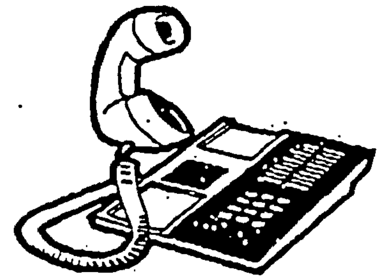
Niagara Mohawk Power Corporation
Nine Mile Point Nuclear Station
Unit 2, P. O. Box 63
Lycoming, New York 13093



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DEPT.: NRC

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COMMENTS:

FROM: Ted Kulczycky
Nuclear Engineering, ESB-2
EXT: 315-349-1949
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NIAGARA MOHAWK NUCLEAR ENGINEERING

DISPOSITION COVER SHEET

NINE MILE POINT NUCLEAR STATION Unit (1, 2 or 0=Both) : 1 Discipline : ANALYSIS

Title	Calculation No.	Rev	Disp
UNIT 1 FUEL HANDLING ACCIDENT DOSES IN UNIT 1 CONTROL ROOM	H21C045	01	01A
	Originator: T. M. KURTZ TMK		Date: 5/23/98

(Sub)System(s)	Index No.	Checker	Date
202	N/A	A. C. MOISAN acm	5/23/98
Design/Configuration Change No.: N1-98-016		Approver: T. G. KULCZYCKY TGK	Date: 5/23/98

NMPC Acceptance/Date: N/A

Superseded Document(s) : NONE

Description of Change

Calculation H21C045, revision 01, used 95% RBEV filter efficiency for elemental iodine to be consistent with Regulatory Guide 1.52 guidance and system design. Technical Specification 3.4.4.c states that the minimum allowable filter efficiency is 90%. Therefore, this disposition determines control room doses based on 90% RBEV charcoal filter efficiency.

Resolution

Doses were: Thyroid: 5.38 Rem, Gamma: 0.0219 Rem, and Beta (skin): 0.822 rem. For a design basis Unit 1 Fuel Handling accident, control room doses are less than 10CFR50 Appendix A GDC 19 acceptance criteria assuming 90 % RBEV charcoal filter efficiency for elemental and methyl iodide. Therefore, the conclusions of H21C045, revision 01, remain valid.

Cross Reference change(s):
NONE

Confirmation Required (Yes / No) : No See Page(s) : ______	Final Issue Status (APP / FIO / VOI) : APP	File Location (Calc / Hold) :Calc	Operations Acceptance Req'd. (Yes / No) : No

Evaluation Number(s): N/R
Copy of Applicability Review Attached (Yes / N/R)? N/R

Key Words : DOSES, GDC 19, FILTER EFFICIENCY, CONTROL ROOM HABITABILITY, FUEL HANDLING ACCIDENT.

Component ID(s) (As shown in MEL) :
FLT-202-41
FLT-202-42

Nine Mile Point Nuclear Station | Unit: 1 | Disposition: 01A

Originator/Date	Checker/Date	Calculation No.	Revision
T. M. Kurtz / 5/23/98	A. C. Moisan / 5/23/98	H21C045	01

Ref.

DATA / ASSUMPTIONS

1. The Reactor Building Emergency Ventilation charcoal efficiency for methyl iodide and elemental iodine is assumed to be 90%. This is in accordance with Unit 1 Technical Specifications 3.4.4.c.
2. The no other changes are made to the DATA / ASSUMPTIONS used in H21C045, revision 01.
3. Refer to H21C045, revision 01, page 12 for references.

CALCULATION

The results of DRAGON run #1072 dated 5/23/98, using the inputs from calculation H21C045, revision 01 with the 90% filter efficiency, are:

CR DOSES NO CR FILTERS
RBEV FILTER ACTIVATION AT T=15 SECONDS
720 HOUR DOSE (REM)

	THYROID	GAMMA	BETA
DOSES IN CONTROL ROOM	5.58	0.0219	0.822
GDC LIMIT	30	5	30

RESULTS / CONCLUSIONS

All doses resulting from a design basis fuel handling accident are less than the GDC 19 criteria with no activation of control room air treatment system.

COMPUTER RUN LOG

JOB#	DATE	DESCRIPTION
1072	5/23/98	DRAGON Unit 1 FHA to Unit 1 CR - no CR filters

The output card is found on the following page.

REFERENCES

See parent calculation H21C045, revision 01 (DATA / ASSUMPTION item 3)

