Air Cargo shipment motor vehicle transport and on site handling



Chargers to suit laboratories in world wide locations

Lens Cap with smear test recess Cat. No. 4012



Smears and Record Sheets

SPECIFICATION

SENSITIVITY
10^{-4} μ Ci per cm^2 of TRITIUM. Surface contamination integrated over an area of 100 cm^2 can be measured on a smooth, impervious and opaque working surface. Maximum permissable level (1 MPL) approximately equivalent to 3.7 disintegrations sec cm^2, 222 DPM/cm^2)

DISPLAY SCALER
4 Decades digital display with 8 mm high easily read numerals. Leading zeros suppressed.

FUNCTION
1. Numerical display of counts accumulated in the selected measurement time. Displayed for a further 3 seconds after the end of measurement time.
2. Display of MINUS SIGNS—1 scaler overflows or the measurement is erroneous or loss of vacuum and H.V.
3. Flashing display of MINUS SIGNS = batteries need recharging.
4. Decimal points flashing when instrument switched "ON". Continuously illuminated at end of Experiment.

SWITCH MODEL 4000
POSITION
1. Charge batteries. Instrument switched OFF.
2. "ON" 1 sec count automatic.
3. "ON" 10 secs count automatic.

SWITCH MODEL 5000
POSITION
1. Charge batteries. Instrument switched OFF.
2. "ON".

PUSH BUTTON
Count recall. Display contents of scaler for as long as button depressed and for 3 secs after release.

RESET/START
Automatic operations of squeeze and release of vacuum lever.

SAFEGUARDS
1. Automatically switches off H.V. supply on loss of vacuum.
2. Automatically switches off High voltage when measuring chamber exposed to unacceptable light level for measurement.

POWER SUPPLY
Rechargeable Nickel Cadmium batteries with a duty cycle rating of 5 hours.
Recharge time 24 hours from a fully discharged state.

BATTERY CHARGER type
Suitable for use on 120 240 Volts + 15% – 20% 50-60 Hz supply by switch selection. Using this charger the instrument can be left on charge indefinitely without serious risk of damage. Fitted with plug to suit U.S.A., Europe or U.K. as specified.

DISPOSABLE VACUUM SEAL
Fitted to the base of the instrument before each area survey and disposed of as active waste at the end of the survey.

DIMENSIONS
240 mm High x 136 mm Wide x 126 mm Deep excluding the handle and vacuum lever which extend 96 mm from the front of the case.

WEIGHT
3.2 Kilogrammes (7 lbs approx.)

SERVICE
The design rating of the instrument is 100,000 operations per annum. Should the instrument fail to operate it should be returned to this office in its specially designed transit case. Service during the guarantee period will be carried out free of charge for labour and materials.

ADDITIONAL FEATURES in Model 5000
1. Cat. 4050
   Low level discriminator with switched settings of zero, K e V and 200 K e V nominal.
2. Cat. 4051
   Additional preset experimental time of 100 seconds.

Hughes Whitlock Ltd

MILTON ROAD, MALVERN, WORCS. WR14 3L

INTERNATIONAL RADIOLOGICAL PROTECTION
ASSOCIATION

4TH CONGRESS - PARIS, FRANCE

TRITIUM CONTAMINATION MEASUREMENT - A SIMPLE AND SATISFACTORY METHOD

G. D. Whitlock

Hughes Whitlock Ltd.,
1 Wilton Road, Malvern, England.

1. INTRODUCTION

Tritium surface contamination is difficult to measure because of the very low energy of its pure beta emission (18.6 KeV Max.). In practical terms this means that one has to be able to detect particles with a range of 1.5 mm in air and 2μ in a material of unit density. Furthermore the tritium may be in the form of a thin film or a thick film, containing fluorescent, chemiluminescent, or volatile components. To be satisfactory for radiological protection purposes the measuring instrument should be able to detect all forms. The Whitlock Tritium meter described in this paper has this capability. It also has the ability to measure other more energetic betas, electron capture, X-rays and soft gamma rays.

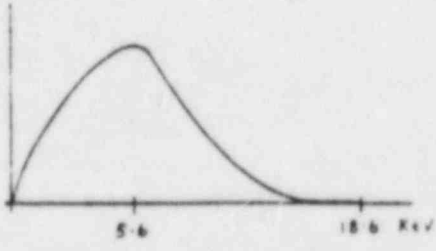
2. DEFINITIONS

2.1 A Thin Source is presumed to be a molecular layer of Tritium contamination evenly distributed over a perfectly smooth surface. 2.2 A Thick Source is similarly distributed and uniformly active but 8μ or greater in thickness.

