UNIVERSITY OF MARYLAND AT COLLEGE PARK

NUCLEAR ENGINEERING
MATERIALS AND NUCLEAR ENGINEERING

November 3, 1993

Section 50.4 Distribution
Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: ANNUAL REPORT

Dear Sir/Madam:

Enclosed is the Annual Report for the MUTR in accordance with requirements set forth in the Technical Specifications. This report covers the time period from July 1, 1992 to June 30, 1993.

Sincerely,

Dr. Walter J. Chappas
Maryland University Training Reactor

cc: Dr. Aris Christou, Chairman, Materials and Nuclear Engineering

Mr. Allan Adams
U.S. Nuclear Regulatory Commission
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Reactor Files

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MARYLAND UNIVERSITY TRAINING REACTOR (MUTR)

License # R-70
Facility Docket # 50-166

ANNUAL OPERATING REPORT

for the period

July 1, 1992 - June 30, 1993

Department of Materials and Nuclear Engineering
University of Maryland
College Park, Md 20742-2115

TABLE OF CONTENTS

I. INTRODUCTION

The Maryland University Training Reactor is an open-pool type, TRIGA fueled reactor. The core is cooled by natural convection of the pool water with auxiliary coolers provided for protection of filters and ion exchange equipment associated with the reactor support piping.

The MUTR is used for academic instruction and operator training, performing neutron and gamma irradiations, neutron activation analysis experiments, and tours and demonstrations for internal and outside groups. Operator training includes qualification training for student and staff operators as well as for visiting nuclear power plant trainees.

II. REACTOR USAGE

During the past year the MUTR operated a total of 149 runs, which can be broken down into the following categories.

Operator training	80 runs
Tours, Labs & Demonstrations	35 runs
Calibration and Maintenance	5 runs
Nuclear Engineering Classes	20 runs
Irradiations and Activations*	9 runs

* Many of the Engineering classes involved activations and are not counted in the total runs under activations.

To perform these runs, the core produced 31.5 MWh, with a corresponding burn-up of 1.64 grams of Uranium-235.

Operator training was undertaken for facility operator qualification and visiting power plant trainees. Three operators were granted licenses by the NRC; two being issued instant Senior Reactor Operator certificates, and one issued a Reactor Operator certificate. Power plant trainees from the Baltimore Gas and Electric Calvert Cliffs

Plant also participated in several two week long training sessions to give them some operational reactor training time.

A substantial number of the runs were conducted for tours and demonstrations. These involved high school, university, and visiting University of Maryland students. In these group tours a total of 847 students visited the MUTR. Individual tours were also conducted with a total of 564 students.

Many of these groups account for more than one visit, as it was common for a high school to return with groups from different classes.

III. SURVEILLANCE TESTS AND INSPECTIONS

The following calibration and maintenance operations were performed on the indicated dates.

WATER SAMPLE TEST	monthly
AIR SAMPLE TEST	monthly
AT POWER SURVEY	quarterly
ALARM SYSTEM CHECK[1]	continuous
POWER CALIBRATION	8/05/92
REPLACED ION EXCHANGER RESIN*	9/10/92
REPLACED PARTICULATE FILTER *	1/14/93
REPLACED ION EXCHANGER RESIN*	2/19/93
CONTROL ROD DROP TEST	3/31/93
RADIATION SURVEY	4/15/93
INSTALLED NEW HEAT EXCHANGER*	4/30/93
RAM CALIBRATION	6/15/93
INSTALLED NEW UPPER CONTROL CONSOLE**	6/30/93

[1]The Facility's alarm system was replaced by a new digital system , Moose Products inc., Model Z1100 (2/28/93). This system continuously monitors all points of the facility installation as well as phone line connections to Campus Police, giving an alarm should a fault occur. The alarm is both audible and visual (SUPERVISORY TROUBLE being displayed at all control terminals), and will not clear until the fault is rectified.

Most of the maintenance performed during this reporting period were routine consisting of fine tuning or adjusting of operating equipment. Various items from Section III of the report fall under the categories of Maintanence Operations Performed and Changes to the Facility. The above items accompanied with a (*) are considered maintenance operations and the above operations designated (**) are considered changes to the facility.

