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22108 W. EIGHT MILE ROAD • SOUTHFIELD, MICHIGAN 48034

EXPERIMENTAL MACHINE PARTS

MANUFACTURERS AND DESIGNERS OF FINER TOOLS FOR MODERN INDUSTRY

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October 22, 1987

Regional Materials Licensing Section
USNRC Region III
799 Roosevelt Road
Glen Ellyn, Il 60137

Madam or Sir:

This letter is to request an amendment to license STB1463 and to up date our application. The amendment is as follows: We request condition 8A of license STB1463 be changed to 500 pounds.

We are also enclosing a revised floor plan of the work area showing the present locations of the restricted areas. Waste material consisting of machine chips are packed into steel drums and stored in a truck trailer behind the building on company property.

Enclosed please find a check for $120.00 in payment of application fee.

In the interest of the national defense of the United States and that of other friendly nations, we request your expeditious review and approval of this application.

Should any question arise concerning this application, please do not hesitate to contact either Dr. Bruce T. Austin, directly, at (513) 229-8933 or myself at (313) 352-1466.

Thank you for your prompt attention to this matter.

Sincerely,

Michael D. Huard

MICHAEL D. HUARD
President

MDH/bl
enc.

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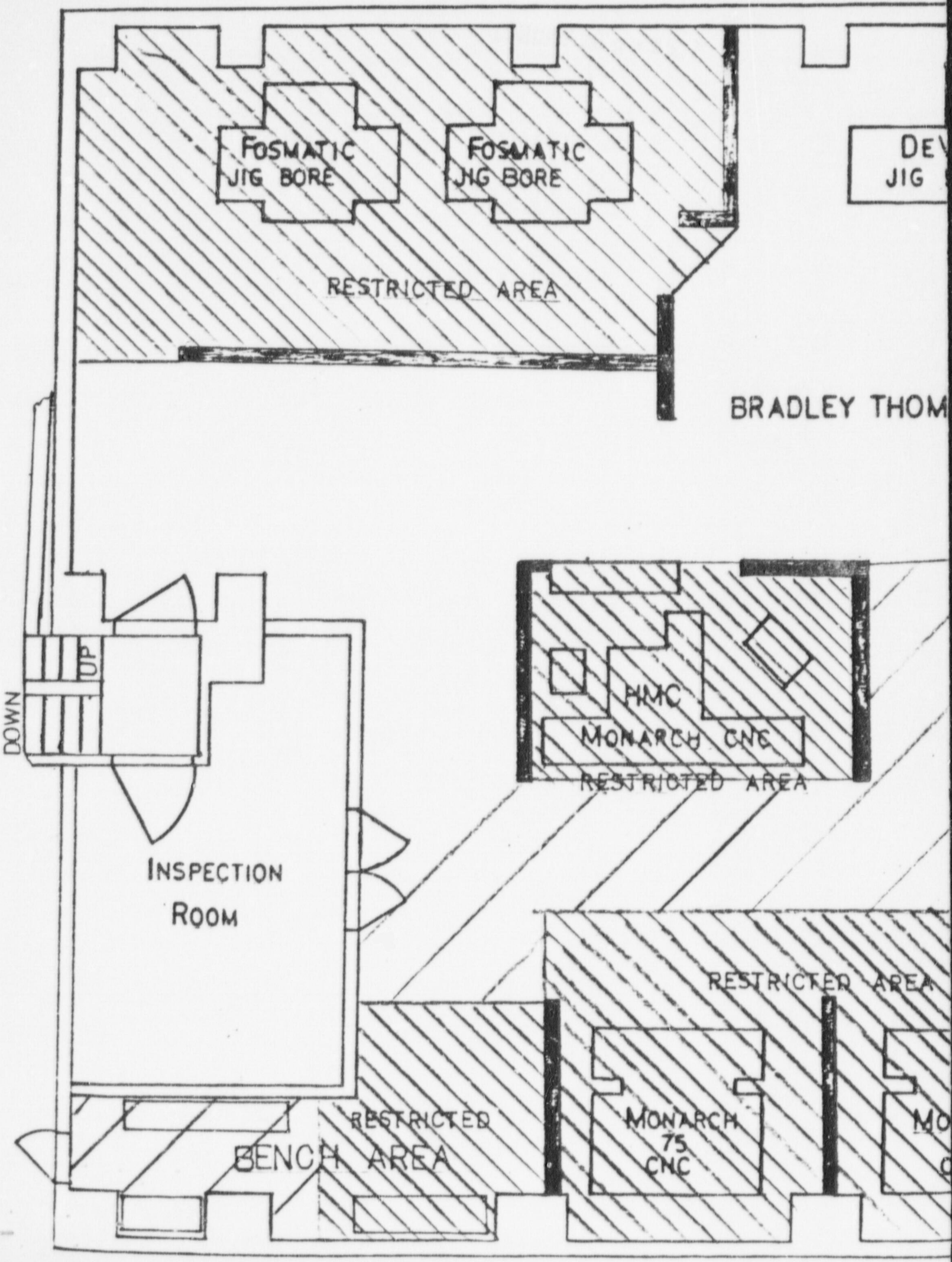
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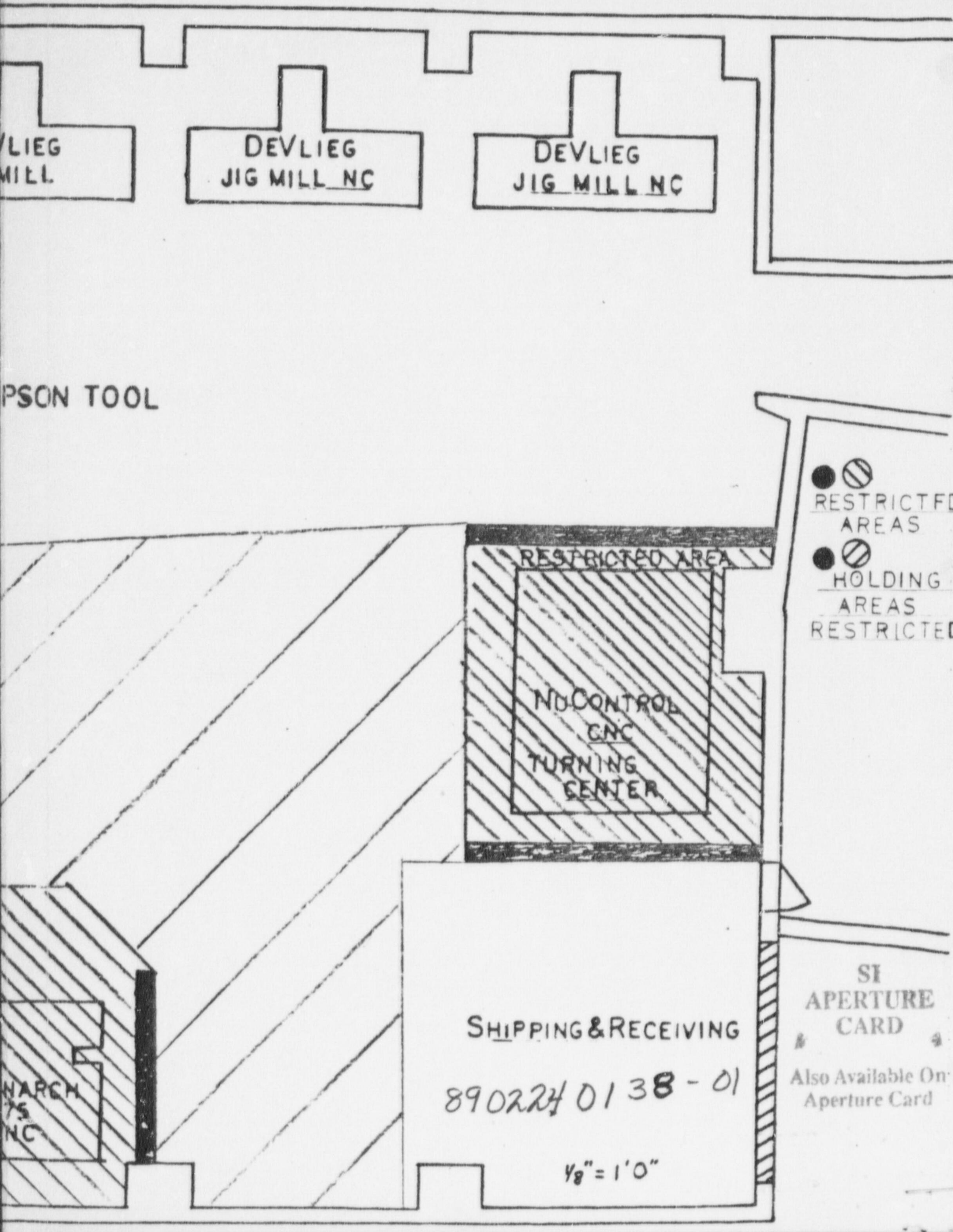
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MEDICAL RADIATION CONSULTANTS, Inc.
2101 Prudence Drive
Dayton, Ohio 45431