* * * * * * * * * * CARD IMAGE OF INPUT SUBMITTED TO DRAGON * * * * * * * * * *

```
CARD COLUMNS                 1         2         3         4         5         6         7         8    CARD COLUMNS
                    12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD NO.
     1              **NMPI FHA  15 SECONDS TO 720 HRS RBEV FILTER NO CRATS FILTER
     2                5   1110 1 0111      0      1      0      0 0.0075 0.0025      1
     3               SPENT FUEL POOL               1     0     0     0     0 2.0+5     0     0     0
     4               REFUEL FLOOR             1.07+6     0     0   0.0   0.0 2.0+5  0.90   0.9     0
     5               CONTROL ROOM             1.31+5     0     0     0     0   1.0     0     0     1
     6                  0.00+0 2.85+4 3.26+1 2.31+4 3.69-4 4.26+3 0.00+0 0.00+0
     7                  0.00+0 0.00+0 0.00+0 3.69-1 1.71+2 9.65+2 2.77-2 5.21+1
     8                  0.00+0 2.01+2 4.29+2 5.68+4 6.82+2 1.30+4 0.00+0 0.00+0
     9               1           1     0     0     1     0 2530. 2530.3.12-4           1     12.78-4
    10               2           1     0     0     1     0 2530. 2530.3.12-4           1     11.39-3
    11               3           1     0     0     1     0 2530. 2530.3.12-4           1     14.17-3
    12               4           1     0     1     1     0 2530. 2530.3.12-4           1     1   2.0
    13               5           0     0     0     0     0 2530. 2530.1.22-8           1     1 720.0

                    12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

H21C04501A
JOB # 1072
Pg 3 of 3

From: <kulczyckyt@nimo.com>
To: WND2.WNP3(DSH)
Date: 5/21/98 3:18pm
Subject: NMPC Unit 1 Control Room doses resulting from a Fuel HandlingAccident.

Attached calculation determines the radiological consequences of a Fuel Handling Accident to the Unit 1 Control Room.

(See attached file: U1_FHA.doc)

The document is in WORD for Windows version 7.0 format - if unable to read please call. My number is 315-349-1949 or try my pager 1-800-732-4365, pager # 1072.

Ted Kulczycky

CC: GATED.nrcsmtp("moisana@nimo.com","mazzaferrop@nimo...

Activated w/o SGTS = 52 rem thyroid @ 10% gap

0.364 rem wb

Basis for meeting CR dose is setpoint for refueling bridge monitor. That monitor is in TS @ Table 3.6.2.j.

NOTE: This revision is a total rewrite

OBJECTIVE OF CALCULATION

The objectives of this calculation are to:

determine doses in the Unit 1 Control Room resulting from a Unit 1 Fuel Handling Accident (FHA).

confirm that the activity released is sufficient to alarm the refuel bridge radiation monitor

Doses calculated will be compared to the 10CFR50 App A GDC19 (REF 9) dose limits to confirm that the Unit 1 Control Room is habitable following a design basis FHA at Unit 1.

METHOD

Core activity at end of an operating cycle is decayed for 24 hrs as that is assumed to be the earliest point at which fuel is anticipated to be moved. Using the Regulatory Guide 1.25 (REF 1) guidance and the Stone & Webster (SWEC) computer code DRAGON (REF 11), the gap activity in 125 fuel pins of 8x8 fuel is assumed to be released to the fuel pool water. Per the regulatory guide, the water provides a DF of 100 for halogens and 1 for noble gas. The Unit 1 Control Room is assumed to intake air at the normal Unit 1 Control Room ventilation intake rate with emergency filtration conservatively assumed not to actuate. The activity release is completed within two hours and CR doses are calculated for 720 hr and the dose results are then compared to the dose limits given in GDC 19 (REF 9). An output of the DRAGON code is a gamma dose rate in the refuel floor airspace. This result is compared to the technical specification trip point of refuel bridge radiation monitor.

Changes from Revision 0

Due to recent modifications to the Unit 1 Control Room ventilation system and also recalculation of Control Room free air envelope have resulted in the following changes to this analysis

288
2875
3163

Variable	Rev 00	Rev 01
Control room normal intake rate	3550 cfm	2500 cfm
Control room free air volume	1.36+5 ft3	1.31+5 ft3

Revision 0 assumed a partially filtered release from the Unit 1 Reactor Building. Revision 1 provides more discussion of the actual response time of the RB isolation dampers and compares the time required to isolate the reactor building (RB) ventilation versus the time required for the activity released from the pool to reach the RB isolation dampers calculated in REF 16 to show that none of the activity released as a result of a FHA is released unfiltered due to the environment.

Revision 0 used 90% filter efficiency for RBEV which was overly conservative. To be consistent with other Regulatory Guide 1.52 (REF 15) guidance, the following RBEV filter efficiencies are used - elemental (inorganic) - 95% and methyl (organic) - 90%. NO.

Incorporate independent reviewer's comments.

DATA / ASSUMPTIONS

The reactor is assumed to be operating at 102% of full thermal power at the time of plant shutdown (REF 2, page 15.6.5-5 and REF 3 recommend that 102% power be used in analyses to allow for possible instrument errors in registering the power level).

Reactor power level is 1850 MWt and 102% power is 1887 MWt. (REF 4 a).

The core inventory in curie/MWt (from REF 6) is multiplied by the core power level of 1850 MWt and then by 1.02 to account for the instrument uncertainty to give core activity at the time of shutdown. These data are given in Table 1.

125 fuel rods of 8x8 fuel are assumed to fail in the accident (REF 5 Section XV.C.3.2). 8x8 fuel assemblies contain 62 fuel rods each (REF 5 section XV.C.3.2) each and there are 532 fuel assemblies in the reactor (REF 5 Section I.B.4.0) making a total of 62 * 532 = 32984 fuel rods total. Using 8 x 8 fuel is assumed to be more conservative than 9x9 or 11x11 as there is more activity per fuel rod and therefore more activity released as a result of an 8x8 accident.

Release parameters as defined in Safety Guide 25 (REF 1)

10% of the total core halogen and noble gas activity is in the fuel rod gaps with the exception of Kr-85 where the fraction is 30% 2875 / 288 / 2587
all gap activity in the damaged fuel rods is released to the fuel pool water
the fuel pool water has an effective DF of 1 for noble gas and 100 for halogens
radial peaking factor of 1.5 is assumed in the rods that are damaged.
breathing rate of 3.47E-04 m3/sec. This is assumed for the duration (0-720 hr) of the accident.
