<< 10 CFR 50.54(q) Screening Evaluation Form >>

Screening and Evaluation Number	Applicable Sites	
EREG #: 2193370	BNP	☐
	CNS	☐
	CR3	☐
	HNP	☐
5AD #: 2193356	MNS	X
	ONS	☐
	RNP	☐
	GO	☐

Document and Revision

HP/0/B/1009/002 Alternative Method for Determining Dose Rate within the Reactor Building Rev 003

Part I. Description of Activity Being Reviewed (event or action, or series of actions that may result in a change to the emergency plan or affect the implementation of the emergency plan):

AR02080957, the primary change to this procedure is to change the location of the survey used to determine dose rates within the reactor building when 1 or 2 EMFs 51A/B are inoperable during emergency conditions. The survey location is being changed from on contact with the outside surface of the outer upper airlock to on contact with the outside surface of the Spent Fuel Building to Upper Containment VE Door. With the additional distance from the containment source and additional shielding provided by the VE door the multiplication factor used in Step 4.1.3 and Enclosure 5.1 is changed from 740.0 to 1363. The variables used in determining the new multiplication factor are included with the procedure as Enclosure 5.2. Location of survey is being changed because it is unlikely that a survey of the outer airlock door will be possible with VE in operation. The fuel building location is simpler, safer and doable with VE in service.

Instrument names Teletector and Extender have been deleted. Teletector and Extender are trade names which are no longer used here.

References to survey instrument MCHPS number have been deleted and simply replaced with instrument number.

Additional changes: Inserted Revision History page, restored procedure format

Part II. Activity Previously Reviewed?	Yes	☐	No	X

<< 10 CFR 50.54(q) Screening Evaluation Form >>

Is this activity Fully bounded by an NRC approved 10 CFR 50.90 submittal or Alert and Notification System Design Report? If yes, identify bounding source document number or approval reference and ensure the basis for concluding the source document fully bounds the proposed change is documented below: Justification:	10 CFR 50.54(q) Effectiveness Evaluation is not required. Enter justification below and complete Attachment 4, Part V.	Continue to Attachment 4, 10 CFR 50.54(q) Screening Evaluation Form, Part III
Bounding document attached (optional)		☐

Part III. Editorial Change	Yes ☐	No X
Is this activity an editorial or typographical change only, such as formatting, paragraph numbering, spelling, or punctuation that does not change intent? Justification:	10 CFR 50.54(q) Effectiveness Evaluation is not required. Enter justification and complete Attachment 4, Part V.	Continue to Attachment 4, Part IV and address non editorial changes

Part IV. Emergency Planning Element and Function Screen (Reference Attachment 1, Considerations for Addressing Screening Criteria)

Does this activity involve any of the following, including program elements from NUREG-0654/FEMA REP-1 Section II? If answer is yes, then check box.

1	10 CFR 50.47(b)(1) Assignment of Responsibility (Organization Control)	
1a	Responsibility for emergency response is assigned.	☐
1b	The response organization has the staff to respond and to augment staff on a continuing basis (24-7 staffing) in accordance with the emergency plan.	☐
2	10 CFR 50.47(b)(2) Onsite Emergency Organization	
2a	Process ensures that onshift emergency response responsibilities are staffed and assigned	☐
2b	The process for timely augmentation of onshift staff is established and maintained.	☐
3	10 CFR 50.47(b)(3) Emergency Response Support and Resources	
3a	Arrangements for requesting and using off site assistance have been made.	☐
3b	State and local staff can be accommodated at the EOF in accordance with the emergency plan. (NA for CR3)	☐
4	10 CFR 50.47(b)(4) Emergency Classification System	
4a	A standard scheme of emergency classification and action levels is in use. (Requires final approval of Screen and Evaluation by EP CFAM.)	☐
5	10 CFR 50.47(b)(5) Notification Methods and Procedures	

<< 10 CFR 50.54(q) Screening Evaluation Form >>

5a	Procedures for notification of State and local governmental agencies are capable of alerting them of the declared emergency within 15 minutes (60 minutes for CR3) after declaration of an emergency and providing follow-up notification.	☐
5b	Administrative and physical means have been established for alerting and providing prompt instructions to the public within the plume exposure pathway. (NA for CR3)	☐
5c	The public ANS meets the design requirements of FEMA-REP-10, Guide for Evaluation of Alert and Notification Systems for Nuclear Power Plants, or complies with the licensee's FEMA-approved ANS design report and supporting FEMA approval letter. (NA for CR3)	☐

<< 10 CFR 50.54(q) Screening Evaluation Form >>

Part IV. Emergency Planning Element and Function Screen (cont.)		
6	10 CFR 50.47(b)(6) Emergency Communications	
6a	Systems are established for prompt communication among principal emergency response organizations.	☐
6b	Systems are established for prompt communication to emergency response personnel.	☐
7	10 CFR 50.47(b)(7) Public Education and Information	
7a	Emergency preparedness information is made available to the public on a periodic basis within the plume exposure pathway emergency planning zone (EPZ). (NA for CR3)	☐
7b	Coordinated dissemination of public information during emergencies is established.	☐
8	10 CFR 50.47(b)(8) Emergency Facilities and Equipment	
8a	Adequate facilities are maintained to support emergency response.	☐
8b	Adequate equipment is maintained to support emergency response.	☐
9	10 CFR 50.47(b)(9) Accident Assessment	
9a	Methods, systems, and equipment for assessment of radioactive releases are in use.	x
10	10 CFR 50.47(b)(10) Protective Response	
10a	A range of public PARs is available for implementation during emergencies. (NA for CR3)	☐
10b	Evacuation time estimates for the population located in the plume exposure pathway EPZ are available to support the formulation of PARs and have been provided to State and local governmental authorities. (NA for CR3)	☐
10c	A range of protective actions is available for plant emergency workers during emergencies, including those for hostile action events.	☐
10d	KI is available for implementation as a protective action recommendation in those jurisdictions that chose to provide KI to the public.	☐
11	10 CFR 50.47(b)(11) Radiological Exposure Control	
11a	The resources for controlling radiological exposures for emergency workers are established.	☐
12	10 CFR 50.47(b)(12) Medical and Public Health Support	
12a	Arrangements are made for medical services for contaminated, injured individuals.	☐
13	10 CFR 50.47(b)(13) Recovery Planning and Post-accident Operations	
13a	Plans for recovery and reentry are developed.	☐
14	10 CFR 50.47(b)(14) Drills and Exercises	
14a	A drill and exercise program (including radiological, medical, health physics and other program areas) is established.	☐
14b	Drills, exercises, and training evolutions that provide performance opportunities to develop, maintain, and demonstrate key skills are assessed via a formal critique process in order to identify weaknesses.	☐
14c	Identified weaknesses are corrected.	☐
15	10 CFR 50.47(b)(15) Emergency Response Training	
15a	Training is provided to emergency responders.	☐