No other major maintenance was performed during this reporting period.

All maintenance and Facility changes were performed in accordance with 10 CFR 50.59.

IV. CHANGES TO THE FACILITY

The most significant change to the reactor involved the addition of a vertical extension to the existing console. The extension was placed in the chosen position to allow the radiation area monitors to be placed at eye-level for the operator. This work was completed after approval was obtained from the Reactor Safety Committee under the provisions of Section 10 of the Code of Federal Regulations Section 50.59. Approval was granted on June 10, 1993. The console extension is now being used to house two ultrasonic level detectors which monitor the levels of the biological shield as well as the level of the storage sump in the water handling room. An additional fuel temperature monitor has also been added in the extended console. The mass flow computer that was purchased in FY '92 has been installed and is operational.

All maintenance and facility changes were performed in accordance with 10 CFR 50.59.

V. ENVIRONMENTAL SURVEYS OF SURROUNDING AREAS

Reactor surveys taken with portable neutron and beta/gamma detectors while at power indicate no changes in shielding requirements or a need to redesignate restricted areas.

All continuous monitoring for this year (reported under personnel exposure as internal building monitoring) was accomplished using fixed mounted film badges throughout the interior of the reactor building itself.

VI. RADIOACTIVE RELEASE AND DISCHARGE TO THE ENVIRONMENT

Airborne releases by the MUTR where in the form of ^{41}Ar originating from dissolved air in the pool tank and air activated inside of the sample ports. Calculations done for the SER show that ^{41}Ar releases from the pool tank do not exceed 10CFR20 requirements. Further calculations done for power operations with a sample port open show that the additional release of ^{41}Ar is insignificant. Attachment 1: "Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements" documents these calculations.

The Reactor Storage Sump was dumped via the city sewer system after sampling under the supervision of the Radiation Safety Office showed that concentrations of dissolved and suspended radioisotopes were below MPC levels. Discharge dates were 11/26/92 and 1/25/93

VII. FACILITY PERSONNEL AND VISITOR EXPOSURE SUMMARY

For this reporting period, all badged facility personnel and students received less than 10 mrem. The Reactor Building fixed mounted film badges recorded the following exposures:

Monitor	Location	Dose
1	Control Room	<10 mrem
2	Pool Surface	1230 mrem
3	Hot Room	170 mrem
4	Prep Room	170 mrem
5	S. Wall Upper	10 mrem
6	S. Wall Lower	60 mrem
7	E. Wall Lower	30 mrem
8	Pump Room	870 mrem
9	N. Wall Lower	300 mrem
10	W. Wall Lower	<10 mrem

The Pocket Dosimeters recorded minimal exposure for all guests and service personnel. Calibrations of these self-reading dosimeters were performed at six month intervals by our Radiation Safety Department.

VIII. UNSCHEDULED REACTOR SHUTDOWNS/REPORTABLE OCCURRENCES

No Reportable Occurrences took place during this reporting period.

There were two unscheduled reactor shutdowns during the reporting period.

The first unscheduled shutdown occured September 30, 1992, when the up button for the regulating control rod apparently stuck in the up position (as reported by the RO trainee operating at the time) leading to a period scram. Subsequently, the duty SRO was unable to duplicate this fault. To date, the up button for the regulating control rod has yet to fault again in this manner.

The second unscheduled shutdown occured January 6, 1993. During an extended high power operation, the reactor operator determined it necessary to shutdown the reactor after the discovery of a hairline fracture in the PVC piping of the primary water system. No significant loss of primary water occured. The primary water system has since been repaired as part of the new particulate filter instalation (Section III) using metal piping in place of PVC.

IX. CHANGES IN THE FACILITY ORGANIZATION

No special experiments were performed during this reporting period.

Dr. Walter J. Chappas was approved by the University to be the permanent Reactor Director. The University also approved Dr. Aristos Cristou to be the permanent Chairman, Materials and Nuclear Engineering.

During the reporting period three individuals earned NRC licenses on the MUTR. Michael Scalingi and Matthew Goodman qualified Senior Reactor Operators, and Troy Martz qualified Reactor Operator.