2.1 A Thin Source

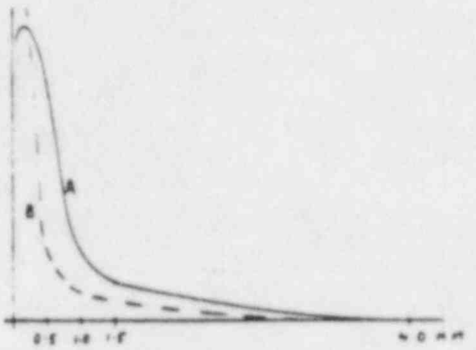
A Thin Source in a vacuum produces a spectrum of emission energy as shown in Fig. 1

Fig. 1



In air the max. range of the max. energy (18.6 KeV) beta is approximately 4 mm. Taking geometry into account, where the mean angle of emission is in the region of 30° to the surface, then the mean range of the max. energy betas is approx. 1.5 mm. These factors apply to all energies of beta particles emitted and the result is a very degraded spectrum as in Fig. 2.A). This shows the spectrum in air of beta particles emitted from a surface.

Fig. 2



2.2 Thick Sources

Thick Sources present an even further degraded spectrum because of self absorption. Though the max. range of the max. energy betas is 8 μ in a material of unit density the main range of max. energy particles is only 2 μ. The spectrum of betas originating from 8 μ below the surface is overlapped by the spectra of betas from other layers of activity closer to the air interface. The resulting spectrum of betas in air approximates to Fig. 2(B). In both cases the feature to note is the very small number of betas with a range $\geq$ 1.0 mm.

3. PRACTICAL CONSEQUENCES

3.1

The sensitive area of the radiation detector has to be very close to the source ($\ll$ 1 mm) almost irrespective of the activity present.

3.2

Surface scratches $\geq$ 2 μ in depth are potentially infinitely thick sources of ^3H contamination and require the detector to be even closer to the source.

3.3

A distance variation of as little as 0.025 mm (1 thou. inch) can significantly affect the measurement.

4. THE INSTRUMENT SPECIFICATION

A Whitlock Tritium meter (WTM) is capable of measuring Tritium surface contamination with a sensitivity of 10^{-8} μ Ci/cm² integrated over 100 cm² in a measuring time of 10 seconds. It consists of a thin large area (100 cm²) windowless plastic scintillator viewed by two 30 mm dia. photomultipliers in coincidence. Associated discriminators amplifiers, digital display timer and H. V. supply are powered by re-chargeable batteries. The whole area of the detector is maintained at a distance of 0.5 mm ± 0.025 mm from the surface being measured by a disposable rubber moulding. This moulding also forms a sealing ring to exclude light, when a partial vacuum of half an atmosphere is developed in the measuring area, by manual operation of the single action vacuum pump incorporated in the body of the instrument.

5. THE INSTRUMENT IN USE

The instrument in use is placed on a smooth metal plaque provided as an accessory. The vacuum pump handle is released and a vacuum is established which keeps the instrument firmly in position. Under the measuring conditions now established where the area, pressure and all important distance are kept constant, the instrument is switched on and several 10 second measurements are taken initially, to determine the background for the area, within reasonable statistics. Depressing the pump lever releases the vacuum, resets the scaler and allows the instrument to be positioned on the surface to be measured. Release of the pump lever provides a vacuum and starts a one or 10 second measurement of contamination. As each measurement is of 100 cm² large areas of laboratory working surfaces can be surveyed very rapidly. It has been shown that to obtain meaningful measurements with any detector the distance factor must be kept within very close tolerances. If this requirement cannot be met, as on floor or door handle surfaces, direct surface measurements cannot be made without the risk of a false negative. In these circumstances another accessory enables the instrument to measure wipes or smears.

6. SMEARS

Smears consisting of 50 mm dia. filter papers or aluminium discs are wiped over the contaminated surface, placed active side uppermost in a 1 mm deep recess provided and measured with the instrument. Assuming 10% of the contamination has been removed by the smear some compensation can be made by smearing ten times the normal wipe area or increasing the measurement time to 100 secs. When measuring smears the safest presumption is that the activity is being presented in a thick source form particularly if a liquid spill has been wiped. It is interesting to measure both sides of the filter paper after wiping liquid contamination as it is often found that a small amount of activity can be detected on the side which has not been in contact with the wiped surface. This can give some indication of the total absorbed activity.

7. COMPARISON WITH LIQUID SCINTILLATION COUNTING

7.1 Instrumentally

Instrumentally the electronics are very similar apart from compactness and battery operation of the Tritium meter (WTM) and the 3 channel capability of the Liquid Scintillation Counter (LSC). The major difference is apparent when one can take a representative sample of surface contamination to the LSC to obtain the advantage of the 4π geometry and the elimination of air absorption. This advantage is partially counterbalanced by chemical interference (quenching) of the scintillation process and a small possibility of self absorption. The WTM measures smears on site and information is immediately available for decisions.