<< 10 CFR 50.54(q) Screening Evaluation Form >>

Part IV. Emergency Planning Element and Function Screen (cont.)		
16	10 CFR 50.47(b)(16) Emergency Plan Maintenance	
16a	Responsibility for emergency plan development and review is established.	☐
16b	Planners responsible for emergency plan development and maintenance are properly trained.	☐

PART IV. Conclusion If no Part IV criteria are checked, a 10 CFR 50.54(q) Effectiveness Evaluation is not required, then complete Attachment 4, 10 CFR 50.54(q) Screening Evaluation Form, Part V. Justification:	☐
If any Attachment 4, 10 CFR 50.54(q) Screening Evaluation Form, Part IV criteria are checked, then complete Attachment 4, 10 CFR 50.54(q) Screening Evaluation Form, Part V and perform a 10 CFR 50.54(q) Effectiveness Evaluation. Program Element 4a requires final approval of Screen and Evaluation by EP CFAM.	X

Part V. Signatures: EP CFAM Final Approval is required for changes affecting Program Element 4a. If CFAM approval is **NOT** required, then mark the EP CFAM signature block as not applicable (N/A) to indicate that signature is not required.		
Preparer Name (Print): Randy Gibson	Preparer Signature: [signature]	Date: 5/14/18
Reviewer Name (Print): Renard O. Burris	Reviewer Signature: [signature]	Date: 5/15/18
Approver (EP Manager Name (Print): Kevin L. Murray	Approver Signature: K. L. Murray	Date: 5-24-18
Approver (EP CFAM, as required) Name (Print) N/A	Approver Signature: N/A	Date: N/A

QA RECORD

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

Screening and Evaluation Number	Applicable Sites	
EREG #:2193370	BNP	☐
	CNS	☐
	CR3	☐
	HNP	☐
5AD #:2193356	MNS	X
	ONS	☐
	RNP	☐
	GO	☐

Document and Revision

HP/0/B/1009/002 Alternative Method for Determining Dose Rate within the Reactor Building Rev 003

Part I. Description of Proposed Change:

AR02080957, the primary change to this procedure is to change the location of the survey used to determine dose rates within the reactor building when 1 or 2 EMFs 51A/B are inoperable during emergency conditions. The survey location is being changed from on contact with the outside surface of the outer upper airlock to on contact with the outside surface of the Spent Fuel Building to Upper Containment VE Door. With the additional distance from the containment source and additional shielding provided by the VE door the multiplication factor used in Step 4.1.3 and Enclosure 5.1 is changed from 740.0 to 1363. The variables used in determining the new multiplication factor are included with the procedure as Enclosure 5.2. Location of survey is being changed because it is unlikely that a survey of the outer airlock door will be possible with VE in operation. The fuel building location is simpler, safer and doable with VE in service.

Instrument names Teletector and Extender have been deleted. Teletector and Extender are trade names which are no longer used here.

References to survey instrument MCHPS number have been deleted and simply replaced with instrument number.

Additional changes: Inserted Revision History page, restored procedure format

Attachment 6, 10 CFR 50.54(q) Initiating Condition (IC) and Emergency Action Level (EAL) and EAL Bases Validation and Verification (V&V) Form , is attached (required for IC or EAL change)	Yes No X

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

Part II. Description and Review of Licensing Basis Affected by the Proposed Change:

DESCRIPTION

MNS Emergency Plan Section I ACCIDENT ASSESSMENT rev 18-1

I.6 Release Rates/Projected Dose For Offscale Instrumentation

If instrumentation used for dose assessment is offscale or inoperable, dose rates within the Reactor Building will be determined using procedure HP/0/B/1009/002, Alternative Method for Determining Dose Rate Within the Reactor Building, or HP/0/B/1009/006, Procedure for Quantifying High Level Radioactivity Release During Accident Conditions.

The change to HP/0/B/1009/002 continues to meet the requirement of **MNS Emergency Plan Section I(6) Release Rates/Projected Dose For Offscale Instrumentation**

Part III. Description of How the Proposed Change Complies with Regulation and Commitments.

If the emergency plan, modified as proposed, no longer complies with planning standards in 10 CFR 50.47(b) and the requirements in Appendix E to 10 CFR Part 50, then ensure the change is rejected, modified, or processed as an exemption request under 10 CFR 50.12, Specific Exemptions, rather than under 10 CFR 50.54(q):

NUREG 0654 I (6). Each licensee shall establish the methodology for determining the release rate/projected doses if the instrumentation used for assessment are offscale or inoperable.

10CFR50.47(b)(9) Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.

MNS Procedure HP/0/B/1009/002, Alternative Method for Determining Dose Rate Within the Reactor Building, describes and provides a method to determine dose rates in the Reactor Building during an emergency situation when 1EMF51 A&B or 2EMF51 A&B are not available. Revision 2 of the procedure was approved on 11/23/1999 and required the user to obtain a dose rate at the 'Upper Personnel Hatch Air Lock Door (R/hr)' described in step 4.1.3. The current perspective is that it would be extremely difficult to open the VE (Annulus Ventilation) Door at the Upper Containment (U/C) access point and doing so would also present a significant personnel safety concern. A preferential location would be the outside of the VE Door from the associated Spent Fuel Building near the U/C access. The travel path and this location are more easily accessible, exposes the performer to lower dose rates and does not subject the user to unnecessary safety risks. The selected location at the Spent Fueling Building side of the VE door is also directly aligned with the airlock doors to provide practical dose rate information. The new calculated correction factor was derived using the same methodology as the previous factor but is at a farther distance and accounts for additional shielding encountered by the additional VE door.

MNS continues to maintain methodology for determining the release rate/projected doses if the instrumentation

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

used for assessment are offscale or inoperable. The changes to HP/0/B/1009/002 provides a safer more efficient method to determine dose rates in the event (1)(2) EMF 51A & EMF51B is offscale or inoperable.

These proposed changes continue to support the requirements described in **10CFR50.47(b)(9) and NUREG 0654 I (6).**

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

Part IV. Description of Emergency Plan Planning Standards, Functions and Program Elements Affected by the Proposed Change (Address each function identified in Attachment 4, 10 CFR 50.54(q) Screening Evaluation Form, Part IV of associated Screen):

AD-EP-ALL-0602 Attachment 5 10 CFR 50.54(q) Effectiveness Evaluation Form states:
9 10 CFR 50.47(b)(9) Accident Assessment
9a Methods, systems, and equipment for assessment of radioactive releases are in use.