Dr. Aristos Christou
Chairman
Materials and Nuclear Engineering

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MARYLAND UNIVERSITY TRAINING REACTOR

CALCULATION FILE COVER SHEET

TITLE: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

PREPARED BY: [signature] Date: 2 Nov 93

J. E. Floyd
Reactor Operator

REVIEWED BY: [signature] Date: 11/3/93

Dr. W. D. Chappas
Reactor Director

MARYLAND UNIVERSITY TRAINING REACTOR

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

1.0 INTRODUCTION

This calculation file documents work done to determine the release of ^{41}Ar by the Maryland University Training Reactor (MUTR), Docket # 50-166, during the operational period beginning July 1, 1992, and ending June 30, 1993. Assumptions made for this calculation are documented herein. These calculations were performed for inclusion in the Annual Operating Report.

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

2.0 10CFR20 REQUIREMENTS

10CFR20 [20.1001 - 20.2402] Appendix B, Table 2 documents the maximum permissible effluent concentrations of radionuclides. ^{41}Ar has a maximum effluent concentration of $1x10^{-8}$ $\mu Ci/ml$ in air. The calculations contained in this document will show that in the worst case scenario, the ^{41}Ar released by MUTR is well below the requirement stated above.

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

3.0 SOURCES OF ^{41}Ar

There are five possible sources of ^{41}Ar at the MUTR. The sources and there contribution to ^{41}Ar production and release are as follows:

1. Pneumatic Transfer System: This system has an air hose which extends down into the fueled region of the core. However, the system is pressurized with CO_2 during operation and its overall volume is small. Thus when the system is idle the amount of ^{41}Ar produced is limited to the amount of ^{40}Ar that manages to diffuse into the system when it is not in use. Furthermore any ^{41}Ar that is created by activation of ^{40}Ar must diffuse through over 50 feet of hose before it can enter the reactor building. The time required for such diffusion combined with the negligible amounts of production means that the Pneumatic Transfer System does not contribute to ^{41}Ar production and release.
2. Pool Tank: A small amount of air is dissolved in the pool tank. The ^{40}Ar contained in this air can be activated and diffuse bank into the reactor building at the pool surface. This amount is not insignificant.
3. Thermal Column: ^{40}Ar contained in the small amounts of air trapped in the Thermal Column can be activated. However, this air is assumed not to diffuse out into the reactor building. The Thermal Column is not a source of ^{41}Ar.
4. Beam Tubes: When plugged there is no mechanism via which ^{41}Ar produced inside the Beam Tubes can leave the pool tank region. However, if the plugs are removed during operation ^{41}Ar will diffuse through the tube and reach the reactor building. The Beam Tubes are only source of ^{41}Ar if the are unplugged during operation.
5. Through Tube: As for the Beam Tubes it is not a source of ^{41}Ar when the tube is plugged. When unplugged, however, it is a source.

For the operational period covered by the annual report, only items 2 and 5 must be accounted for, see sections 4 and 5. Items 1 and 3 are not a source, and the Beam Tubes were never unplugged during operation.

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Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

4.0 POOL TANK ^{41}Ar PRODUCTION AND RELEASE

The SER, page 11-2, states that the ^{41}Ar release into the reactor building during an operational year of 30 MWh is less than 0.1 Ci. During the time period covered by the annual report the reactor was operated for 31.5 MWh. Thus ^{41}Ar release from the pool tank is 0.1 Ci. It was also determined in the SER that such a release amounts to less than 1 mrem of dose to the general public. If the MUTR were operated for 400 MWh the dose to the general public would still be less than 1 mrem.

A 0.1 Ci release over a continuous run of 31.5 MWh would correspond to an equilibrium value of approximately 1 mCi of ^{41}Ar in the reactor building or a concentration of 6×10^{-7} μCi/ml. When exhausted by the exhaust fans through the upper portion of the reactor building, the ^{41}Ar levels will be well below 10CFR20 requirements by the time the ^{41}Ar diffuses down to unrestricted areas.

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5.0 THROUGH TUBE ^{41}Ar PRODUCTION AND RELEASE

^{41}Ar in the Through Tube is produced by activation of ^{40}Ar by the Through Tube flux. The flux in the through tube can be considered a cosine shaped flux whose amplitude is equal to the peak flux seen in the Through Tube. Once produced the ^{41}Ar will only be released in to the reactor building if it diffuses through the tube to the open end before it decays.