halogens above the water are 75% inorganic (elemental) and 25% organic (methyl)
all activity released from pool released from building in 2 hrs (or on filters) 2475

The accident is assumed to occur 24 hrs after shutdown as that is judged to be the earliest that fuel can be moved after shutdown. This is consistent with the USAR and previous analysis.

The free volume of the Unit 1 control room is 1.31E+5 ft^3. (REF 8).

The control room normal intake rate is 2250 cfm ± 10%. 2250 cfm + 10% = 2475 cfm, 2875? ±10%

use 2500 cfm (REF 18).

The doors of the control room are weather-stripped and the penetrations sealed to maintain a positive pressure of approximately one-sixteenth of an inch of water (REF 5, page III-11), however, an unfiltered inleakage of 10 cfm to the control room is assumed per REF 2, Section 6.4.III.3.d.(2).(ii). An additional 20 cfm is assumed to account for an unfiltered inleakage (REF 7) through an unsealed drain. The total inleakage of 30 cfm combined with the normal ventilation flow rate makes the total Unit 1 CR air intake rate 2530 cfm.

Stack 0 - 2 hr and 2 hr -720 χ/Q values are given in Table 2 (REF 6).

GDC 19 (REF 9) dose limit 5 Rem whole body or its equivalent. This equates to 30 Rem Thyroid and 30 Rem Beta (skin) per SRP (REF 2 Section 6.4).

Per calculation SO-GOTHIC-REFUEL001 (REF 16) minimum transit time for the activity to travel from the top of reactor cavity water to the nearest refuel floor exhaust duct inlet is 12 seconds.

The response of the reactor building ventilation to a refuel bridge radiation monitor high radiation signal is as follows (REF 17):

t=0 signal to isolate received
t=1 second logic response time (conservative) - judgment
t=5 seconds BV-202-32 closes - last test 1.9 seconds
t=5.5 seconds BV-202-31 closes - last test 2 seconds

The refuel bridge radiation monitor is assumed to initiate a signal within ~2.5 seconds of sensing high radiation making total time to isolate the RB, after sensing radiation, approximately 8 seconds. DRAGON output will show enough activity will be present at t=1 seconds to alarm the monitor making the time from the activity leaving the pool until the secondary containment is isolated approximately 9 seconds. It is estimated that the transit time from the inlet of refuel floor ductwork to the RB isolation damper is ≥ 3 seconds making the minimum total transit time required for the activity to pass from the top of cavity water to the RB isolation damper ≥ 15 seconds. As the time required to isolate the RB is approximately 9 seconds, the release is filtered by the RBEV. For purposes of this calculation, following a 15 second delay in the Reactor Building for the activity to travel from the pool to the RB exhaust damper, the activity is assumed to be released as a puff release through the RBEV filters. This model simplifies the calculation and also ensures that all activity available to be released to the environment is released within 2 hours.

The iodine removal efficiency of the RBEV filters is assumed to be 95% for elemental iodines and 90% for organic iodines. The RBEV duct heaters control the humidity to less than 70% per Section VII.H.2.0 of the UFSAR (REF 5). Based on humidity control and penetration , Regulatory Guide 1.52, Table 2 (REF 15) assigns a filter efficiency of 95% for elemental iodines for 2 inch charcoal beds. The methyl iodine filter efficiency of 90% assumed is conservative as Reg Guide 1.52 Table 2 also assigns a methyl filter efficiency of 95% for 2" deep filters that have humidity control of 70%. Particulates are not discussed as Reg Guide 1.25 states that 75% of the iodines released from the pool are elemental and 25% are organic.

Lat Tat

The release point for RBEVS is the Main Stack. (REF 5 Section VII.H.1.0, page VII-36).

Refuel bridge setpoint ≤ 1000 mr/hr per Table 3.6.2j of the Tech Specs (REF 4c).

The free air volume above refuel floor is 1,072,600 ft3 (REF 14). This value is conservatively used to calculate the dose rate at the refuel bridge monitor. The DRAGON (REF 11) model uses a finite hemispherical cloud model with the calculated radius of the cloud resulting in a cloud volume equal to the room being modeled - in this case 1.07E6 ft3. This results in a very dispersed source. In reality the refuel bridge monitor is located directly over the pool which means as the activity is released from the pool into the air above the pool, the monitor would likely be immersed or at least be very close to a much smaller cloud which would be much more concentrated than the one assumed by DRAGON (REF 11).

Table 1

CORE INVENTORY AT 102% THERMAL POWER		
ISOTOPE	ACTIVITY (Ci/MWt)	CORE INVENTORY (Ci)
I-131	2.90E+04	5.47E+07
I-132	4.20E+04	7.93E+07
I-133	4.80E+04	9.06E+07
I-134	6.20E+04	1.17E+08
I-135	4.90E+04	9.25E+07
KR-83M	3.00E+03	5.66E+06
KR-85M	6.50E+03	1.23E+07

KR-85	3.00E+02	5.66E+05
KR-87	1.20E+04	2.26E+07
KR-88	1.70E+04	3.21E+07
KR-89	2.00E+04	3.77E+07
XE-131M	1.80E+02	3.40E+05
XE-133M	2.00E+02	3.77E+05
XE-133	5.60E+04	1.06E+08
XE-135M	1.70E+04	3.21E+07
XE-135	9.80E+03	1.85E+07
XE-138	4.40E+04	8.30E+07

TABLE 1: Ci/MWt from Reference 6, pages 6 & 7, is multiplied by 1850 MWt * 1.02 to determine core inventory.

Table 2

X/Q VALUES @ MAIN STACK RELEASE FOR CONTROL ROOM AIR INTAKE (SEC/M3)	
TIME	X/Q
0-2 HR	3.12E-04
2-720 HR	1.22E-08

TABLE 2: All X/Q values taken from REF 6, pages 12 & 13.

CALCULATION

The core activities at the time of shutdown are input to SWEC computer code RADIOISOTOPE (REF 12) run # 9203 dated 5/1/98 in units of µCi and decayed for 24 hrs with the results presented in Table 3. The total core activity is then multiplied by 10% (except Kr-85 which is 30%) to get activity in gap. This value is then multiplied by 125/32984 to get gap activity in the damaged fuel pins and multiplied by 1.5 to account for the radial peaking factor. This final result is total activity released to the fuel pool. All this calculating is performed in Table 3 A card input of the input to this run is included in Appendix A

TABLE 3				
CURIES RELEASED TO UNIT 1 FUEL POOL				
	CORE ACT 24 HRS AFTER SHUTDOWN	CORE GAP ACT 24 HRS AFTER SHUTDOWN	GAP ACTIVITY IN 125 FUEL RODS (W/PEAKING FACTOR)	ACTIVITY RLSD FROM POOL
ISOTOPE	Ci	Ci	Ci	Ci
I-131	5.02E+07	5.02E+06	2.85E+04	2.85E+02
I-132	5.74E+04	5.74E+03	3.26E+01	3.26E-01
I-133	4.07E+07	4.07E+06	2.31E+04	2.31E+02
I-134	6.50E-01	6.50E-02	3.69E-04	3.69E-06
I-135	7.49E+06	7.49E+05	4.26E+03	4.26E+01
KR-83M	6.50E+02	6.50E+01	3.69E-01	3.69E-01