Bruce T. Austin, Ph.D.
Medical Physicist

Ms. B.J. Holt
Regional Materials Licensing Section
USNRC Region III
799 Roosevelt Road
Glen Ellyn, Il 60137

October 29, 1985

Dear Ms. Holt;

This letter is forwarded directly to you at the request of Mr. Michael D. Huard, President of the Bradley - Thompson Tool Company, Southfield, Michigan and is in response to the letter of October 18, signed by Patricia Vacherlon for Dr. Bruce S. Mallett.

This information is in support of the Source Material License application pending for the Bradley - Thompson Tool Company, assigned control number 79420, and differs from a similar response, dated October 11, in that it responds to the order of the above letter rather than to my notes of our telephone call of August 26.

1. Mr. Huard has in excess of 20 years of experience in the processing of Magnesium-thorium alloys under the provisions of the general license issued under 10 CFR part 40. He is personally expert in precision machine tool operation and in management of machine tool operations of the Company. Since submission of the application, he has received training in the previously specified topics relevant to his role as Corporate Radiation Safety Officer.

2. Initial training of material users was conducted by Mr. Solari and myself as adjuncts to Mr. Huard. Subsequent training, particularly that associated with daily operating procedures required for compliance with license conditions has been conducted by Mr. Huard. Future training will be conducted by Mr. Huard with assistance by Mr. Solari or myself as he deems necessary.

3. Bioassays will be performed and evaluated by Mr. Solari or myself when indicated. Assay procedures will be those indicated by the exposure necessitating evaluation, rather than being limited to urinalysis.

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4. Air sampling procedures, instrumentation, radioassay and

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calculation procedures are to be conducted in accordance with the enclosed description by Mr. Solari.

5. Survey instrument calibration will be performed by the instrument manufacturer or other person or organization authorized to calibrate survey instruments by the Nuclear Regulatory Commission.

6. Waste materials will be transferred to a licensee that is authorized to receive radioactive waste for disposition.

7. The consulting physicists will spend time on site as indicated by the scope of licensed activities and in accordance with the request of the Corporate Radiation safety Officer. On site time presently exceeds 20 hours and is anticipated to total in excess of 25 hours prior to initiation of licensed activities. Future time commitment are anticipated to be reduced as Mr Huard becomes familiar with license requirements and establishes routine operational procedures.

I regret the delay in your receipt of this information and the impact that the delay had had on the operations of the Tool Company. Should any question arise concerning matters pertaining to this application, please do not hesitate to contact me through the service at (513) 229-8933.

Sincerely,

Bruce T. Austin, Ph.D.
Consultant Physicist

cc. M. Huard

THE CHI-SQUARE TEST

It has been assumed that the observed counts are distributed according to the Poisson distribution, although the inclusion of the factor K_o permits application of the formulae if this is not the case. In real-life situations this is a hypothesis which must be tested. The appropriate test is a special form of the Chi-square test, tailored to the Poisson distribution (8). In general,

$$X = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where O_i and E_i are the observed and expected numbers, respectively, of occupants in each of the subdivisions in the distribution. For the Poisson distribution

$$X = \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{\bar{x}}$$

$$= \frac{\sum_i x_i^2}{\bar{x}} - n\bar{x}$$

where x_i is one of <u>n</u> observed number of counts (<u>not</u> count rate), and $\bar{x}$ and s are the experimental mean and standard deviation of the x_i. Each of the counts x_i are taken for the same counting interval, i.e., preset time is used. After considerable disagreement on the subject, statisticians now seem agreed that the test statistic X is distributed according to the chi-square distribution with n-1 degress of freedom. The author's preference is to use an alternate test statistic,

$$\frac{X}{n-1}$$

and compare it to the chi-square over degrees of freedom distribution (9). The advantage of this latter statistic is that the expected value is 1, independent of degrees of freedom.

Thorium Particulate Activity Monitoring

Breathing Zone Sample

Samples for particulate radioactivity are taken in the breathing zone area of the worker. The samples are taken through a membrane filter for a period of 4 or more hours. The pump is capable of pulling 0.5 cfm. The sampling head is placed near the machinist so as to sample the air in his breathing zone but will not interfere with his normal working habits. At the end of the sampling period, the membrane filter is removed and placed in a small envelope marked with the date, location, and air volume. The sample will be stored for 48 hours or more to permit the decay of the short lived daughter products of radium and thorium.