The flux in the Through Tube at any one cross sectional location can be considered constant, the air in the tube is a vacuum to the neutron flux. Thus the production and diffusion in the tube can be handled with a 1D approximation. The 1D values at any point in the tube when multiplied by the cross sectional area will then yield the total value for that portion of the tube. The equation governing ^{41}Ar concentration in one dimension is:

$$\frac{dN_{41}(x,t)}{dt} = \Sigma_a^{40}\phi(x,t) + D\frac{d^2N_{41}(x,t)}{dx^2} - \lambda_{41}N_{41}(x,t)$$

Transforming the equation into a form suitable for a finite difference analysis yields:

$$\frac{N_{41}(x_i,t+1)-N_{41}(x_i,t)}{\Delta t} = \Sigma_a^{40}\phi_{max}\cos\left(\frac{\pi x_i}{2a}\right) + D\frac{N_{41}(x_{i+1},t)-2N_{41}(x_i,t)+N(x_{i-1},t)}{\Delta x^2} - \lambda_{41}N_{41}(x_i,t)$$

Rearranging terms gives:

$$N_{41}(x_i,t+1) = \Delta t\Sigma_a^{40}\phi_{max}\cos\left(\frac{\pi x_i}{2a}\right) + \frac{D\Delta t}{\Delta x^2}[N_{41}(x_{i+1},t)+N_{41}(x_{i-1},t)] + N_{41}(x_i,t)\left[1-\Delta t\left(\lambda_{41}+\frac{2D}{\Delta x^2}\right)\right]$$

By segmenting the Through tube into a equal number of nodes the ^{41}Ar released into the building can be calculated. There are three conditions required for this problem, an initial and two boundary conditions. The initial condition is that $N_{41}(x,0)=0$. The first boundary condition is that $N_{41}(x_0,t)=0$, where x_0 is an extrapolated boundary at the open end of the tube. The second boundary condition is $dN_{41}(x_N,t)/dt=0$, where x_N is the final node position at the closed end of the tube. It was also assumed that any ^{41}Ar that makes it to the open end of the tube is instantaneously diffused through out the reactor building free air volume. A FORTRAN program called AR41CAL was written to do this calculation. The program listing can be found in Appendix A of this document.

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

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Three cases were run using this code. The first case represents a typical reactor run of 1 hour at full power. The second case represents a 10 hour run at full power to represent an equilibrium activation of ^{41}Ar in the through tube. The third case is a 100 hour run at full power. This run condition can not be reached at the MUTR do to the buildup of Xenon. Each case was run for 10 hours beyond the reactor run. This was done to account for the Through Tube plug not being replaced immediately at the end of a run. The value of 10 hours allows for 5 ^{41}Ar half-lives to pass; therefore, any ^{41}Ar remaining in the Through Tube after 10 hours will be insignificant compared to the original levels and will not affect the end results. The case outputs are given in Appendix B. The following table shows the results of these three cases.

Case	Production (mCi)	Release (mCi)	Maximum Level (mCi/ml)
1 hour	2.408	0.014	3.07×10^{-12}
10 hours	24.08	0.164	8.33×10^{-12}
100 hours	240.8	1.705	8.70×10^{-12}

From these cases it can be seen that less than 0.02 mCi of ^{41}Ar are released into the reactor building for every hour of full power run with the Through Tube unplugged. Furthermore, the concentration levels inside the reactor building are well below 10CFR20 requirements.

6.0 CONCLUSIONS

During the worst case scenario, operating the reactor for over 10 hours at full power with the Through Tube unplugged, the ^{41}Ar exhausted from the reactor building will be below 10CFR20 requirements in unrestricted areas. Even if the run time approached 100 hours of continuous operation, the ^{41}Ar levels will still be below 10CFR20 requirements in unrestricted areas. Since it is unlikely that the reactor will ever be operated for a continuous period of time longer than 100 hours, it can be said that ^{41}Ar releases from the MUTR will never be greater than 10CFR20 requirements in unrestricted areas.