KR-85M	3.00E+05	3.00E+04	1.71E+02	1.71E+02
KR-85	5.66E+05	1.70E+05	9.65E+02	9.65E+02
KR-87	4.88E+01	4.88E+00	2.77E-02	2.77E-02
KR-88	9.17E+04	9.17E+03	5.21E+01	5.21E+01
KR-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00
XE-131M	3.53E+05	3.53E+04	2.01E+02	2.01E+02
XE-133M	7.55E+05	7.55E+04	4.29E+02	4.29E+02
XE-133	1.00E+08	1.00E+07	5.68E+04	5.68E+04
XE-135M	1.20E+06	1.20E+05	6.82E+02	6.82E+02
XE-135	2.28E+07	2.28E+06	1.30E+04	1.30E+04
XE138	0.00E+00	0.00E+00	0.00E+00	0.00E+00

The DRAGON model used is as follows:

Fuel pool water volume - not required due to release is in fractions per day

Release water to RB air space 2.0E+5 fractions per day for the period 0 to 2 hrs. This is the DRAGON recommended value for puff releases.

Volume 2 Refuel floor air space volume 1.07+6 ft3

No release rate for 15 seconds followed by a puff release through the RBEV filters. The 15 second delay models the time for the cloud of activity to reach the RB isolation damper.

Exhaust filter efficiency = 0.95 elemental and 0.90 methyl

Unit 1 Control Room

volume - 1.31E+5 cubic ft
intake rate 0 to 720 hrs 2530cfm
filter efficiencies 0 - 720 hrs = 0

Breathing rate 0-720 hrs 3.47E-04 m3/sec

0 - 2 hr stack χ/Q is 3.12E-4 sec/m3 No χ/Q is required after 2 hours as all the activity has been released.

Activities in units of Ci from column 3 Table 3 are instantaneously released to Volume 1 (pool water) at T=0 with the iodine fractions being 0.0075 for elemental and 0.0025 for methyl to model the pool DF of 100 and the species fractions above the fuel pool as recommended by Reg Guide 1.25.

The results of DRAGON run #8842 5/16/98 are listed in Table 4 below.

TABLE 4 - CR DOSE NO CR FILTER			
RBEV FILTER ACTIVATION AT T=15 SECONDS			
720 HR DOSE (REM)			
	THYROID	GAMMA	BETA
RELEASE FROM RB	3.49E+00	2.18E-02	8.22E-01
GDC LIMIT	3.00E+01	5.00E+00	3.00E+01

The DRAGON run also gave a gamma dose rate on the refuel floor of 15.5 Rem per hour at 1 sec and 17.2 Rem/hr at 5 seconds. This proves that the Technical Specification alarm limit of 1000 mRem/hr will be reached within 1 second of the activity leaving the pool and supports the estimated 9 second time for the RB to isolate post FHA.

A second DRAGON run (run #8825 dated 5/16/98) was made which was a duplicate of the DRAGON run made above except with no RBEV filters. This run determines the dose with a puff release with no filtration. This run allows for determination of doses resulting from FHAs where fuel damage less than that required to alarm the monitor occurs. These doses are also compared to GDC 19 to ensure there is not a FHA which fails to alarm the radiation monitor but could exceed GDC 19 dose criteria. The results are given below:

The thyroid dose for a FHA with 125 failed rods with no holdup and no filtration was 50.4 Rem. This means that:

$$\frac{30\,\mathrm{Re}m}{50.4\,\mathrm{Re}m} * 125Rods = 75Rods$$

are required to fail in order to receive a Thyroid dose in excess of 30 Rem with no RBEV actuation.

Remembering that 125 rods resulted in a (conservative) dose rate of 15.5 Rem/hr at the refuel bridge monitor, then:

$\frac{75 Rods}{125 Rods} * 15.5 Rem/hr = 9.3 Remhr$ at the refuel bridge monitor which is well above the setpoint of 1000 mRem/hr .

RESULTS/CONCLUSIONS

Gamma dose rate on refuel floor at T= 1 seconds - 15.5 Rem/hr gamma. Note this is a very conservative model. It is likely that the dose rate would be much larger as the monitor is on the refuel bridge right above where the bubble of activity would emerge from the pool.

All doses resulting from a Design Basis FHA at Unit 1 result in doses within the GDC 19 criteria. See Table 4 above.

A fuel handling accident which would not result in sufficient activity to alarm the refuel bridge monitor also would not result in sufficient activity being released to exceed GDC 19 dose limits.

COMPUTER RUN LOG

JOB #	DATE	DESCRIPTION OF RUN
9203	5/1/98	RADIOISOTOPE (REF 12) Core activities decayed for 24 hrs.
8842	5/16/98	DRAGON (REF 11) Unit 1 FHA to Unit 1 CR - no CR filters
8825	5/16/98	DRAGON (REF11) Unit 1 FHA to Unit 1 CR - no RBEV or CR Filters.

Note: Card image of computer run listed above is given in APPENDIX A

REFERENCES

Reg Guide 1.25 (also known as Safety Guide 25), "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling Water and Pressurized Water Reactors".

NUREG-0800, Standard Review Plan.

Regulatory Guide 1.49, Revision 1, "Power Levels of Nuclear Power Plants."

Nine Mile Point Unit 1 Technical Specifications.

a. Facility Operating License which accompanied the Technical Specifications

b. Section 3.4.4.b, 3.4.4.c, and 3.4.4.d, "Limiting Condition for Operation of Emergency Ventilation System."

c. Table 3.6.2j

Nine Mile Point Unit 1 Final Safety Analysis Report Revision 15

G&H Calculation No. N83-1, Rev 1 in CDS as Calc H21C020, " LOCA - CR, TSC & EOF Doses"

NMPC calculation S10-CR277.A-U1.210 Revision 00.

Calculation S10-210HV12 and drawings C18810C sheet 1, C18812C sheet 1, C18804C sheet 1 as described in Mechanical Design Input to Design Change N1-98-016 dated 5/17/98

10CFR Part 50, Appendix A, General Design Criteria 19.

NMPC Procedure N1-OP-10 Revision 13

DRAGON Computer Code, SWEC Number NU-115, Version 5, Level 0

RADIOISOTOPE Computer Code SWEC Number NU-007, Version 1, Level 2.

Drawing C-18778-C, Revision 6 Reactor Building Ventilation System.

NMPC Calculation SO.Gothic-RB01 - (Attachment 3) - Revision 0.

Regulatory Guide 1.52, Revision 2, 3/78, "Design, Testing , and Maintenance Criteria for Post Accident ESF Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled-Nuclear Power Plants".

Calculation SO-GOTHIC-REFUEL001, "Predicting the Flow Behavior within the Reactor Refuel Floor at 340' Elevation with Normal Reactor Building Ventilation System", 5/21/98.

System Design Basis Document-601 Rev 0 and drawing C22026-C Sheet 8A as described

in Electrical Design input to design change N1-98-016 dated 5/19/98, file code ESB1-E98-0014.

Internal Correspondence, file code M98-014, from T. Mogren to T. Kulczycky dated 5/18/98 "Outside Air Flow Rate for Control Room Ventilation".

APPENDIX A (4 pages total)

CARD IMAGE OF COMPUTER RUNS

NM NIAGARA MOHAWK NUCLEAR ENGINEERING

CALCULATION COVER SHEET

Page 1 (Next 2)
Total 17
Last 17

NINE MILE POINT NUCLEAR STATION Unit (1, 2 or 0=Both) : 1 Discipline : Health Physics

Title	Calculation No.			
Title: Unit 1Fuel Handling Accident Doses in Uni1 Control Room	H21C045			
	(Sub)system(s): ARM	Building: RB	Floor Elev.: 340	Index No.: N/A