Counting Procedure

Remove filters from envelope and place in new planchet.
Count filter on Gas flow proportional counter for 30 minutes.
(The voltage must be set on the alpha plateau.)
Count the background for an equivalent period of time.

Calculation Procedure

Calculate net count rate (net cpm) for the membrane filter.

Calculate the concentration of activity as follows:
    Concentration = (net cpm)/(Eff) (2.22E6) (Air volume in milliliters)
    where Eff = counter efficiency and 2.22E6 = dpm/microCurie

Calculate % MPC = concentration x 100 / (6E-11 uCi/ml)
    where 6E-11 is the MPC for natural thorium (appendix B, 10CFR20)

Equipment required:

    Membrane filter: Gelman or equivalent
    Air Pump: WISA model DBGM
    Gas flow detector: Nuclear Measurements Corporation

SENSITIVITY OF MEASUREMENTS

Air volume collected at 0.5 cubic feet per minute

Sampling Time	Air Volume
1 hours	14158 ml
2 hours	28316 ml
3 hours	42475 ml
4 hours	56632 ml
6 hours	84948 ml
8 hours	113264 ml

Background counting rate: 0.5 cpm
Counting efficiency: 50 %
Collection efficiency: 100 %

COUNTING AND REPORTING PRACTICES

Critical Level

The critical level is used only to determine if a measurement is statistically different from background. For equal sample and background counting time the critical level becomes: (ref 1)

Critical level = 1.65 x square root(2xRb/T) where:
1.65 is the one sided confidence level
Rb is the background counting rat and
T is the counting time.

The critical level is 0.30 cpm for Rb=0.5 and T=30 minutes.

The detection limit (LD) is:
LD = 2 x 1.65 x (square root (2xRb/T)) (ref 2)

The detection limit is 0.6 cpm for the conditions described above. This corresponds to a limit 1.20 dpm or 5.405E-7 uCi on the filter as a lower limit of detection. The overall limit of detection therefore varies with the volume of air sampled. Sampling for 4 hours gives a lower limit of 1.91E-11 uCi/ml or 0.315 MPC. Sampling for 8 hours results in a lower limit of detection of 9.55E-12 uCi/ml or 0.16 MPC.

Ref 1) Currie L.A. Limits for Qualitative Detection and Quantitative Determination. Analytical Chemistry, Vol 40, No. 3, Mar 1969

Ref 2) Hartwell, J.K. Detection limits for Radioisotopic counting techniques ARH-2537, Jun 22, 1972

INTRODUCTION

Environmental surveillance and bioassay are two health physics disciplines in which it is necessary to measure trace quantities of radioactivity. A clear understanding of the statistical limit of radioactivity measurement (the "minimum detectable activity," or MDA) is therefore indispensable. Unfortunately, a careful review of the literature reveals numerous, and often discordant definitions relating to the detection limit of a counting instrument. This paper, tutorial in nature, presents several definitions (following principally Currie (1))

the critical level
the detection level
the less-than level
the determination limit

and discusses their application. In addition, the Loevinger-Berman criterion for optimizing counter performance, and the chi-square test for assessing counter performance are discussed.

NOTATION AND ASSUMPTIONS

The following notation will be used:

n = number of counts accumulated in a counting time T
σ_n = standard deviation in $\underline{n}$ counts
R = count rate = n/T
σ_R = standard deviation in count rate R

T_b = time to count background
R_b = background count rate
σ_b = standard deviation in R_b

T_t = time to count total (source plus background)
R_t = total count rate
σ_t = standard deviation in R_t

R_s = count rate from source alone
σ_s = standard deviation in R_s

K_o = ratio of observed to expected (Poisson) standard deviation

K_1 = normal distribution multiplier for one-sided confidence interval (e.g., for 95% confidence, $K_1 = 1.65$)

K_2 = normal distribution multiplier for two-sided confidence interval (e.g., for 95% conficence, $K_2 = 1.96$)

L_c = the critical level

L_d = the detection limit

L_ℓ = the less-than level

L_q = the determination limit

Counts occurring in a time interval are assumed to be Poisson-distributed (later, this requirement will be relaxed somewhat). The number of accumulated counts is assumed to be sufficiently large to permit the probability distribution of accumulated counts to be adequately approximated by a normal distribution having mean and variance equal to the expected number of counts. This is a reasonable assumption in almost all cases of practical interest: even when the number of accumulated counts is as small as twenty, the normal approximation is acceptable. The usual assumptions are made (e.g., independence of errors) which permit application of first-order propagation of errors theory (2).

With the above assumptions, the standard deviation σ, of n counts is

$$\sigma = \sqrt{n}$$

so

$$\sigma_R = \frac{\sqrt{n}}{T} = \sqrt{\frac{R}{T}} .$$

Also, if

$$c = a - b$$

$$\sigma_c^2 = \sigma_a^2 + \sigma_b^2$$

THE CRITICAL LEVEL

The Critical Level is defined as the net count rate which must be exceeded before the sample is said (at some degree of confidence) to contain measurable radioactivity above background. The Critical Level

$$L_c = K_1 \sigma_o$$

where K_1 is the one-sided confidence factor and σ_o is the standard deviation of zero net count rate. If we wish a 95 percent confidence level (five percent of background counts will be judged to have radioactivity above background), then $K_1 = 1.65$. The factor K_o is, for the present, taken equal to 1, and will be discussed later.

Since $R_s = R_o = R_t - R_b = 0$

$$\sigma_o^2 = \sigma_t^2 + \sigma_b^2$$

$$\sigma_t^2 = \frac{R_t}{T_t} = \frac{R_b}{T_t}$$

$$\sigma_b^2 = \frac{R_b}{T_b}$$

So $$\sigma_o^2 = \frac{R_b}{T_t} + \frac{R_b}{T_b} = R_b \frac{(T_t + T_b)}{T_t \, T_b}$$

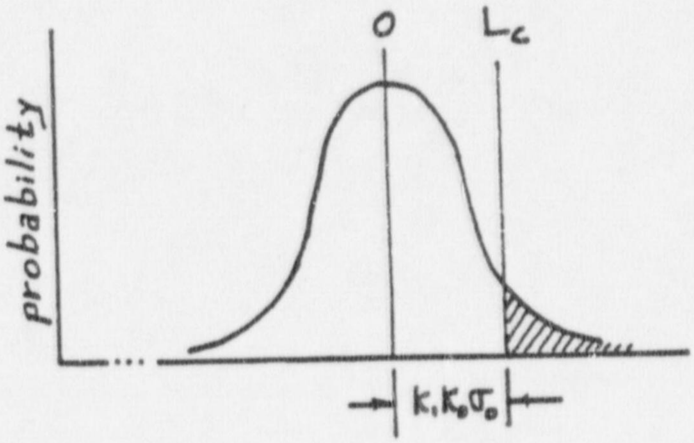

Figure 1. The Critical Level L_c.

$$\boxed{L_c = K_o K_1 \left[\frac{R_b}{T_b} \left(1 + \frac{T_b}{T_t}\right) \right]^{1/2}} \qquad (1)$$

If sample and background counting times are equal, $T_b = T_t \equiv T$

then $$L_c = K_o K_1 \left[\frac{2R_b}{T} \right]^{1/2} \qquad (2)$$

THE DETECTION LIMIT

The Detection Limit is defined as the smallest count rate which can be detected with a specified degree of confidence.