NUREG 0654
NUREG 0654 I. Accident Assessment
Planning Standard states
" Adequate methods, systems and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use."

NUREG 0654 I (6). Each licensee shall establish the methodology for determining the release rate/projected doses if the instrumentation used for assessment are offscale or inoperable.

10CFR50.47(b)(9) Adequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use.

MNS continues to maintain methodology for determining the release rate/projected doses if the instrumentation used for assessment are offscale or inoperable. The changes to HP/0/B/1009/002 provides a safer more efficient method to determine dose rates in the event (1)(2) EMF 51A & EMF51B is offscale or inoperable as described in **NUREG 0654 I (6)**..

These proposed changes continue to support the requirements Adequate methods, systems and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use as described in **10CFR50.47(b)(9).**

Part V. Description of Impact of the Proposed Change on the Effectiveness of Emergency Plan Functions:

Part V. Description of Impact of the Proposed Change on the Effectiveness of Emergency Plan Functions:
MNS Procedure HP/0/B/1009/002, Alternative Method for Determining Dose Rate Within the Reactor Building, describes and provides a method to determine dose rates in the Reactor Building during an emergency situation when 1EMF51 A&B or 2EMF51 A&B are not available. Revision 2 of the procedure was approved on 11/23/1999

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

and required the user to obtain a dose rate at the 'Upper Personnel Hatch Air Lock Door (R/hr)' described in step 4.1.3. The current perspective is that it would be extremely difficult to open the VE (Annulus Ventilation) Door at the Upper Containment (U/C) access point and doing so would also present a significant personnel safety concern. A preferential location would be the outside of the VE Door from the associated Spent Fuel Building near the U/C access. The travel path and this location are more easily accessible, exposes the performer to lower dose rates and does not subject the user to unnecessary safety risks. The selected location at the Spent Fueling Building side of the VE door is also directly aligned with the airlock doors to provide practical dose rate information. The new calculated correction factor was derived using the same methodology as the previous factor but is at a farther distance and accounts for additional shielding encountered by the additional VE door.

MNS continues to maintain methodology for determining the release rate/projected doses if the instrumentation used for assessment are offscale or inoperable. The changes to HP/0/B/1009/002 provides a safer more efficient method to determine dose rates in the event (1)(2) EMF 51A & EMF51B is offscale or inoperable as described in **NUREG 0654 I (6)**..

These proposed changes continue to support the requirements Adequate methods, systems and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use as described in **10CFR50.47(b)(9).**

The change to HP/0/B/1009/002 continues to meet the requirement of **MNS Emergency Plan Section I(6) Release Rates/Projected Dose For Offscale Instrumentation.**

The proposed changes described in Revision 003 of HP/0/B/1009/002 Alternative Method for Determining Dose Rate within the Reactor Building do not result in a reduction in effectiveness of facilities, response organizations, or response equipment. The proposed changes do not reduce the effectiveness of The McGuire Emergency Plan or the Emergency Plan Implementing Procedure HP/0/B/1009/002 .

Part VI. Evaluation Conclusion.
Answer the following questions about the proposed change.

1	Does the proposed change comply with 10 CFR 50.47(b) and 10 CFR 50 Appendix E?	Yes X	No ☐
2	Does the proposed change maintain the effectiveness of the emergency plan (i.e., no reduction in effectiveness)?	Yes X	No ☐
3	Does the proposed change maintain the current Emergency Action Level (EAL) scheme?	Yes X	No ☐
4	Choose one of the following conclusions:		
a	The activity does continue to comply with the requirements of 10 CFR 50.47(b) and 10 CFR 50, Appendix E, and the activity does not constitute a reduction in effectiveness or change in the current Emergency Action Level (EAL) scheme. Therefore, the activity can be implemented without prior NRC approval.		X

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

b	The activity does not continue to comply with the requirements of 10 CFR 50.47(b) or 10 CFR 50 Appendix E or the activity does constitute a reduction in effectiveness or EAL scheme change. Therefore, the activity cannot be implemented without prior NRC approval.	☐

Part VII. Disposition of Proposed Change Requiring Prior NRC Approval		
Will the proposed change determined to require prior NRC approval be either revised or rejected?	Yes ☐	No ☐
If No, then initiate a License Amendment Request in accordance 10 CFR 50.90 and AD-LS-ALL-0002, Regulatory Correspondence, and include the tracking number:____.		

<< 10 CFR 50.54(q) Effectiveness Evaluation Form >>

Part VIII. Signatures: EP CFAM Final Approval is required for changes affecting risk significant planning standard 10 CFR 50.47(b)(4). If CFAM approval is **NOT** required, then mark the CFAM signature block as not applicable (N/A) to indicate that signature is not required.		
Preparer Name (Print): Randy Gibson	Preparer Signature: [signature]	Date: 5/14/18
Reviewer Name (Print): Renard O. Burris	Reviewer Signature: [signature]	Date: 5/15/18
Approver (EP Manager) Name (Print): Kevin L. Murray	Approver Signature: K. L. Murray	Date: 5-24-18
Approver (CFAM, as required) Name (Print): N/A	Approver Signature: N/A	Date: N/A

If the proposed activity is a change to the E-Plan or implementing procedures, then create two EREG General Assignments. If required by Section 5.6, Submitting Reports of Changes to the NRC, then create two EREG General Assignments.	
• One for EP to provide the 10 CFR 50.54(q) summary of the analysis, or the completed 10 CFR 50.54(q), to Licensing.	☐
• One for Licensing to submit the 10 CFR 50.54(q) information to the NRC within 30 days after the change is put in effect.	☐

QA RECORD

Duke Energy Company MCGUIRE NUCLEAR STATION **Alternative Method For Determining Dose Rate Within the Reactor Building** **Reference Use**	Procedure No. **HP/0/B/1009/002** Revision No. **003**

PERFORMANCE

This Procedure was printed on 6/26/2018 9:02 AM from the electronic library as:

(ISSUED) - PDF Format

Date(s) Performed	Work Order/Task Number (WO#)

COMPLETION

☐ Yes ☐ NA Checklists and/or blanks initialed, signed, dated, or filled in NA, as appropriate?
☐ Yes ☐ NA Required attachments included?
☐ Yes ☐ NA Charts, graphs, data sheets, etc. attached, dated, identified, and marked?
☐ Yes ☐ NA Calibrated Test Equipment, if used, checked out/in and referenced to this procedure?
☐ Yes ☐ NA Procedure requirements met?