Originator(s)
A. Moisan

Checker(s) / Approver(s)
T. Kurtz/T. Kulczycky

Rev	Description	Design Change No.	Prep'd By	Date	Chk	Date	App	Date
00	Original Issue	N/A	GOM	5/1/98	TJK	5/1/98	TGK	5/1/98

Computer Output/Microfilm Filed Separately (Yes / No / NA): No Safety Class (SR / NSR / Qxx) : SR

Superseded Document(s) : None

Document Cross Reference(s) - For additional references see page(s) : 13

Ref No	Document No.	Doc Type	Index	Sheet	Rev
	See page 13				

General Reference(s) :
See page 13

Remarks :
Calculation determines Unit 1 Control Room doses from a design basis Unit 1 Fuel Handling Accident. This calculation determines that no Unit 1 Control Room emergency filter actuation is required to reduce doses below GDC 19 limits.

Confirmation Required (Yes / No) : No See Page(s) :	Final Issue Status (APP / FIO / VOI) : APP	File Location (Calc / Hold) :CALC	Operations Acceptance Required (Yes / No) : No

Evaluation Number(s) / Revision : SE 98-010 Rev 0
Copy of Applicability Review Attached (Yes / N/R)?N/R

Component ID(s) (As shown in MEL) :
RIC-RO16C-10

Key Words : doses, GDC 19, radiation, monitors, Control Room Habitability, CRAT, fuel handling accident

Post-It™ brand fax transmittal memo 7671 # of pages ▸ 17

To D. Hood	From P. Trenca
Co.	Co.
Dept.	Phone # 315-349-1322
Fax # 301-415-2102	Fax #

NIAGARA MOHAWK NUCLEAR ENGINEERING

CALCULATION CONTINUATION SHEET

Project Nine Mile Point Nuclear Station *Unit* 1 *Disposition* N/A

Originator/Date	*Checker/Date*	*Calculation No.*	*Rev*
A. Moisan 5/1/98	T. Kurtz 5/1/98	H21C045	00

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NIAGARA MOHAWK
NUCLEAR ENGINEERING

CALCULATION CONTINUATION SHEET

Project Nine Mile Point Nuclear Station *Unit* 1 *Disposition* N/A

Originator/Date	*Checker/Date*	*Calculation No.*	*Rev*
A. Moisan 5/1/98	T. Kurtz 5/1/98	H21C045	00

OBJECTIVE OF CALCULATION

The objectives of this calculation are to:

1. determine doses in the Unit 1 Control Room resulting from a Unit 1 Fuel Handling Accident (FHA).
2. confirm that the activity released is sufficient to alarm the refuel bridge radiation monitor

Doses calculated will be compared to the 10CFR50 App A GDC19 (REF 9) dose limits to confirm that the Unit 1 Control Room is habitable following a design basis FHA at Unit 1.

METHOD

Core activity at end of cycle is decayed for 24 hrs as that is assumed to be the earliest point at which fuel is anticipated to be moved. Using the Safety Guide 25.(also known as Reg Guide 1.25) guidance and the Stone & Webster (SWEC) computer code DRAGON (REF 11), the gap activity in 125 fuel pins of 8x8 fuel is then released to the fuel pool water. Per the safety guide, the water provides a DF of 100 for halogens and 1 for noble gas. The activity is then released to the Refuel Floor airspace and then to the tack. A dose rate at T=5 seconds is calculated to ensure that the Refuel bridge monitor alarms. If so, the RBEV emergency filtration is assumed to start at T=15 seconds. The Unit 1 Control Room is assumed to intake air at the normal Unit 1 Control Room ventilation intake rate with emergency filtration conservatively assumed not to actuate. The activity release is completed within two hours and CR doses are calculated for 720 hr. The results are then compared to the dose limits given in GDC 19 (REF 9). An output of the DRAGON code is a gamma dose rate in the refuel floor airspace. This result is compared to the technical specification trip point of refuel bridge radiation monitor.

DATA / ASSUMPTIONS

1. The reactor is assumed to be operating at 102% of full thermal power at the time of the accident. (REF 2, page 15.6.5-5 and REF 3 recommend that 102% power be used in analyses to allow for possible instrument errors in registering the power level).

2. reactor power level is 1850 MW_t and 102% power is 1887 MW_t. (REF 4 a).

3. The core inventory in curie/MW_t (from REF 6) is multiplied by the core power level of 1850 MW_t (DATA/ASSUMPTION #2) and then by 1.02 to account for the instrument uncertainty (DATA/ASSUMPTIONS #1) to give core activity at the time of the accident. These data are given in Table 1.

4. 125 fuel rods of 8x8 fuel are assumed to fail in the accident (REF 5 Section XV.C.3.2). 8x8 fuel assemblies contain 62 fuel rods each (REF 5 section XV.C.3.2) each and there are 532 fuel assemblies in the reactor (REF 5 Section I.B.4.0) making a total of 62 * 532 = 32984 fuel rods total. Using 8 x 8 fuel is assumed to be more conservative than 9x9 or 11x11 as there is more activity per fuel rod.

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Project Nine Mile Point Nuclear Station *Unit* 1 *Disposition* N/A

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5. Release parameters as defined in Safety Guide 25 (REF 1)

- 10% of the total core halogen and noble gas activity is in the fuel rod gaps with the exception of Kr-85 where the fraction is 30%
- all gap activity in the damaged fuel rods is released to the fuel pool water
- the fuel pool water has an effective DF of 1 for noble gas and 100 for halogens
- radial peaking factor of 1.5 is assumed in the rods that are damaged.
- breathing rate of 3.47E-04 m^3/sec is assumed for the duration (0-720 hr) of the accident.
- halogens above the water are 75% inorganic (elemental) and 25% organic (methyl)
- all activity released from pool released from building in 2 hrs (or on filters)

6. The accident is assumed to occur 24 hrs after shutdown as that is judged to be the earliest that fuel can be moved after shutdown. This is consistent with the USAR and previous analysis.

7. The free volume of the Unit 1 control room is 1.36E+5 ft^3. (REF 8).

8. The Unit 1 control room normal intake rate is 3550 cfm unfiltered. This is calculated by taking the maximum flow rate of 16,300 minus the minimum recirc flow rate of 12,750 cfm (REF 5, Section III-B 2.2). In order to maximize dose thus bounding all possible Unit 1 CR emergency ventilation scenarios, no actuation of Unit 1 CR ventilation is assumed.

9. The doors of the control room are weather-stripped and the penetrations sealed to maintain a positive pressure of approximately one-sixteenth of an inch of water (REF 5, page III-11), however, an unfiltered inleakage of 10 cfm to the control room is assumed per REF 2, Section 6.4.III.3.d.(2).(ii). An additional 20 cfm is assumed to account for an unfiltered inleakage (REF 7) through an unsealed drain. The total inleakage of 30 cfm combined with the normal ventilation flow rate makes the total Unit 1 CR air intake rate 3580 cfm.