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

APPENDIX A

AR41CAL FORTRAN LISTING

```
      PROGRAM AR41CAL
C*********************************************************************
C     PROGRAM     AR41CAL (Argon-41 Calculation)
C
C     PURPOSE     This program calculates the Argon-41 production in the
C                 MUTR reactor building with one through tube plug open.
C                 The net results are given in mCi/ml in the building.
C                 The levels are given in 1/2 hour time steps from the
C                 begining of the run. Also the max level is given. The
C                 program calulates the level using a 1D diffusion calc
C                 assuming a cosine flux distibution across the active
C                 length of the through tube.
C
C     AUTHOR      Jason E. Floyd
C*********************************************************************
      COMMON/CASEINF/POWER,RTIME,DELT,DELX,OUTINT,MAXTIME
      COMMON/TUBEDIM/TUBEBEG,TUBEEND,COREBEG,COREEND,MAXPOS,CORELEN,EXB
      COMMON/ARCAL/NAR41,MAXFLUX,SIGMAAR,LAMBDA,DIFF,PI,PROD
      DOUBLE PRECISION MAXFLUX,SIGMAAR,LAMBDA,POWER,PROD,RELEASE,
     /     DELX,DELT,DIFF,RADIUS,VOLUME,BLEVEL,CI,MAXLEVEL,ACTVTY,
     /     NAR41(402,2),CORELEN,EXB,PI
      INTEGER TUBEBEG,TUBEEND,COREBEG,COREEND,MAXPOS,RTIME,MAXTIME,
     /     OUTTIME,OUTINT,TIME,NTSTEP
C*********************************************************************
C     VARIABLE LIST FOR AR41CAL
C
C     ACTVTY: ACTIVITY LEVEL IN mCi/ml
C     BLEVEL: BUILDING AR-41 LEVELS IN ATOMS/ml
C     CI: 1 CURIE
C     COREBEG: NODE LOCATION OF BEGINNING OF ACTIVE TUBE LENGTH
C     COREEND: NODE LOCATION OF END OF ACTIVE TUBE LENGTH
C     CORELEN: ACTIVE CORE LENGHT
C     DELX: NODE SPACING FOR 1D CALCULATION
C     DELT: TIME STEP
C     DIFF: AR-41 DIFFUSION COEFFICIENT
C     EXB: EXTRAPOLATED CORE BOUNDARY
C     LAMBDA: ARGON-41 DECAY CONSTANT
C     MAXFLUX: PEAK THROUGH TUBE FLUX (n/cm^2 kW)
C     MAXLEVEL: MAXIMUM AR-41 LEVELS IN BUILDING
C     MAXPOS: MAXIMUM NODE POSITION
C     MAXTIME: TIME TO END CALCULATION AT
C     NAR41(X,T): ARGON-41 NUMBER DENSITY AT TUBE CENTERLINE FOR NODE X
C                 T = 1/2   CURRENT TIME STEP/NEXT TIME STEP
C     NTSTEP: NUMBER OF TIME STEPS IN CASE
C     OUTINT: TIME INTERVAL BETWEEN LEVEL OUTPUTS
C     OUTTIME: TIME OF NEXT OUTPUT
C     POSIT: CURRENT NODE
C     POWER: CORE POWER LEVEL DURING RUN
C     RADIUS: THROUGH TUBE RADIUS
C     RTIME: RUN TIME
C     SIGMAAR: MACROSCOPIC ABSORPTION CX FOR AR40
C     TIME: CURRENT TIME
C     TUBEBEG: NODE POSITION OF OPEN TUBE END
C     TUBEEND: NODE POSITION OF CLOSED TUBE END
C     VOLUME: FREE AIR VOLUME OF BUILDING
C*********************************************************************
C     LOAD CONSTANTS AND INITIALIZE ARRAY
C
      CI = 3.7E+10
```