The Detection Limit could be taken to be equal to the critical level, L_c. See Figure 2. If this is done, there is one chance in two that true count rates equal to L_c will go undetected. It is not very satisfactory to specify a detection limit which can be detected only half the time; it is preferable to set the Detection Limit at some higher count rate such that the observed count rate will rarely be below the Critical Level, for example, not more than 5 percent of the time. The Detection Limit, as defined by equation (3), satisfies the requirement for the confidence level specified by K_1.

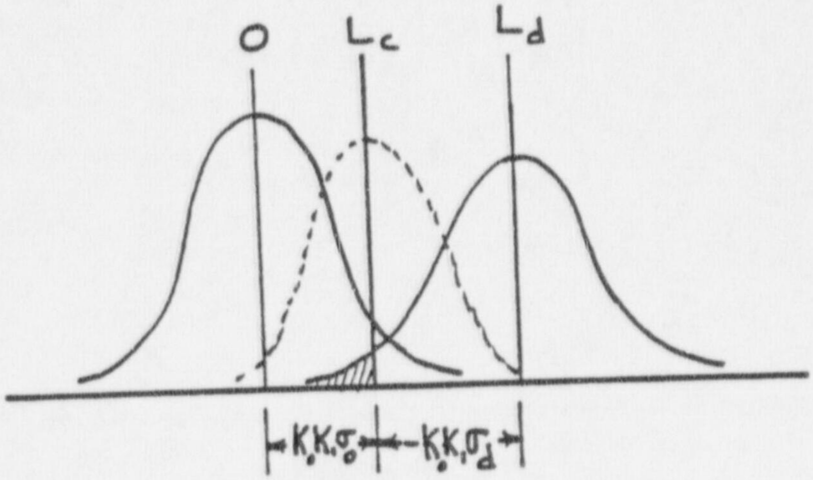

Figure 2. The Detection Limit L_d.

$$L_d = L_c + K_1 \sigma_d$$

Again, K_1 is the <u>one-sided</u> confidence factor. Since

$$L_d = R_d = R_t - R_b$$

$$\sigma_d^2 = \sigma_t^2 + \sigma_b^2$$

$$= \frac{R_t}{T_t} + \frac{R_b}{T_b} = \frac{R_d + R_b}{T_t} + \frac{R_b}{T_b} .$$

But $R_d = L_d$ so $\sigma_d^2 = \frac{L_d}{T_t} + \frac{R_b}{T_b} \left(1 + \frac{T_b}{T_t}\right)$

and

$$L_d = L_c + K_1 \left[\frac{L_d}{T_t} + \frac{R_b}{T_b} \left(1 + \frac{T_b}{T_t}\right) \right]^{1/2}$$

Solving for L_d and substituting the expression for L_c:

$$L_d = \frac{K_o^2 K_1^2}{T_t} + 2K_o K_1 \left[\frac{R_b}{T_b} \left(1 + \frac{T_b}{T_t}\right) \right]^{1/2} = \frac{K_o^2 K_1^2}{T_t} + 2L_c \tag{3}$$

If the sample and background counting times are equal, $T_b = T_t \equiv T$, then

$$L_d = \frac{K_o^2 K_1^2}{T} + 2K_o K_1 \left[\frac{2R_b}{T} \right]^{1/2} \tag{4}$$

In most cases where one is attempting to minimize the Detection Limit, counting times are long and the first term is negligible compared to the second:

$$\frac{K_o^2 K_1^2}{T} << 2K_o K_1 \left(\frac{2R_b}{T} \right)^{1/2}$$

The Detection Limit is then given by the following approximate formula often seen in the literature.

$$L_d = 2K_1 \left(\frac{2R_b}{T}\right)^{1/2} \quad . \qquad (5)$$

Choosing $K_1 = 1.65$ will result in only 5 percent of true count rates equal to L_d being missed (classified as background).

Again, a factor K_o has been inserted into equations (3) and (4) and will be discussed later.

THE LESS-THAN LEVEL

Suppose we have a sample with a count rate at or above the background count rate, but less than the Critical Level. We will conclude that we have not detected net radioactivity, but how large could the true count rate be and still produce a count rate not more than was observed? Neither L_c nor L_d answers this question. The Less-Than Level is defined as the maximum true net count rate which a sample could have (at a specified confidence level), based on a measured R_s, where R_s is less than L_c. The Less-Than Level is developed similarly to the Detection Limit, except with $R_s < L_c$. The Less-Than Level

$$L_\ell = R_s + K_1 \sigma_\ell$$

$$\sigma_\ell^2 = \sigma_t^2 + \sigma_b^2$$

$$= \frac{R_t}{T_t} + \frac{R_b}{T_b}$$

$$= \frac{R_L + R_b}{T_t} + \frac{R_b}{T_b} = \frac{L_\ell}{T_t} + \frac{R_b}{T_b} \left(1 + \frac{T_b}{T_L}\right)$$

So, $$\sigma_\ell^2 = \frac{L_\ell}{T_t} + \left(\frac{L_c}{K_o K_1}\right)^2$$

Thus, $$L_\ell = R_s + K_o K_1 \left[\frac{L_\ell}{T_t} + \frac{L_c^2}{K_o^2 K_1^2}\right]^{1/2}$$

Solving for L_ℓ yields

$$L_\ell = R_s + \frac{K_o^2 K_1^2}{2T_t} + \left[\frac{R_s K_o^2 K_1^2}{T_t} + L_c^2 + \frac{K_o^4 K_1^4}{4T_t^2} \right]^{1/2} \qquad (6)$$

If $R_s = L_c$, then $L_\ell = L_d$.

If $R_s = 0$, then $L_\ell > L_c$.