10. Stack 0 - 2 hr and 2 hr -720 χ/Q values are given in Table 2 (REF 6).

11. GDC 19 (REF 9) dose limit 5 Rem whole body or its' equivalent. This equates to 30 Rem Thyroid and 30 Rem Beta (skin) per SRP (REF 2 Section 6.4)

12. The release rate from the refuel floor is calculated as follows:

- normal ventilation flow rate from above refuel floor 29000 cfm (REF 13)
- free air volume above refuel floor 1,072,600 ft^3 (REF 14)
- 50% mixing is assumed and judged to be reasonable. This value only used to calculate release rate and the release rate has to be sufficient to ensure that all of the activity is released to the environment within 2 hrs. Note the total refuel floor volume is used to calculate the gamma dose rate to the refuel bridge rad monitor.

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13. RBEV Filter efficiency is assumed to be 90% for both methyl and elemental iodine. This is conservative as 99% efficiency for particulate and elemental agrees with the original Licensing basis as described in the UFSAR (REF 5, Sections XV.C.5.1.8 and VII-H.2.0) which describes the filter efficiency as 99% for methyl iodide and other iodine forms and the Technical Specifications (REF 4, Section 3.4.4.b) which gives the halogenated hydrocarbon test requirement of ≥ 99%.

14. A delay of 3 seconds has been introduced to RBEVS to reduce spurious actuations (REF 5 page VII-36) while ensuring a valid actuation occurs. It will be shown in this calculation that sufficient radiation is present to alarm the refuel bridge monitor at T=5 seconds which causes RBEVs to actuate. For conservatism, a 10 second delay in RBEVS actuation is assumed in this calculation. The reactor building is maintained at a negative pressure of 0.25" water gauge with respect to the atmosphere during this accident and following RBEV actuation.

15. The release point for RBEVS is the Main Stack. (REF 5 Section VII.H.1.0, page VII-36).

16. Refuel bridge setpoint ≤ 1000 mr/hr per Table 3.6.2j of the Tech Specs (REF 4c)

Project Nine Mile Point Nuclear Station　　Unit 1　　Disposition N/A

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Table 1

CORE INVENTORY AT 102% THERMAL POWER		
ISOTOPE	ACTIVITY (Ci/MW_t)	CORE INVENTORY (Ci)
I-131	2.90E+04	5.47E+07
I-132	4.20E+04	7.93E+07
I-133	4.80E+04	9.06E+07
I-134	6.20E+04	1.17E+08
I-135	4.90E+04	9.25E+07
KR-83M	3.00E+03	5.66E+06
KR-85M	6.50E+03	1.23E+07
KR-85	3.00E+02	5.66E+05
KR-87	1.20E+04	2.26E+07
KR-88	1.70E+04	3.21E+07
KR-89	2.00E+04	3.77E+07
XE-131M	1.80E+02	3.40E+05
XE-133M	2.00E+02	3.77E+05
XE-133	5.60E+04	1.06E+08
XE-135M	1.70E+04	3.21E+07
XE-135	9.80E+03	1.85E+07
XE-138	4.40E+04	8.30E+07

TABLE 1: Ci/MW_t from Reference 6, pages 6 & 7, is multiplied by 1850 MW_t * 1.02 to determine core inventory.

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Table 2

X/Q VALUES @ MAIN STACK RELEASE FOR CONTROL ROOM AIR INTAKE (SEC/M^3)	
TIME	X/Q
0-2 HR	3.12E-04
2-720 HR	1.22E-08

TABLE 2: All X/Q values taken from REF 6, pages 12 & 13.

CALCULATION

The core activities at the time of shutdown are input to SWEC computer code RADIOISOTOPE (REF 12) run # 9203 dated 5/1/98 in units of μCi and decayed for 24 hrs with the results presented in Table 3. The total core activity is then multiplied by 10% (except Kr-85 which is 30%) to get activity in gap. This value is then multiplied by 125/32984 to get gap activity in the damaged fuel pins and multiplied by 1.5 to account for the radial peaking factor. This final result is total activity released to the fuel pool. All this calculating is performed in Table 3 A card input of the input to this run is included in Appendix A

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TABLE 3				
CURIES RELEASED TO UNIT 1 FUEL POOL				
	CORE ACT 24 HRS AFTER SHUTDOWN	CORE GAP ACT 24 HRS AFTER SHUTDOWN	GAP ACTIVITY IN 125 FUEL RODS (W/PEAKING FACTOR)	ACTIVITY RLSD FROM POOL
ISOTOPE	Ci	Ci	Ci	Ci
I-131	5.02E+07	5.02E+06	2.85E+04	2.85E+02
I-132	5.74E+04	5.74E+03	3.26E+01	3.26E-01
I-133	4.07E+07	4.07E+06	2.31E+04	2.31E+02
I-134	6.50E-01	6.50E-02	3.69E-04	3.69E-06
I-135	7.49E+06	7.49E+05	4.26E+03	4.26E+01
KR-83M	6.50E+02	6.50E+01	3.69E-01	3.69E-01
KR-85M	3.00E+05	3.00E+04	1.71E+02	1.71E+02
KR-85	5.66E+05	1.70E+05	9.65E+02	9.65E+02
KR-87	4.88E+01	4.88E+00	2.77E-02	2.77E-02
KR-88	9.17E+04	9.17E+03	5.21E+01	5.21E+01
KR-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00
XE-131M	3.53E+05	3.53E+04	2.01E+02	2.01E+02
XE-133M	7.55E+05	7.55E+04	4.29E+02	4.29E+02
XE-133	1.00E+08	1.00E+07	5.66E+04	5.68E+04
XE-135M	1.20E+06	1.20E+05	6.82E+02	6.82E+02
XE-135	2.28E+07	2.28E+06	1.30E+04	1.30E+04
XE138	0.00E+00	0.00E+00	0.00E+00	0.00E+00

The DRAGON model used is as follows:

Fuel pool water volume - not required due to release is in fractions per day

Release water to RB air space 2.0E+5 fractions per day for the period 0 to 2 hrs. This is the DRAGON recommended value for puff releases.

Volume 2 volume 1.07+6 ft^3

Actual flow rate from RB is calculated as follows:

$$\frac{29000 \,{}^{cf}/_{min}}{1072600cf * 0.5} * \frac{60\,min}{hr} * \frac{24hr}{day} = 77.8\frac{vol}{day}$$

It must be validated that all Ci released from pool (Table 3 above) are either released from RB or on RBEV filter. This is done in Table 4 below.

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Unit 1 Control Room

- volume - 1.36E+5 cubic ft
- intake rate 0 to 720 hrs 3580 cfm
- filter efficiencies 0 - 720 hrs 0

Breathing rate 0-720 hrs 3.47E-04 m^3/sec

0 - 2 hr stack χ/Q is 3.12E-4 sec/m^3 No χ/Q is required after 2 hours as all the activity has been released.

Activities in units of Ci from Table 3 are instantaneously released to Volume 1 (pool water) at T=0.

Because the DRAGON code has a limitation of not being able to vary the Volume 2 filter efficiency, two runs are necessary. They both have a T= 5 second time step. This allows for calculation of the gamma dose rate on the refuel floor. If the dose rate exceeds the refuel bridge setpoint of 1000 mr/hr, the RBEV filters are assumed to actuate 10 seconds later (i.e. at T=15 seconds). Therefore, the two runs are for a 0 to 15 second release from the RB unfiltered and a 15 second to 2 hour filtered release. The curies released during 0-2hrs are checked to ensure that all of the activity is released as required by Reg Guide 1.25. This is performed in Table 4 below.

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Project Nine Mile Point Nuclear Station *Unit* 1 *Disposition* N/A