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Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

```
      DELX = 2.
      DELT = 4.
      DIFF = .25
      EXB = -306 - 1/DIFF
      LAMBDA = 0.000105
      MAXFLUX = 1.6E+09
      MAXPOS = 309
      OUTINT = 900
      OUTTIME = 900
      PROD = 0.
      RELEASE = 0.
      SIGMAAR = 1.6306E-07
      RADIUS = 7.62
      PI = 3.14159
      TIME = 0
      TUBEBEG = 2
      TUBEEND = 401
      COREBEG = 136
      COREEND = 308
      CORELEN = 72
      VOLUME = 1.700E+09
      DO 100 POSIT = 1,MAXPOS
         NAR41(POSIT,1)=0
         NAR41(POSIT,2)=0
 100  CONTINUE
C*********************************************************************
C     OBTAIN POWER LEVEL AND RUNTIME FROM USER. PREPARE OUTPUT HEADER
C
      CALL CASINIT
C*********************************************************************
C     CALCULATE NUMBER OF TIME STEPS AND BEGIN CACULATION
C
      NTSTEP = INT(MAXTIME/DELT)
      TIME = 0
      DO 200 I = 1,NTSTEP
         TIME = TIME + DELT
C*********************************************************************
C     CALL NUMCAL TO CALCULATE ARGON-41 FOR THE CURRENT TIME STEP
C
         CALL NUMCAL(TIME)
C*********************************************************************
C     CALCULATE BULDING CONCENTRATION AND UPDATE RELEASE AND ALSO
C     MAX LEVEL IF NEEDED
C
         BLEVEL = BLEVEL * (1 - LAMBDA * BLEVEL * DELT)
         BLEVEL = BLEVEL+NAR41(TUBEBEG,1)*PI*RADIUS ** 2 / VOLUME
         RELEASE = RELEASE+NAR41(TUBEBEG,1)
         IF (BLEVEL.GE.MAXLEVEL) THEN
            MAXLEVEL = BLEVEL
         ENDIF
C*********************************************************************
C     UPDATE OUPUT FILE IF NEEDED
C
         IF (TIME.EQ.OUTTIME) THEN
            OUTTIME = OUTTIME + OUTINT
            ACTVTY = BLEVEL * LAMBDA / CI * 1000
            WRITE(6,900) TIME,ACTVTY
            WRITE(7,900) TIME,ACTVTY
         ENDIF
 200  CONTINUE
C*********************************************************************
C     WRITE MAXLEVEL, TOTAL PRODUCTION, AND RELEASE TO OUTPUT FILE
C
```

```
      ACTVTY = MAXLEVEL * LAMBDA / CI * 1000
      RELEASE = RELEASE * PI * RADIUS**2 * LAMBDA / CI * 1000
      PROD = PROD * PI * RADIUS**2 * LAMBDA / CI * 1000
      WRITE(6,910) ACTVTY
      WRITE(7,910) ACTVTY
      WRITE(6,920) PROD
      WRITE(7,920) PROD
      WRITE(6,930) RELEASE
      WRITE(7,930) RELEASE
      CLOSE(7)
      STOP
  900 FORMAT(I7.7,10X,E18.10)
  910 FORMAT('MAXIMUM AR-41 CONCENTRATION IS: ',E18.10,' mCi/ml')
  920 FORMAT('TOTAL AR-41 PRODUCTION IS:      ',E18.10,' mCi')
  930 FORMAT('TOTAL AR-41 RELEASE:            ',E18.10,' mCi')
      END
      SUBROUTINE CASINIT
C*********************************************************************
C     ROUTINE     CASEINT (CASE INITIALIZATION)
C
C     PURPOSE     Gets input data from user on runtime and power level.
C                 Opens output file and prints header.
C
C     AUTHOR      Jason E. Floyd
C*********************************************************************
      COMMON/CASEINF/POWER,RTIME,DELT,DELX,OUTINT,MAXTIME
      DOUBLE PRECISION POWER,DELX,DELT
      INTEGER RTIME,OUTINT,MAXTIME
C
      WRITE(6,900)
      READ(5,*) POWER
      WRITE(6,910)
      READ(5,*) RTIME
C*********************************************************************
C     DETERMINE TIME TO END CASE
C
      MAXTIME = 1800 + 1800 * INT((RTIME+36000)/1800)
C*********************************************************************
C     OPEN OUTPUT FILE AND WRITE CASE HEADER
C
      OPEN(7,FILE='ARGON41.OUT',STATUS='UNKNOWN')
      WRITE(6,920) POWER,RTIME
      WRITE(7,920) POWER,RTIME
      WRITE(6,930) MAXTIME
      WRITE(7,930) MAXTIME
      WRITE(6,940) DELX,DELT,OUTINT
      WRITE(7,940) DELX,DELT,OUTINT
      WRITE(6,950)
      WRITE(7,950)
C*********************************************************************
C     RETURN TO AR41CAL
C
      RETURN
  900 FORMAT('CORE POWER LEVEL IN KW')
  910 FORMAT('RUNTIME IN SECONDS')
  920 FORMAT('ARGON-41 FOR POWER=',F10.5,' KW FOR ',I6.6,' SECONDS')
  930 FORMAT('CASE WILL BE RUN UNTIL TIME ',I7.7,' SECONDS')
  940 FORMAT('NODE SPACING=',F5.2,' CM, TIME STEP='F5.2' S, OUTPUT INTER
     /VAL='I5.5' S')
  950 FORMAT('  TIME            ACTIVITY IN mCi/ml')
      END
      SUBROUTINE NUMCAL(TIME)
C*********************************************************************
```