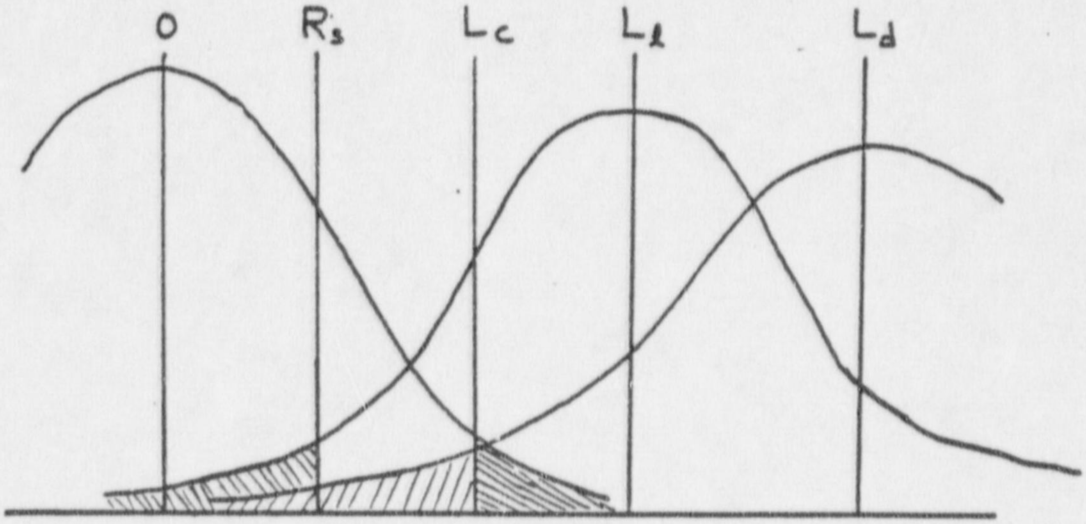

Figure 3. The Less-Than Level, L_ℓ and its relationship to L_c and L_d.

THE DETERMINATION LIMIT

One last quantity of occasional importance is the Determination Limit, defined as the smallest net count rate which can be measured with a pre-specified relative standard deviation (i.e., coefficient of variation). Let

f_q = the reciprocal relative standard deviation (e.g., if the coefficient of variation is to be 0.05, f_q = 20)

then the Determination Limit is given by

$$L_q = \frac{K_o f_q^2}{2T_t}\left[1 + \left(1 + \frac{4T_t R_b (T_t + T_b)}{f_q^2 T_b}\right)^{1/2}\right] \quad (7)$$

When $T_t = T_b \equiv T$

$$L_q = \frac{K_o f_q^2}{2T}\left[1 + \left(1 + \frac{8R_b T}{f_q^2}\right)^{1/2}\right]$$

See the paper by Currie for the derivation.

REPORTING PRACTICES

The following reporting practices are recommended by Lochamy (3).

1. The Critical Level is used only to determine if a measurement is statistically different than background. It should not be used as a Detection Limit or Less-Than Level.

2. The Detection Limit and Determination Limit are not used for routine counting and reporting. In those cases where you are required to specify a minimum detectable activity (e.g., to a regulatory agency), it is recommended that the Detection Limit be given as the practical reporting limit.

3. The Determination Limit is useful when "sensitivity" with a specified relative standard deviation is required.

4. For routine low-level counting, only the Critical Level and Less-Than Level are of interest. Their use is:

   a. If $R_s > L_c$, the result is reported as positive, with the two-sided confidence interval desired, $R_s \pm K_2\sigma_s$, where for example $K_2 = 1.96$ at the 0.05 level, and

$$\sigma_s = K_o\left[\frac{R_t}{T_t} + \frac{R_b}{T_b}\right]^{1/2} .$$

   b. If $R_s \leq L_c$, L_ℓ is calculated using the one-sided confidence interval and the result reported as less than L_ℓ.

The procedure for conducting the test is as follows. Acquire twenty to fifty replicate counts x_i. The counting time and source activity should be similar to those employed when assaying unknowns. In the case under discussion, background samples are appropriate. To realistically simulate the background standard deviation, replicate background samples should be prepared and counted once each. The statistic $X/(n-1)$ is computed and compared to the chi-square over degrees of freedom distribution at the 95 or 98% confidence level. If the data pass this test, Poisson statistics may be assumed and $K_o = 1$ in the formulae. If the chi-square test is failed, K_o is calculated

$$K_o = \frac{\text{observed standard deviation}}{\text{expected (Poisson) standard deviation}}$$

$$= \sqrt{\frac{X}{n-1}} \quad .$$

The author's experience is that many instruments will not regularly pass the chi-square test for background samples counted for long times. Any phenomenon which adds to the variability of the randomness of radioactive decay can cause failure of the test. Examples include instrument instability, diurnal variation in natural background, variation in background count rate due to movement of sources within the laboratory, variations between background samples, and variatior of sample positioning.

OPTIMAL TIME PARTITION

Given an unknown sample and a background sample, what is the optimal way to partition a fixed, total counting time T between the background counting time T_b and the sample counting time T_t?

Consider the detection limit, for which

$$\sigma_d^2 = \frac{R_t}{T_t} + \frac{R_b}{T_b} \quad .$$

Since $T_t = T - T_b$, and T is constant, σ_d^2 is minimized when

$$\frac{\partial}{\partial T_b}\left(\sigma_d^2\right) = \frac{\partial}{\partial T_b}\left(\frac{R_t}{T-T_b} + \frac{R_b}{T_b}\right) = 0 \quad .$$

This yields

$$\frac{T_b}{T_t} = \sqrt{\frac{R_b}{R_t}} \quad .$$

For very weak samples, $R_t \approx R_b$ so the time is divided most efficiently when $T_b = T_t$, that is, when sample and background counting times are equal. This discussion has presumed one unknown sample and one background sample. When there are many unknown samples to be assayed, more than one background sample may be employed (preset time), but since the detection limit is proportional to

$$(1 + \frac{1}{m})^{1/2}$$

where m is the number of background samples counted, there is little to be gained by using more than half-dozen background samples.

COUNTER SET UP

A final question should be addressed. It is readily apparent that both the counting efficiency and the background count rate depend upon the particulars of the instrument adjustments (high voltage, amplifier gain, window location and width, etc.). How should these adjustments be made so as to minimize the detection limit? In 1951 Lovenger and Berman found the elegant answer to this question. The detection limit is minimized when adjustments are made such that

$$\frac{R_s^2}{R_b} = \frac{(R_t - R_b)^2}{R_b}, \text{ or } \frac{(\text{efficiency})^2}{R_b}$$

is minimized. R_s^2/R_b is the proper quantity to be minimized when one is counting weak samples, $R_s << R_b$. When the count rates are not such that $R_s << R_b$, different quantities should be minimized or maximized to maximize counting efficiency.

This simple procedure is not without difficulties and cautions, which are:

1. The efficiency must be measured at various instrument settings, which is not difficult, because an active source may be used. The background count rate must also be accurately measured at these same instrument settings, which can be very time-consuming if the background count rate is low.

2. The background must be fixed and stable during the time-consuming measurements of the preceding paragraphs, and the background during sample counting should not be much different than this value.