Verified By ** Printed Name and Signature*	Date
Procedure Completion Approved ** Printed Name and Signature*	Date

Remarks (*attach additional pages, if necessary*)

IMPORTANT: Do **NOT** mark on barcodes.

Printed Date: *6/26/18*

Attachment Number: *FULL*

Revision No.: *003*

Procedure No.: *HP/0/B/1009/002*

Duke Energy McGuire Nuclear Station **Alternative Method for Determining Dose Rate within the Reactor Building** **EPIP procedure. Issuance of procedure must be coordinated with Emergency Planning to ensure resources are available to update hard copies of procedures.** **Reference Use**	Procedure No. HP/**0**/B/1009/002 Revision No. 003 Electronic Reference No. MC0045FV

Revision History (significant issues, limited to one page)

Rev 003 (12/8/2016) AR02080957, the primary change to this procedure is to change the location of the survey used to determine dose rates within the reactor building when 1 or 2 EMFs 51A/B are inoperable during emergency conditions. The survey location is being changed from on contact with the outside surface of the outer upper airlock to on contact with the outside surface of the Spent Fuel Building to Upper Containment VE Door. With the additional distance from the containment source and additional shielding provided by the VE door the multiplication factor used in Step 4.1.3 and Enclosure 5.1 is changed from 740.0 to 1363. The variables used in determining the new multiplication factor are included with the procedure as Enclosure 5.2.

Instrument names Teletector and Extender have been deleted.

References to survey instrument MCHPS number have been deleted and simply replaced with instrument number.

Additional changes: Inserted Revision History page, restored procedure format

Alternative Method for Determining Dose Rate within the Reactor Building

Reference Use

1. Purpose

This procedure describes an alternative method for determining the approximate dose rate within the reactor building in the event the reactor building monitors (1EMF51A & B or 2EMF51A & B) are inoperable.

The level for this procedure is Reference Use. This procedure must be at the job site at all times.

2. References

None

3. Limits and Precautions

3.1 This procedure is written for use under abnormal conditions which could involve extremely high radiation levels. Only the Radiation Protection Manager (RPM) or designee shall authorize the use of this procedure when needed.

3.2 Appropriate Surveillance and Control coverage shall be used under the direction of the Operations Support Center (OSC).

4. Procedure

4.1 Determination of Dose Rate

4.1.1 Ensure that the high range survey instrument to be used is in calibration and a daily response check has been performed.

4.1.2 Obtain a reading by placing the detector in contact with the exterior center portion of the appropriate unit Spent fuel Building to Upper Containment VE Door.

_____ Unit 1 (1200C) __________ R/hr

_____ Unit 2 (1250C) __________ R/hr

4.1.3 Calculate the reactor building dose rate by use of the following equation:

$$R_B = 1363 \times R_H$$

Where:

R_B = Reactor Building Dose Rate (R/hr)

R_H = Dose Rate outside Spent Fuel Building to Upper Containment VE Door (R/hr)

4.1.4 Forward the following information to the Radiation Protection Technician in the Shift Lab (ext. 4282), TSC Dose Assessors (ext. 4976) or EOF Dose Assessors (382-0744, 0745).

4.1.4.1 Dose rate reading from instrument.

4.1.4.2 Instrument number.

4.1.4.3 Your name.

4.1.4.4 RB doserate calculated in Step 4.1.3.

4.2 Record all necessary information and results on Enclosure 5.1.

4.3 The Reactor Building dose rate shall be determined as directed by the Radiation Protection Manager or designee.

5. Enclosures

5.1 Reactor Building Dose Rate Data Sheet

5.2 Variables Used in Determining Dose Rate within the Reactor Building

Reference Use

DATE/TIME	DOSE RATE (R/HR)	× 1363 =	RX BUILDING DOSE RATE (R/HR)	SURVEYING TECHNICIAN	INSTRUMENT NUMBER
		× 1363 =			
		× 1363 =			
		× 1363 =			
		× 1363 =			
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Reference Use

June 30, 2015

Memorandum to File
McGuire Nuclear Station

Subject: McGuire Nuclear Station (MNS)
Variables Used in HP/0/B/1009/002
File: MC- 752.05 Plant Radiological Monitoring

Condition Statement

MNS Procedure HP/0/B/1009/002, Alternative Method for Determining Dose Rate Within the Reactor Building, describes and provides a method to determine dose rates in the Reactor Building during an emergency situation when 1EMF51 A&B or 2EMF51 A&B are not available. Revision 2 of the procedure was approved on 11/23/1999 and required the user to obtain a dose rate at the 'Upper Personnel Hatch Air Lock Door (R/hr)' described in step 4.1.3. The current perspective is that it would be extremely difficult to open the VE (Annulus Ventilation) Door at the Upper Containment (U/C) access point and doing so would also present a significant personnel safety concern. A preferential location would be the outside of the VE Door from the associated Spent Fuel Building near the U/C access. The travel path and this location are more easily accessible, exposes the performer to lower dose rates and does not subject the user to unnecessary safety risks. The selected location at the Spent Fueling Building side of the VE door is also directly aligned with the airlock doors to provide practical dose rate information. The new calculated correction factor was derived using the same methodology as the previous factor but is at a farther distance and accounts for additional shielding encountered by the additional VE door.

References

(1) A 'MEMORANDUM TO FILE" dated January 23, 1984 from Catawba Nuclear Station (CNS) is included in the CNS Procedure HP/0/B/1009/006, Alternative Method for Determining Dose Rate within the Reactor Building was referenced and agrees with the methodology.