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

```
C     ROUTINE    NUMCAL (Number Density Calculation)
C
C     PURPOSE    This routine uses a 1D nodal diffusion calculation to
C                determine Ar-41 concentraions in the through tube. A
C                zero boundary condition is at the extrapolated boundary
C                of the open end of the tube, and a reflection boundary
C                condition is set at the open end of the tube.
C                Production of Ar-41 assumes a cosine flux shape over
C                the active length of the tube for the duration of the
C                run.
C
C     AUTHOR     Jason E. Floyd
C*********************************************************************
      COMMON/CASEINF/POWER,RTIME,DELT,DELX,OUTINT,MAXTIME
      COMMON/TUBEDIM/TUBEBEG,TUBEEND,COREBEG,COREEND,MAXPOS,CORELEN,EXB
      COMMON/ARCAL/NAR41,MAXFLUX,SIGMAAR,LAMBDA,DIFF,PI,PROD
      DOUBLE PRECISION MAXFLUX,SIGMAAR,LAMBDA,POWER,PROD,
     /     DELX,DELT,DIFF,RADIUS,VOLUME,BLEVEL,CI,MAXLEVEL,ACTVTY,
     /     NAR41(402,2),CORELEN,EXB,PI
      INTEGER TUBEBEG,TUBEEND,COREBEG,COREEND,MAXPOS,RTIME,MAXTIME,
     /     OUTTIME,OUTINT,TIME
C*********************************************************************
C     ZERO CONCENTRATION AT EXTRAPOLATED BOUNDARY CONDITION
C
      NAR41(1,2) = 0
      DO 100 POSIT = 2,TUBEEND
         NAR41(POSIT,2) = DELT / DELX**2 * DIFF * (NAR41(POSIT-1,1) +
     /        NAR41(POSIT+1,1)) + NAR41(POSIT,1) * (1 - DELT *
     /        (LAMBDA + 2 * DIFF / DELX**2))
C*********************************************************************
C     IF IN THE ACTIVE REGION OF THE THRU TUBE AND THE REACTOR IS AT
C     POWER CALCULATE THE AR-41 PRODUCTION
C
         IF ((POSIT.GE.COREBEG).AND.(POSIT.LE.COREEND).AND.(TIME.LE.
     /        RTIME)) THEN
            NAR41(POSIT,2) = NAR41(POSIT,2) + DELT * POWER * MAXFLUX *
     /           SIGMAAR * COS(PI*(EXB+POSIT*DELX)/CORELEN)
            PROD = PROD + DELT * POWER * MAXFLUX * SIGMAAR *
     /           COS(PI*(EXB+POSIT*DELX)/CORELEN)
         ENDIF
C*********************************************************************
C     MAKE THE NODE AFTER THE LAST NODE EQUAL TO THE NODE BEFORE THE
C     LAST NODE TO MEET THE REFECTION BOUNDARY CONDITION
C
         IF (POSIT.EQ.TUBEEND-1) THEN
            NAR41(MAXPOS,2) = NAR41(POSIT,2)
         ENDIF
 100     CONTINUE
      DO 200 POSIT = 1,TUBEEND
         NAR41(POSIT,1) = NAR41(POSIT,2)
 200  CONTINUE
C*********************************************************************
C     RETURN TO AR41CAL
C
      RETURN
      END
```