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TABLE 4				
CURIES RELEASED TO ENVIRONMENT				
				TABLE 3
	ACT RLSD	ACT RLSD	TOTAL ACT	RLSD FROM
	TO ENV	TO ENV	RLSD TO ENV	POOL
	0-15 SEC	15 SEC - 2 HR	0-2 HR	0-2 HR
ISOTOPE	Ci	Ci	Ci	Ci
I-131	3.72E+00	2.84E+01	3.21E+01	2.85E+02
I-132	4.25E-03	2.98E-02	3.41E-02	3.26E-01
I-133	3.01E+00	2.28E+01	2.58E+01	2.31E+02
I-134	4.80E-08	2.95E-07	3.43E-07	3.69E-06
I-135	5.56E-01	4.12E+00	4.68E+00	4.26E+01
TOTAL	7.29E+00	5.53E+01	6.26E+01	5.59E+02
KR-83M	4.81E-03	3.30E-01	3.35E-01	3.69E-01
KR-85M	2.23E+00	1.63E+02	1.65E+02	1.71E+02
KR-85	1.26E+01	9.64E+02	9.77E+02	9.65E+02
KR-87	3.61E-04	2.37E-02	2.41E-02	2.77E-02
KR-88	6.79E-01	4.84E+01	4.91E+01	5.21E+01
XE-131M	2.62E+00	2.02E+02	2.05E+02	2.01E+02
XE-133M	5.60E+00	4.41E+02	4.47E+02	4.29E+02
XE-133	7.41E+02	5.68E+04	5.75E+04	5.68E+04
XE-135M	8.89E+00	1.99E+03	2.00E+03	6.82E+02
XE-135	1.70E+02	1.31E+04	1.33E+04	1.30E+04
TOTAL	9.44E+02	7.37E+04	7.47E+04	7.23E+04

Note that the totals do not match. That is because only 10% of the iodines released from the pool from 15 seconds to 720 hrs actually are released from the building. Making that adjustment, the total iodines released = 5.60E2 Ci which is actually more iodine released than was available. This was a result of not subtracting the iodines released in the 0 to 15 second time period from the total iodine released to the pool for the 15 second to 720 hr case. Note also that more Noble Gas is released to the environment than was released to the fuel pool.

For information a DRAGON run (run #231 dated 5/1/98) was made assuming a puff release (i.e no holdup in either the fuel pool or the Reactor Building), no actuation of RBEV filters or CR filters. The thyroid dose for this bounding analysis was calculated to be 55.9 Rem. This run was made to allow an estimate of what type of fuel handling accident might result in doses in excess of GDC 19 without alarming the refuel bridge monitor. **The discussion below should be used with great caution as there are many variables assumed to be constant.** That is, amount of activity in fuel rod gap, accuracy of the peaking factor used, the release rate from the fuel to the water, from the water to the RB air space, the behavior of cloud as it exits the pool (i.e. does it mix? Is it pulled into ductwork with no mixing?), the release rate out of the building, plateout of the iodines as they travel to the CR are all assumed to be as stated above. This is unlikely to occur specifically in this way and therefore should be used carefully.

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That said, the resulting thyroid dose for a FHA with 125 failed rods with no holdup and no filtration was 55.9 Rem Thyroid. That means that at least:

$\frac{30\,Rem}{55.9\,Rem} * 125 rods = 67 Rods$ required to result in a Thyroid dose in excess of 30 Rem.

Remembering that 125 rods resulted in a (conservative) dose rate of 17.2 Rem to the refuel bridge monitor, then:

$\frac{67\,Rods}{125\,Rods} * 17.2\,Rem = 9.2\,Rem$ at the refuel bridge monitor which is well above the setpoint.

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RESULTS

1. Gamma dose rate on refuel floor at T= 0 seconds - 17.2 Rem/hr gamma. Note this is a very conservative model. It is likely that the dose rate would be much larger as the monitor is on the refuel bridge right above where the bubble of activity would emerge from the pool.

2.

TABLE 5 - CR DOSE NO CR FILTER RBEV FILTER ACTIVATION AT T=15 SECONDS			
	720 HR DOSE (REM)		
RELEASE FROM RB	THYROID	GAMMA	BETA
0-15 SEC UNFILTERED	7.30E-01	2.78E-04	1.07E-02
15 SECOND - 2 HR FILTERED	5.57E+00	2.12E-02	8.14E-01
TOTAL	6.30E+00	2.15E-02	8.25E-01
GDC LIMIT	3.00E+01	5.00E+00	3.00E+01

3. For the model described above, a fuel handling accident which would not result in sufficient activity to alarm the refuel bridge monitor also would not result in sufficient activity being released to exceed GDC 19 dose limits.

CONCLUSIONS

A design basis Unit 1 FHA results in 30 day doses in the Unit 1 Control Room which are less than 10CFR50 Appendix A GDC 19 dose criteria without taking credit for Unit 1 CR emergency filters. This case assumed the relatively slow actuation of the RBEV filter train at T=15 seconds and only assumed a 90% RBEV filter efficiency.

A design basis Unit 1 FHA will easily alarm the refueling platform radiation monitor which has a tech spec alarm limit of ≤ 1000 mr/hr.

For the model listed described above, a FHA which would not release enough activity to alarm the refuel bridge monitor would also not result in CR doses in excess of GDC 19 dose limits even assuming no holdup and no filtration by either RBEV or the CR filters.

COMPUTER RUN LOG

JOB #	DATE	DESCRIPTION OF RUN
9203	5/1/98	RADIOISOTOPE (REF 12) Core activities decayed for 24 hrs.
9752	5/1/98	DRAGON (REF 11) Unit 1 FHA to Unit 1 CR - no CR filters
0231	5/1/98	DRAGON (REF11) Unit 1 FHA to Unit 1 CR - no RBEV or CR Filters.

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Note: Card image of computer run listed above is given in APPENDIX A

REFERENCES

1. Reg Guide 1.25 (also known as Safety Guide 25), "assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling Water and Pressurized Water Reactors".
2. NUREG-0800, Standard Review Plan.
3. Regulatory Guide 1.49, Revision 1, "Power Levels of Nuclear Power Plants."
4. Nine Mile Point Unit 1 Technical Specifications.
   a. Facility Operating License which accompanied the Technical Specifications
   b. Section 3.4.4.b, 3.4.4.c, and 3.4.4.d, "Limiting Condition for Operation of Emergency Ventilation System."
   c. Table 3.6.2j
5. Nine Mile Point Unit 1 Final Safety Analysis Report Revision 14
6. G&H Calculation No. N83-1, Rev 1 in CDS as Calc H21C020, " LOCA - CR, TSC & EOF Doses"
7. NMPC calculation S18.9TB300D23U1.210, Revision 03
8. NMPC Internal Correspondence, R.J. Cazzolli to Distribution, Dated 08/30/91, Subject: DBD Input, File Code: SM-HP91-0115.
9. 10CFR Part 50, Appendix A, General Design Criteria 19.
10. NMPC Procedure N1-OP-10 Revision 13
11. DRAGON Computer Code, SWEC Number NU-115, Version 5, Level 0
12. RADIOISOTOPE Computer Code SWEC Number NU-007, Version 1, Level 2.
13. Drawing C-18778-C, Revision 6 Reactor Building Ventilation System.
14. NMPC Calculation SO.Gothic-RB01 - (Attachment 3) - Revision 0.

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APPENDIX A (3 pages total)

CARD IMAGE OF COMPUTER RUNS