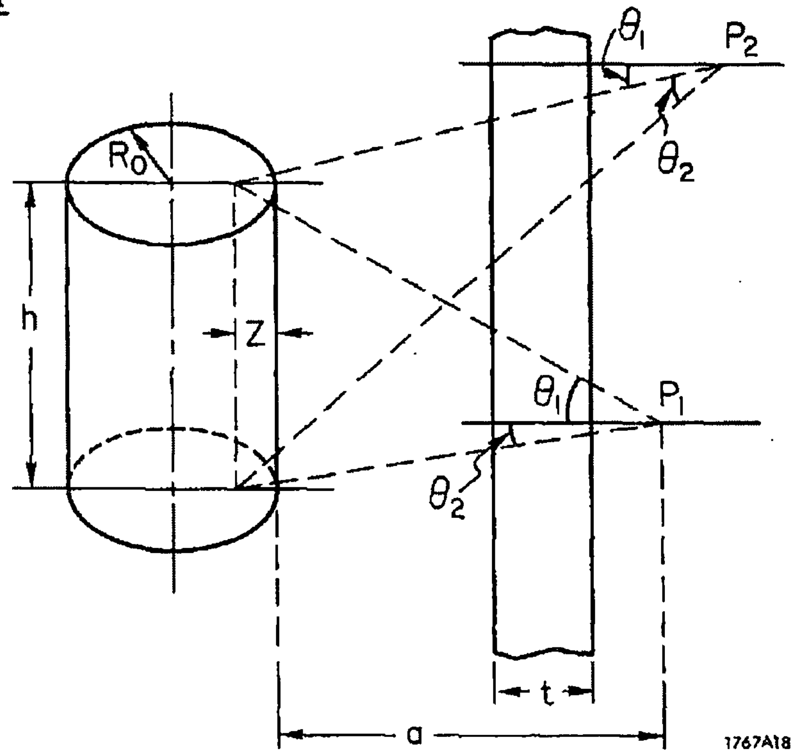
(2) Concepts of Radiation Dosimetry by Kenneth R. Kase and Walter R. Nelson, Stanford Linear Accelerator Center, Stanford University was used as a reference for the equation in deriving the new correction factor.

(3) Radiological Health Handbook, January 1970 Edition, was used as a reference for density and mass attenuation coefficients.

The applicable pages from Reference 2 are provided below for documentation.

Below are the diagrams and equations for calculating the dose rate outside containment.

5.8 Right-Circular Cylinder Source: Infinite-Slab Shield, Uniform Activity Distribution



The slab absorber is parallel to the cylinder axis. The source strength per unit volume, S_V, is constant. The exact solution[3] of this problem is very lengthy and is not generally used. What is usually done[1] (FBM) is to approximate the cylinder by a line source of strength $S_L = \pi R_0^2 S_V$ which is positioned within the cylinder to correctly account for self absorption. There is no simple expression for $Z = Z(R_0, a, b)$, the self absorption distance; however, by empirically fitting the approximate method to the exact calculations,[3] only three curves for Z plus the $F(\theta, b)$ curves (that is, the Sievert integrals) for line sources are needed in order to solve cylinder-slab problems. The three curves needed to obtain Z are given in the Appendix and are used as follows:

<u>CASE</u>: $a/R_0 \geq 10$

Use figure A.20 (see Appendix) and $\mu_s R_0$ to obtain $\mu_s Z$, where $\mu_s(cm^{-1})$ is the macroscopic source attenuation coefficient. Then obtain b_2 from

$$b_2 = b_1 + \mu_s Z \qquad (5.27)$$

where

$$b_1 = \sum_i \mu_i t_i \qquad (5.28)$$

Finally, obtain the flux density at P_1 from

$$\phi_1 = \frac{S_V R_0^2}{4(a+Z)} [F(\theta_1, b_2) + F(\theta_2, b_2)] \qquad (5.29)$$

and at P_2 from

$$\phi_2 = \frac{S_V R_0^2}{4(a+Z)} [F(\theta_2, b_2) - F(\theta_1, b_2)] \qquad (5.30)$$

using the F-functions which are plotted in the Appendix. These estimates of the flux density are supposedly good to ± 10%,* provided $a/R_0 \geq 10$.

*Note: Provided that the correct buildup factors have been included.

CASE: $a/R_0 < 10$

Use Figs. A.21 and A.22 in conjunction with each other to obtain $\mu_s Z$. That is, knowing R_0, a, and μ_s, find m from the first graph; knowing a/R_0 and b_1, fin $\mu_s Z/m$ from the second graph; then multiply these together to obtain $\mu_s Z$. Finall follow the recipe above to obtain ϕ. This approximation will be good to + 40% and -5%.

Other formulas are given for cylinders viewed exterior on end, and interior[1] (FBM).

Example:

Consider a cylindrical tank containing radioactive water uniformly distribute throughout. The field positron is P_1 with $\theta_1 = \theta_2$, and the distance is restricted t

$$R_0 \leq a \leq 70.0 \text{ inches}$$

with

1) $R_0 = 5.5$ inches
2) $h = 14.0$ inches
3) no shielding or buildup
4) self absorption in the water

and

5) the radioactive source consists mainly of 0.511 MeV photons with $\mu_s = 0.092\ \text{cm}^{-1}$ (the total attenuation coefficient for water).

The normalized flux density is obtained from Eq. (5.29), and is

$$2\phi/S_V R_0^2 = \frac{F(\theta, b_2)}{a + Z}$$

where we have dropped the subscript on theta, and where

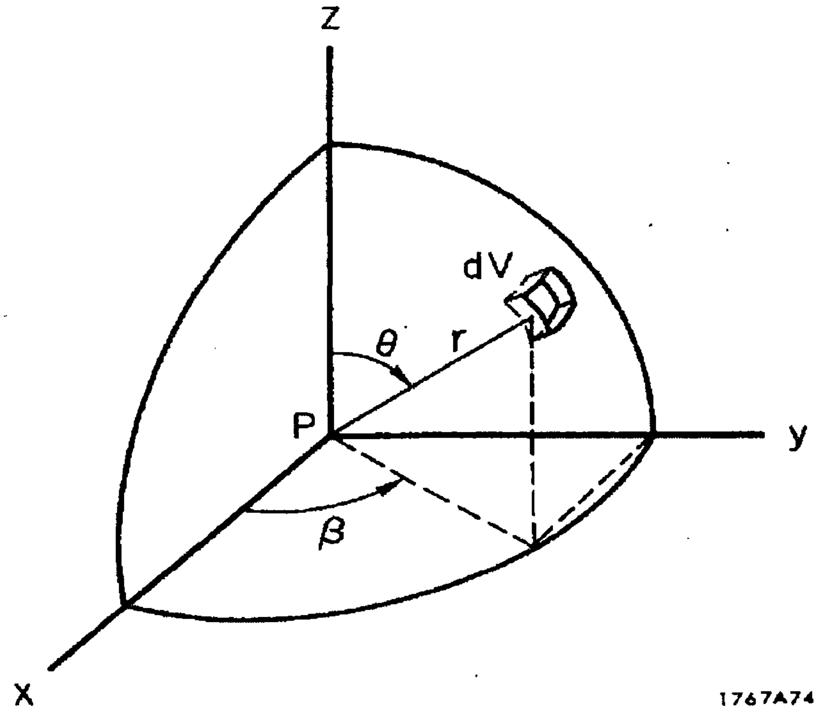
$$\tan\theta = h/2(a + Z)$$

$$b_2 = \mu_s Z \quad .$$

Using Figs. A.14, 20, 21, and 22, we obtain Table 5.1.