3. Instrument settings for which the chi-square test is failed should be avoided in favor of settings for which the test is passed. That is, regions of instrument instability should be avoided.

4. The Lovenger-Berman procedure does not address certain problems. For example, it cannot be used with mixtures of isotopes of variable composition, as the efficiency is not a fixed number. The procedure cannot be used to optimize instrument settings when it is intended to most accurately differentiate between two radionuclides in a composite sample. This latter problem must be solved using mathematical considerations quite different than those described in this paper.

ACKNOWLEDGEMENT

This paper is primarily tutorial in nature. The author has drawn freely from material given by the references.

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Regional Materials Licensing Section
USNRC Region III
799 Roosevelt Road
Glen Ellyn, Il 60137

July 23, 1985

Madam or Sir:

Enclosed, please find a check in the amount of $350.00 in payment of application fee and two copies of an application for issuance of a license to process Magnesium-Thorium alloy by the Bradley - Thompson Tool Company.

In the interest of the national defense of the United States and that of other friendly nations, we request your expeditious review and approval of this application.

Should any question arise concerning this application, please do not hesitate to contact either Dr. Bruce T. Austin, directly, at (513) 229-8933 or myself at (313) 444-1466.

Thank you for your prompt attention to this matter.

Sincerely,

Michael D. Huard

Michael D. Huard
President

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JUL 26 1985

CONTROL NO. 79420

030 28818 N 21-24546-01

NRC FORM 313
(1-84)
10 CFR 30, 32, 33, 34, 35 and 40

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED BY OMB 3150-0120
Expires: 5-31-87

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

FEDERAL AGENCIES FILE APPLICATIONS WITH:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND, MASSACHUSETTS, NEW JERSEY, NEW YORK, PENNSYLVANIA, RHODE ISLAND, OR VERMONT, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIAL SECTION B
631 PARK AVENUE
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA, PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
MATERIAL RADIATION PROTECTION SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH, OR WYOMING, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON, AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND APPLICATIONS TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
MATERIAL RADIATION PROTECTION SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTION.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*
   - [X] A. NEW LICENSE
   - [ ] B. AMENDMENT TO LICENSE NUMBER ____________
   - [ ] C. RENEWAL OF LICENSE NUMBER ____________

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include Zip Code)*

   Bradley - Thompson Tool Company
   22108 W. Eight Mile Road
   Southfield, Michigan 48034

3. ADDRESS(ES) WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED.

   Same as Applicant Address

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION: Bruce T. Austin, Ph.D. Consultant Physicist
   TELEPHONE NUMBER: (513) 229-8933

SUBMIT ITEMS 5 THROUGH 11 ON 8½ x 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
   a. Element and mass number, b. chemical and/or physical form, and c. maximum amount which will be possessed at any one time.
6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.
8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
9. FACILITIES AND EQUIPMENT. Appendix E
10. RADIATION SAFETY PROGRAM. Appendix F
11. WASTE MANAGEMENT. Appendix G
12. LICENSEE FEES *(See 10 CFR 170 and Section 170.31)*
    FEE CATEGORY 10CFR170.31 2G
    AMOUNT ENCLOSED $ 350.00

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, AND 40 AND THAT ALL INFORMATION CONTAINED HEREIN, IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948, 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION

SIGNATURE—CERTIFYING OFFICER	TYPED/PRINTED NAME	TITLE	DATE
Michael D. Huard	Michael D. Huard	President	7/23/85

14. VOLUNTARY ECONOMIC DATA

a. ANNUAL RECEIPTS
- [ ] < $250K
- [ ] $250K – 500K
- [ ] $500K – 750K
- [ ] $750K – 1M
- [ ] $1M – 3.5M
- [ ] $3.5M – 7M
- [ ] $7M – 10M
- [ ] > $10M

b. NUMBER OF EMPLOYEES *(Total for entire facility excluding outside contractors)*

c. NUMBER OF BEDS

d. WOULD YOU BE WILLING TO FURNISH COST INFORMATION *(dollar and/or staff hours)* ON THE ECONOMIC IMPACT OF CURRENT NRC REGULATIONS OR ANY FUTURE PROPOSED NRC REGULATIONS THAT MAY AFFECT YOU? *(NRC regulations permit it to protect confidential commercial or financial—proprietary—information furnished to the agency in confidence)*
- [ ] YES
- [ ] NO

RECEIVED
JUL 2 8 1985
REGION III

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	COMMENTS	APPROVED BY
appl	Ayz III	2G		OP
AMOUNT RECEIVED	CHECK NUMBER			DATE
$350	63985			8/1/85

PRIVACY ACT STATEMENT ON ...

~~8512050314~~ 851113
REG3 LIC40
STB-1463 PDR
14pp

CONTROL NO. 79420

Appendix A, Item 5   Licensed Material

a. Element and Mass Number	b. Chemical and Physical Form	c. Maximum Amount To Be Possessed At Any One Time
Natural Thorium (predominantly Thorium 232)	Thorium Oxide Alloyed with Magnesium NTE 4% By Weight	200 pounds

Natural Thorium in the form of a clean metallic alloy with Magnesium is to be acquired as raw castings. The Thorium content of the allcy is not to exceed 4% by weight and is usually 3% by weight as supplied by the foundry. Total possession is of the raw and finished castings and cuttings remaining from the machining process. The maximum amount to be posessed at any one time is 200 pounds.

Appendix B, Item 6 Purpose For Which Material Will Be Used

Material will be possessed and used pursuant to the physical processing of finished castings.

Magnesium - Thorium alloy, not to exceed 4% by weight, will be acquired as raw castings from the supplying foundry. Castings will be machined to design specifications using modern milling, drilling, boring, and tapping equipment that is maintained to exacting standards.

Approximately 4% of the raw casting will be removed in machining operations (2 lbs. of a typical 52 lb raw casting). Waste cuttings will be accumulated and contained by vacuum systems that are designed to contain cuttings at the time of production.

Wastes will be contained in the vacuum system collection drums until drums are filled. Inner plastic liners will be tied and filled drums sealed for removal as radioactive waste.

Finished castings will be inspected, partially assembled and forwarded to the prime contractor or other subcontractors as directed by the prime contractor. Neither finished castings or wastes will be distributed to the general public under the provisions of 10 CFR 40.13.