A BE 254

7.2 Fluorescent Compounds

Fluorescent Compounds do not affect the WTM because the photomultipliers only receive light photons passed to them by total internal reflection. Furthermore both photomultipliers have to detect a photon within the preset coincidence time for an event to be recorded. Fluorescence of sufficient intensity to introduce photons through minor imperfections in the plastic scintillator surface in sufficient numbers would be visible to the naked eye. In LSC the fluorescence is inserted in the optical system. From then on it is the same in both instruments and the number of false events detected depends upon the timing of the coincidence circuits.

7.3 Chemiluminescence

Chemiluminescence is generated when certain chemicals are introduced into the liquid scintillation "cocktail" and false positives can be obtained from chemical "whiteners" in paper smear material. This situation is not possible with the WTM.

7.4 Thin and Thick Source Identification

Only the WTM is capable of measuring contamination in-situ on surfaces but it is interesting to note that in Fig. 2 the spectrum of energies emanating from a thick source is displaced to the left of that obtained from a thin source. This is similar to the spectral shift caused by different levels of quenching in an LSC. The degree of quenching can be measured by channels ratio techniques. The WTM can be fitted with pushbutton selected channels and the ratio of two successive measurements in "infinity" and "window" modes of counting would show whether a thick or thin source was being measured.

7.5 The Presence of Volatile Tritium

The presence of volatile Tritium or outgassing from the surface is indicated by the WTM by gross variability of count on successive measurements of the same surface area. During measurement the WTM produces a vacuum of ½ atmos. in the measuring "chamber" and if under these circumstances the surface contamination changes to gaseous tritium the geometry and air absorption characteristics drastically change. This phenomena is sometimes exhibited when measuring wet smears and if successive measurements are carefully recorded it may be possible to determine diffusion characteristics or quantify the volatile fraction. The LSC cannot give these indications.

7.6 Smears vs. Direct Measurements

The shortcoming of smears measured by either LSC or WTM is related to the nature of the surface being wiped. If the surface is covered with a large number of small scratches a large proportion of the activity could be deposited at the bottom of each miniature valley.

8 CONCLUSION

The Whitlock Tritium Meter provides a simple and satisfactory answer to the complex problem of measuring Tritium surface contamination for radiological protection purposes.

NRC FORM 699 U.S. NUCLEAR REGULATORY COMMISSION

TELEPHONE OR VERBAL CONVERSATION RECORD

MBRONE

DATE: 2/27/85

TIME: 1450 A.M. / P.M.

☐ INCOMING CALL ☑ OUTGOING CALL ☐ VISIT

PERSON CALLING	OFFICE/ADDRESS	PHONE NUMBER	EXTENSION
Thompson	RI		5303

PERSON CALLED	OFFICE/ADDRESS	PHONE NUMBER	EXTENSION
Robert Merlino, President	HM&M Assoc., Inc.	(617) 371-1692	

CONVERSATION

SUBJECT: Policy & Guidance Directive 84-20

SUMMARY

Told Mr. Merlino that I received a new directive that all waste brokers who desire to store waste for more than 180 days or possess more than 50 curies must file an environmental impact statement. I told him I would extend his response time to this application as well as send a letter to this affect.

"OFFICIAL RECORD COPY"

ML10

MS:12
P7

REFERRED TO:

ACTION REQUESTED

☐ ADVISE ME OF ACTION TAKEN.

INITIALS

DATE

ACTION TAKEN

INITIALS

DATE

NRC FORM 318 (4-79)

NRCM 0240 U.S. NUCLEAR REGULATORY COMMISSION

TELEPHONE OR VERBAL CONVERSATION RECORD

DATE 3/12/85

TIME 15:25 ☐ A.M. ☐ P.M.

☒ INCOMING CALL ☐ OUTGOING CALL ☐ VISIT

PERSON CALLING	OFFICE/ADDRESS	PHONE NUMBER	EXTENSION
Bob Meeting	Harris Assoc.		
PERSON CALLED	**OFFICE/ADDRESS**	**PHONE NUMBER**	**EXTENSION**
Thompson	RI		5303

CONVERSATION

SUBJECT: Response to Deficiencies.

SUMMARY

Mr. Meeting read 6 possible answers to my questions on last deficiency letter. I told him I did not see a problem with his corrections but will have to review the formal correction in writing.

"OFFICIAL RECORD COPY"

ML10

REFERRED TO:

ACTION REQUESTED

☐ ADVISE ME OF ACTION TAKEN.

INITIALS

DATE

ACTION TAKEN

INITIALS

DATE

NRC FORM 318 (6-78)