Below are the diagrams and equations for calculating the dose rate inside containment.

5.10 Spherical Source: Field Position at Center of Sphere



- 125 -

$$d\phi = \frac{S_V e^{-\mu_s r} dV}{4\pi r^2} = \frac{S_V e^{-\mu_s r} r^2 \sin\theta \, dr \, d\theta \, d\beta}{4\pi r^2}$$

$$\phi = \frac{S_V}{4\pi} \int_0^{R_0} \int_0^{\pi} \int_0^{2\pi} e^{-\mu_s r} \sin\theta \; dr \; d\theta \, d\beta$$

$$= \frac{S_V}{\mu_s} \left(1 - e^{-\mu_s R_0}\right) \qquad (5.32)$$

This submersion situation is applicable to finding the dose rate in a radioactive cloud or in a body of contaminated water. By symmetry, the uncollided flux from a hemisphere (that is, no buildup) is exactly one-half of this.

Provided on the next three (3) pages are the figures used from Reference 2 in solving equation 5.29.

Specifically;

Fig A.21 is used to determine m

Fig A.22 is used to determine $\frac{1}{m}\mu_s Z$

Fig A.14 is used to determine $F(\theta_1, b_2) and\ F(\theta_2, b_2)$.

Enclosure 5.2

Variables Used in Determining Dose Rate within the Reactor Building

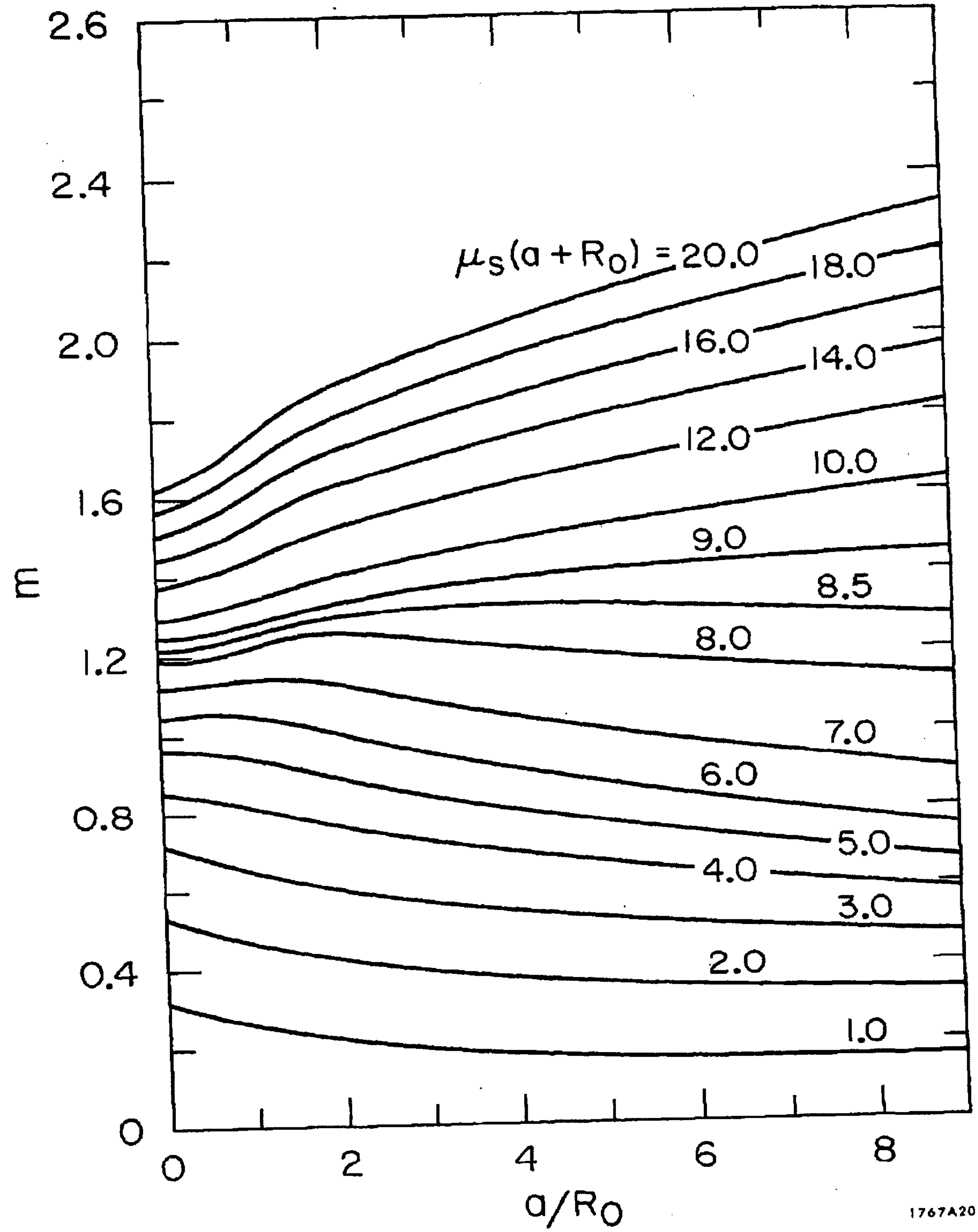


FIG. A.21

Self-absorption distance, Z, of a cylinder for $a/R_0 < 10$.