Appendix C, Item 7 Individuals Responsible For Radiation Safety

Bruce T. Austin, Ph.D.
Consultant Physicist

Training

1968 B.S. Chemistry, Grinnell College

1970 M.S. Radiation Biology, The University of Iowa

1973 Ph.D. Radiation Biology, The University of Iowa

Experience

1972-76 Staff Health Physicist, USAF RHL, Wright-Patterson AFB
USAF World-wide Health and Medical Physics Field Service
1972-74 Chief Film Dosimetry Branch, USAF World-wide service
1974-76 Executive Secretary USAF Radioisotope Committee

1976-82 Professor of Radiological Sciences, Wright State Univ
School of Medicine and University RSO

1982-85 Medical Physicist and Hospital RSO, Grandview Hospital

1976-85 Consultant in Health and Medical Physics
Named as RSO and/or consultant to numerous current USNRC licenses including: 34-06904-01 SNM 1603 34-11912-03 34-11912-04 SNM 1419

Arthur J. Solari
Consultant Physicist

Training

1950 B.S. MIT

1953 M.S. Health Physics, Boston College

Experience

1951-52 AEC Fellowship University of Rochester

1952-55 Health Physicist, Brookhaven National Laboratory

1955-57 Instructor in Radiology, University of Michigan

1957-85 University Radiation Safety Officer, Univ. of Mich.

1961 Certified ABHP
Named as RSO on several current USNRC Licenses including:
21-00215004 21-00215-06 SNM 1835 SUD 1398 SNM 1529

Appendix C, Item 7 (cont)

Michael D. Huard
President and Corporate Radiation Safety Officer

Mr. Huard is expert in precision machining operations and the successful management of Bradley - Thompson Tool Co. He will receive practical training in the administrative and supervisory requirements of Corporate Radiation Safety from the consultant physicists.

Mr Huard will be trained in the following topical areas as the topics relate to the licensed activities:

Principles and practices of radiation protection

Measurements of radioactivity, monitoring techniques and the use of monitoring instruments

Calculations related to the use and measurement of radioactivity

Biological effects of radiation

Safety practices applicable to protection from the chemical toxicity and pyrophoric properties of source material

Appendix D, Item 8 Training of Material Users

Material users will be trained machinists who are expert in the processing of Magnesium alloys. As such, they will be familiar with the requirements associated with the safe, precision processing of Magnesium - Thorium alloy.

Prior to beginning licensed activities, Corporate training of material users will include emphasis on the use of sharp tools and machine speeds consistent with production of large chips and shavings, requirements to position waste removal equipment to provide effective removal of wastes, and housekeeping requirements in the Magnesium - Thorium work area.

Material users will also be trained in emergency procedures to be followed in the event of mechanical accident or fire in the processing area. Restrictions against drinking, eating, and smoking in the processing area will be emphasized to prevent accidental ingestion of processing scrap.

All material users and employees who may frequent the processing area in the course of their duties will be instructed in accordance with the requirements of 10 CFR 19.12. This training, to be offered on an annual basis or more frequently if indicated by employee turnover, will include:

Identification of licensed materials and associated hazards

Precautions and procedures to minimize hazards

Purposes and functions of protective devices

NRC regulations to be observed

Terms of the NRC license applicable to employees who work in or frequent the processing area

Standard and emergency procedures to be followed

Responsibility of individuals to report unsafe acts or conditions in the processing area

The right of employees to receive personnel monitoring reports upon request

Otherwise uninvolved workers and visitors will be advised of the restricted access to the Magnesium - Thorium processing area during processing activities.

Appendix D, Item 8 (cont)

Personnel receiving training will be provided the opportunity to ask questions of the individual conducting training and will be encouraged to ask questions of his or her supervisor concerning radiation safety as they might arise.

Comprehension of individuals participating in training will be assessed by the Radiation Safety Officer by observation of compliance with instruction and oral quiz.

Records, including the date and duration of training, the names of participants, and the name of the individual conducting the training will be maintained with radiation safety records.

Appendix E, Item 9 Facilities and Equipment

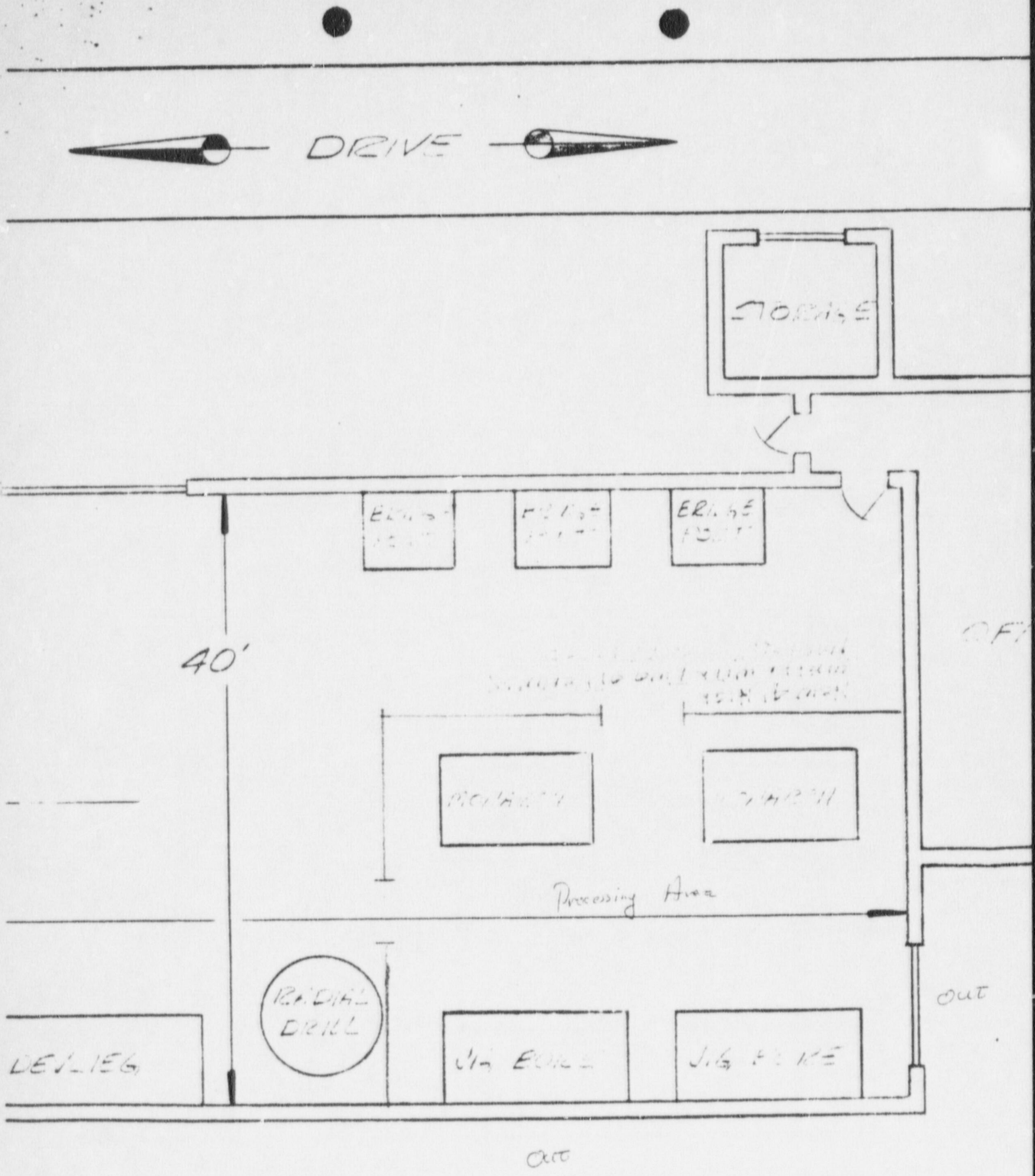
Magnesium - Thorium processing activities will be limited to the area illustrated in the enclosed drawing. Four machine tools will be isolated from surrounding areas by a partition wall designed to restrict access to the processing area and to afford a defined area within which waste removal activities may be confined.