```
* * * * * * * *   CARD IMAGE OF INPUT SUBMITTED TO RADIOISOTOPE   * * * * * * * *

CARD COLUMNS              1         2         3         4         5         6         7         8     CARD COLUMNS
                 12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD NO.
    1              UNIT 1 CORE ACTIVITIES AT T= 24 HRS
    2               1    0                          17               3
    3                  24.0
    4               1    5.66E12
    5               2    1.23E13
    6               3    5.66E11
    7               4    2.25E13
    8               5    3.21E13
    9               6    3.77E13
   10               7    3.40E11
   11               8    3.77E11
   12               9    1.06E14
   13              10    3.21E13
   14              11    1.05E13
   15              13    8.30E13
   16              25    5.47E13
   17              26    7.93E13
   18              27    9.06E13
   19              28    1.17E14
   20              29    9.25E13

                 12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

RADIOISOTOPE RUN # 9203
5/1/98

CALC H21C045
REV 00
P15

* * * * * * * * * CARD IMAGE OF INPUT SUBMITTED TO DRAGON * * * * * * * * *

```
CARD COLUMNS           1         2         3         4         5         6         7         8        CARD COLUMNS
              12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD NO.
   1          **NMPI FHA 0-15 SEC NO RBEV FILTER NO CRATS FILTER
   2            4   1110 1 1111       0         1         0          0 0.0075 0.0025      1
   3           SPENT FUEL POOL                  1         0         0         0         0 2.0+5    0         0         0
   4           REFUEL FLOOR                1.07+6         0         0       0.0       0.0  77.9    0         0         0
   5           CONTROL ROOM                1.36+5         0         0         0         0   1.0    0         0         1
   6              0.00+0 2.85+4 3.26+1 2.31+4 3.69-4 4.26+3 0.00+0 0.00+0
   7              0.00+0 0.00+0 0.00+0 3.69-1 1.71+2 9.65+2 2.77-2 5.21+1
   8              0.00+0 2.01+2 4.29+2 5.68+4 6.82+2 1.30+4 0.00+0 0.00+0
   9          1             1         0         1         1         0 3580. 3580.3.12-4             1    11.39-3
  10          2             1         0         1         1         0 3580. 3580.3.12-4             1    14.17-3
  11          3             0         0         0         1         0 3580. 3580.3.12-4             1    1  2.0
  12          4             0         0         0         0         0 3580. 3580.1.22-8             1    1 720.0
  13          **NMPI FHA  15 SECONDS TO 720 HRS RBEV FILTER NO CRATS FILTER
  14            4   1110 1 1111       0         1         0          0 0.0075 0.0025      1
  15           SPENT FUEL POOL                  1         0         0         0         0 2.0+5    0         0         0
  16           REFUEL FLOOR                1.07+6         0         0       0.0       0.0  77.8  0.9       0.9         0
  17           CONTROL ROOM                1.36+5         0         0         0         0   1.0    0         0         1
  18              0.00+0 2.85+4 3.26+1 2.31+4 3.69-4 4.26+3 0.00+0 0.00+0
  19              0.00+0 0.00+0 0.00+0 3.69-1 1.71+2 9.65+2 2.77-2 5.21+1
  20              0.00+0 2.01+2 4.29+2 5.68+4 6.82+2 1.30+4 0.00+0 0.00+0
  21          1             1         0         0         1         0 3580. 3580.3.12-4             1    11.39-3
  22          2             1         0         0         1         0 3580. 3580.3.12-4             1    14.17-3
  23          3             1         0         1         1         0 3580. 3580.3.12-4             1    1  2.0
  24          4             1         0         0         0         0 3580. 3580.1.22-8             1    1 720.0

              12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

DRAGON RUN #9752
5/1/98

CALC H21C04S
REV 00
P 16

```
* * * * * * * * * * CARD IMAGE OF INPUT SUBMITTED TO DRAGON   * * * * * * * * * *

CARD COLUMNS            1         2         3         4         5         6         7         8     CARD COLUMNS
               12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD NO.
    1          *ANNPI NO ADEV FILTERS AND NO CRFILTERS
    2           2   1010 1 1011       0         1         0         0 0.0075 0.0025     1
    3           SPENT FUEL POOL                 1         0         0         0         0 2.0+5     0         0         0
    4           CONTROL ROOM               1.35+5         0         0         0         0   1.0     0         0         1
    5               0.00+0 2.95+4 3.26+1 2.31+4 3.69-4 4.26+3 0.00+0 0.0010
    6               0.0010 0.0010 0.0010 1.69-1 1.71+2 9.65+2 2.77-2 5.21+1
    7               0.00+0 2.01+2 4.29+2 5.68+4 6.82+2 1.35+4 0.00+0 0.00+0
    8          1              1         0         0         0         0 3580. 3580.3.12-4               1         1   2.0
    9          2              0         0         0         0         0 3580. 3580.1.22-8               1         1 720.0

               12345678901234567890123456789012345678901234567890123456789012345678901234567890
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DRAGON RUN # 231
5/1/98

MAY-05-98 TUE 06:36 R. B. ABBOTT FAX NO. 349441

CALC N2(C045
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