Note: Use in conjunction with Fig. A.22

Variables Used in Determining Dose Rate within the Reactor Building

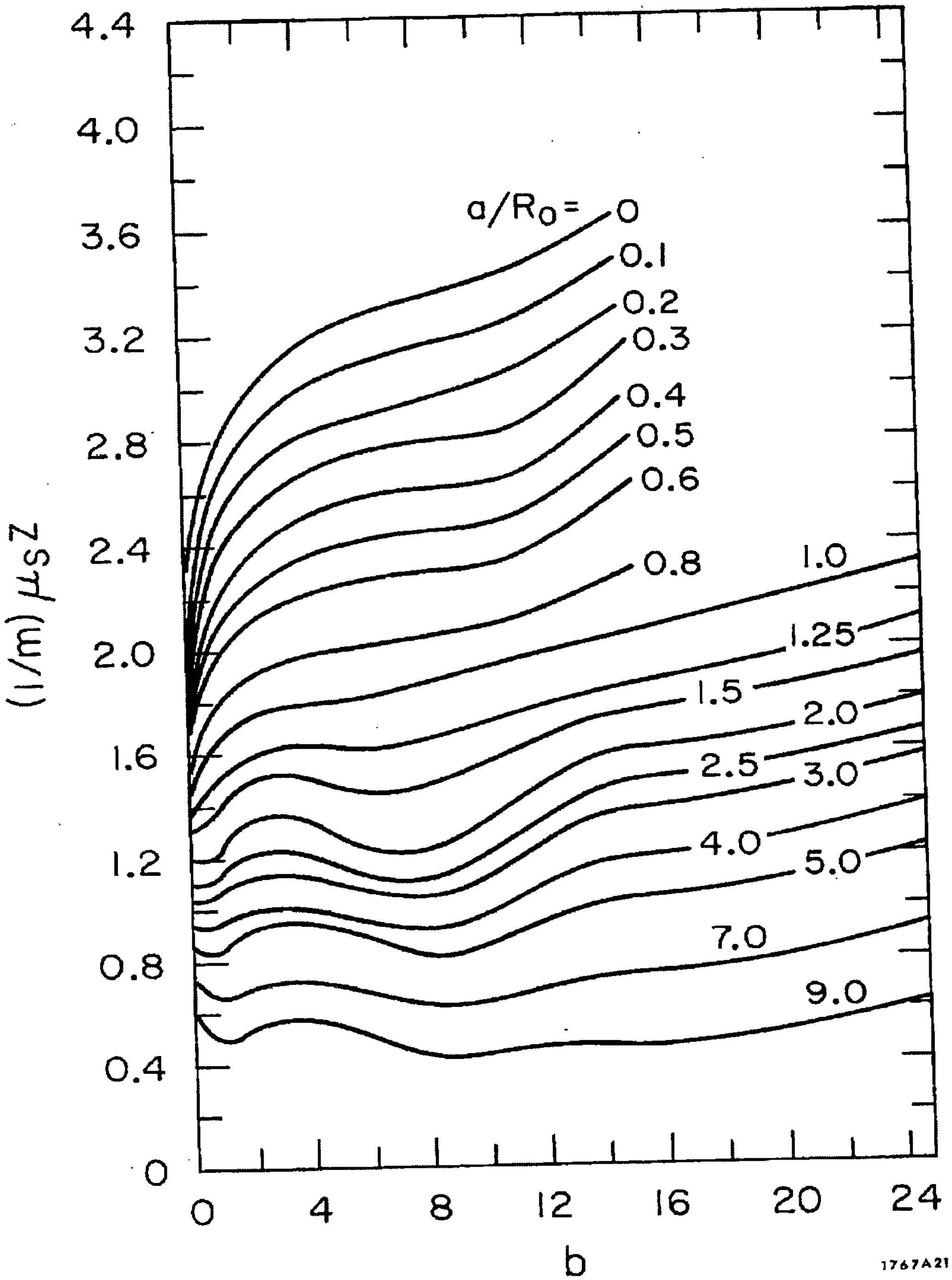


FIG. A.22

Self-absorption distance, Z, of a cylinder for $a/R_0 < 10$.

Note: Use in conjunction with Fig. A.21

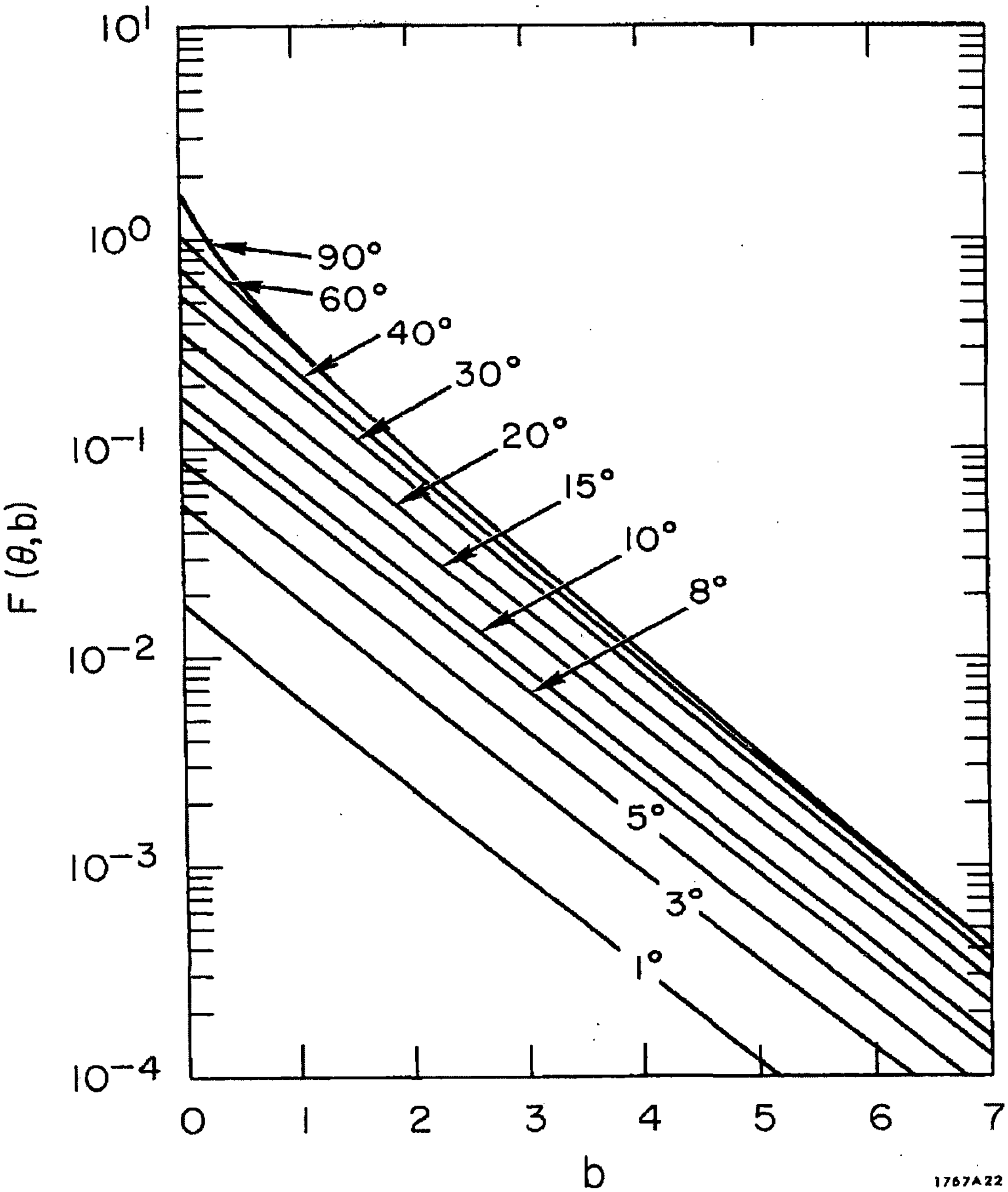

10¹
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
F (θ,b)
90°
60°
40°
30°
20°
15°
10°
8°
5°
3°
1°
0
1
2
3
4
5
6
7
b
1767A22