The processing area is located in a high bay machine shop area on a concrete floor. HVAC in the area is minimal with only low velocity air movement, except that provided by the vacuum system for waste removal and containment.

Material storage of finished castings will be located in the area indicated. Raw castings will be held in the processing area until finished. Wastes will be contained in the vacuum system drums adjacent to the machine tools until filled. When filled, drums will be sealed and prepared for shipment as LSA waste in the processing area.

Materials are secured against removal as are other valuable properties of the Company. When not in the possession of material users, items in stages of finishing will be secured in the processing area. Finished items will be secured in the storage area prior to shipping.

Given the nature of the proposed activities, no special ventilation or containment system is necessary to assure compliance with the permissible occupational and environmental concentration limits specified in 10 CFR 20.


DRIVE
STORAGE
40'
Processing Area
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Appendix F, Item 10 Radiation Safety Program

The radiation safety program is a multifaceted administrative management effort to prevent the reduction of waste to respirable particles or gases, to document the protection of material users, and to document the containment and control of material.

Personnel Monitoring

The previous operational experience of licensees authorized to process Magnesium - Thorium alloys indicates that material users are not likely to receive an occupational radiation dose in excess of 10% of the standards specified in 10 CFR 20.101 unless material is ground or otherwise reduced to respirable gasses or aerosols. In addition, and due to the training required for expert machine tool operation, personnel under the age of 18 years will not be employed as material users.

In accord with the provisions of 10 CFR 20.202, personnel monitoring devices will not be issued to material users.

Bioassays

Routine bioassay of material users is not expected to be indicated for the proposed activities. Previous experience in Magnesium - Thorium processing operations indicate that derived air concentrations of respirable Thorium will not exceed a few percent of the limits specified in 10 CFR 20, Appendix B, Table I.

Should pre-operational or periodic sampling of breathing zone air indicate that derived air concentrations cannot be maintained at a small fraction of the relevant standards, bioassays by urinalysis will be conducted in accordance with the procedures and schedule of USNRC Regulatory Guide 8.11.

Surveys and Monitoring

Machines and work areas will be monitored for fixed and removable activity at the end of each work shift. Each material user will be responsible for survey and clean-up of his or her work area. Periodic surveys of the processing and storage areas will be conducted by the Radiation Safety Officer or his designee on a weekly schedule or as otherwise indicated. Results of the weekly survey will be recorded and maintained for inspection purposes.

Initially, and whenever processing operations are to be reinitiated or revised, the breathing zone of material users will be monitored as a precaution to confirm airborne concentrations. Air monitoring results will be maintained for inspection purposes.

When Magnesium - Thorium processing is to be discontinued in the processing area, a survey of all machine surfaces, work areas, and floor areas will be conducted prior to release for other material processing. Complete documentation, including a drawing illustrating any area in which contamination was observed prior to cleaning will be retained in radiation safety files. For the puyrposes of area release, a contamination limit of 100 DPM per 100 cmsq will be observed.

In the event of unusual occurrance, area survey and air sampling will be performed by a consultant physicist to preclude or identify material release to the environment or area contamination.

Radiation Detection Instrument

One Ludlum Model 3 radiation survey meter equipped with a Model 43-5 alpha scintillation probe will be maintained by the licensee for routine area survey purposes. The unit has a range of 0-5,000 cpm and a calculated MDL of 114 pCi/100cmsq Thorium - 232 at a count rate that is three times background.

Proper instrument operation will be confirmed prior to and following each survey using a check source of Thorium - 230 to demonstrate constancy. The meter will be calibrated on an annual basis or upon damage or repair that could affect calibration. Calibration will be performed by Medical Radiation consultants, Inc. using National Bureau of Standards traceable Thorium - 230 standards. While sources are not USNRC regulated, procedures and record keeping procedures will be as specified in USNRC License No. 34-06904-01. The licensee will maintain calibration records for not less than 2 years.

Radiation Safety Program

Purpose

This is a formal, planned program to protect the health of employees, minimize danger to life and property, and make every reasonable effort to maintain radiation exposures and releases to unrestricted areas as low as reasonably achievable.

Appendix F, Item 10 (cont)

Scope

This program is applicable to the receipt, possession, processing, storage, transfer, and disposal of licensed material.

Reference

1. Title 10 Code of Federal Regulations, Parts 19, 20, and 40
2. License No. , issued to Bradley - Thompson Tool Company
3. USNRC Regulatory Guide 8.11
4. NBS/ICRP Handbooks

Responsibilities

1. The Bradley - Thompson Tool Company has overall responsibility for the radiation safety of all individuals who work in or frequent restricted areas under its control. The Company is responsible for compliance with applicable USNRC regulations and the terms of the license issued to the Company.

2. The Radiation Safety Officer or his designees are responsible for the conduct of day-to-day radiation safety operations, including the review and approval of standard operating and emergency procedures.

3. Material users are responsible for performing their jobs in a safe manner and in accordance with approved standard operating and emergency procedures. Material users must be alert to and immediately report all unsafe acts or conditions in the processing area to the Radiation Safety Officer or his designee.

Program Tasks

1. Provide training on a routine basis for personnel who work in or frequent the processing area.

2. Develop and implement procedures for routine and emergency operations involving licensed materials.

3. Provide appropriate radiological monitoring for personnel.

4. Control contamination.

5. Conduct area and environmental monitoring.

6. Obtain license authority and comply with license provisions appropriate to the radioactive material used.

7. Maintain inventory control of licensed materials.

8. Conduct investigations of all accidents or incidents and issue any necessary report.

9. Conduct and annual audit of the effectiveness of the radiation safety program.

Appendix G, Item 11 Waste Management

Waste Magnesium - Thorium will be collected and contained for ultimate disposal in vacuum system drums. Wastes will be shipped to the Prime Contractor, General Electric, Aircraft Engine Business Group, Cincinnati, Ohio, or to another authorized recipient for reclaimation or disposal.