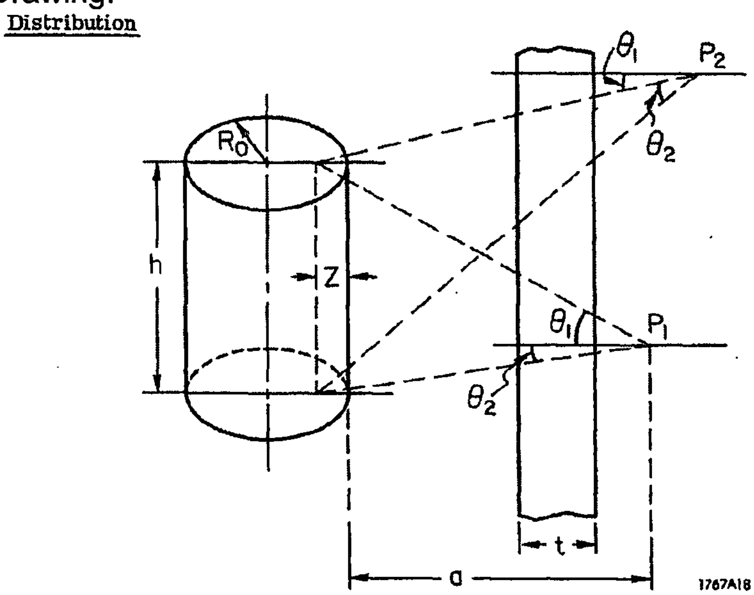
FIG. A.14

<u>Calculation and Solution</u>

Assumptions:

- The average gamma energy per disintegration is 0.5 MeV
- 1 photon per decay
- Steel (VE door and airlock doors) was modeled as iron (Fe) when selecting density and mass attenuation coefficients
- Radioactive concentrations inside containment were considered an instantaneous uniform concentration
- Assumed the concentration in Upper Containment was the only influence on dose rate calculated at SFP VE door
- STP was assumed for the density and mass attenuation coefficient of air
- Dose rates inside containment were calculated assuming a sphere of infinite radioactive cloud of radius R_0 =57'6".

MNS Model Drawing:



Where:

R_0=57' 6"
h = 64' 3" and is considered from the U/C Floor to Dome
a= 22'
t=3.5"
θ_1=32°
θ_2=2°
Z=49.9'
P_1= detector location (on SFP side of VE Door at SFP Door at U/C)

Variables Used in Determining Dose Rate within the Reactor Building

Using equation 5.29 of Reference 2, and following the steps outlined for **CASE**: $a/R_0<10$ on page 120, the flux outside containment at point P_1 is calculated as follows:

$$\phi_1 = \frac{S_V R_0^2}{4(a+Z)} \left[F(\theta_1, b_2) + F(\theta_2, b_2)\right]$$

$$\frac{a}{R_0} = \frac{22'}{57.5'} = .383$$

$$\mu_s = .0870 \frac{cm^2}{g} \times .001293 \frac{g}{cm^3} = 1.12 \times 10^{-4}\, cm^{-1}$$

$$\mu_s(a+R_0) = 1.12 \times 10^{-4} cm^{-1}(670.56cm + 1752.6cm) = .273$$

Note: the mass attenuation coefficient and density used to find μ_s were taken from Reference 3.

$$b_1 = \sum_i \mu_i t_i = (661.67\ cm)(1.12 \times 10^{-4}\ cm^{-1}) + (8.89cm)(.471cm^{-1}) = 4.26$$

From figure A.21, m= 0.1, using a/R_0 and $\mu_s(a+R_0)$

From figure A.22 $\frac{1}{m}\mu_s Z = 2.5$

since $m = 0.1$

$\mu_s Z = .25$

and $Z = 2232\ cm = 73.2'$

$b_2 = b_1 + \mu_s Z = 4.5$

and

at P_1 $\varphi_1 = \frac{S_v R_0^2}{4(a+Z)}[F(\theta_1, b_2) + F(\theta_2, b_2)]$

From figure A.14 $F(32°, 4.5) = 4 \times 10^{-3}$ *and* $F(2°, 4.5) = 4 \times 10^{-4}$

$$\varphi = \frac{S_v(1752.6\ cm)^2}{4(670.56\ cm + 2232\ cm)}[(4 \times 10^{-3}) + (4 \times 10^{-4})] = 1.16\, S_v$$

Note: φ is the flux is at the detector or P_1 and S_v is the activity

Using equation 5.32 of Reference 2, the flux inside containment is calculated as follows:

$$\phi = \frac{S_V}{4\pi}\int_0^{R_0}\int_0^{\pi}\int_0^{2\pi} e^{-\mu_s r} \sin\theta \; dr\; d\theta\, d\beta$$

$$= \frac{S_V}{\mu_s}\left(1 - e^{-\mu_s R_0}\right)$$

$$\varphi = \frac{S_v}{\mu_s}\left(1 - e^{-\mu_s \times R_0}\right) = \frac{S_v}{1.12 \times 10^{-4} cm^{-1}}\left(1 - e^{-1.12\times 10^{-4} cm^{-1} \times 1752.6 cm}\right) = 1591.3\, S_v$$

Finally the ratio of the inside and outside containment flux are given as:

$$\frac{1591.3\, S_v}{1.168\, S_v} = 1363$$

Note: S_v (activity) is constant for both equations and cancels on division.

Conclusion

Applying the same methodology as previously used but at an increased distance and accounting for additional shielding results in the following equation for use in MNS Procedure HP/0/B/1009/002:

$DRi = 1363\ X\ DRo$

Where:

DRi=Dose Rate Inside the Reactor Building (indicative of Unit 1/2 EMF51 A&B Dose Rate Reading)

DRo=Dose Rate obtained on SFP side of SFP VE Door at Upper Containment

This number is applicable to either unit at McGuire Nuclear Station and is independent of concentration or time after shutdown.

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