APPENDIX B

AR41CAL CASE OUTPUTS

1 Hour at Full Power

ARGON-41 FOR POWER= 250.00000 KW FOR 003600 SECONDS
CASE WILL BE RUN UNTIL TIME 0041400 SECONDS
NODE SPACING= 2.00 CM, TIME STEP= 4.00 S, OUTPUT INTERVAL=00900 S

TIME	ACTIVITY IN mCi/ml
0000900	-0.1070969988E-51
0001800	0.5162039140E-32
0002700	0.1867650207E-24
0003600	0.7298393504E-21
0004500	0.1133527619E-18
0005400	0.3519077431E-17
0006300	0.4307693578E-16
0007200	0.2920954381E-15
0008100	0.1327047791E-14
0009000	0.4531208049E-14
0009900	0.1250763710E-13
0010800	0.2928986189E-13
0011700	0.6016728670E-13
0012600	0.1110881687E-12
0013500	0.1877688714E-12
0014400	0.2947226932E-12
0015300	0.4344135621E-12
0016200	0.6066857717E-12
0017100	0.8085598381E-12
0018000	0.1034426223E-11
0018900	0.1276607432E-11
0019800	0.1526194370E-11
0020700	0.1774008479E-11
0021600	0.2011518147E-11
0022500	0.2231559265E-11
0023400	0.2428769672E-11
0024300	0.2599722588E-11
0025200	0.2742808224E-11
0026100	0.2857948308E-11
0027000	0.2946233184E-11
0027900	0.3009554426E-11
0028800	0.3050280186E-11
0029700	0.3070995730E-11
0030600	0.3074313207E-11
0031500	0.3062743624E-11
0032400	0.3038619087E-11
0033300	0.3004052530E-11
0034200	0.2960923557E-11
0035100	0.2910881217E-11
0036000	0.2855356952E-11
0036900	0.2795582900E-11
0037800	0.2732612417E-11
0038700	0.2667340801E-11
0039600	0.2600525069E-11
0040500	0.2532802155E-11
0041400	0.2464705284E-11

MAXIMUM AR-41 CONCENTRATION IS: 0.3074992466E-11 mCi/ml
TOTAL AR-41 PRODUCTION IS: 0.2408635586E+01 mCi
TOTAL AR-41 RELEASE: 0.1463356457E-01 mCi

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

10 Hours at Full Power

ARGON-41 FOR POWER= 250.00000 KW FOR 036000 SECONDS
CASE WILL BE RUN UNTIL TIME 0073800 SECONDS
NODE SPACING= 2.00 CM, TIME STEP= 4.00 S, OUTPUT INTERVAL=00900 S

TIME	ACTIVITY IN mCi/ml
0000900	-0.1070969988E-51
0001800	0.5162039140E-32
0002700	0.1867650207E-24
0003600	0.7298393504E-21
0004500	0.1133527619E-18
0005400	0.3519077431E-17
0006300	0.4307693597E-16
0007200	0.2920961679E-15
0008100	0.1327161142E-14
0009000	0.4534726880E-14
0009900	0.1255070334E-13
0010800	0.2958174648E-13
0011700	0.6149204934E-13
0012600	0.1156048686E-12
0013500	0.2002206799E-12
0014400	0.3238812076E-12
0015300	0.4944238875E-12
0016200	0.7178968866E-12
0017100	0.9974553735E-12
0018000	0.1332428969E-11
0018900	0.1717804008E-11
0019800	0.2144349318E-11
0020700	0.2599490629E-11
0021600	0.3068822342E-11
0022500	0.3537924044E-11
0023400	0.3994039746E-11
0024300	0.4427244412E-11
0025200	0.4830925919E-11
0026100	0.5201639490E-11
0027000	0.5538542944E-11
0027900	0.5842658081E-11
0028800	0.6116153837E-11
0029700	0.6361763149E-11
0030600	0.6582369770E-11
0031500	0.6780752161E-11
0032400	0.6959449287E-11
0033300	0.7120709432E-11
0034200	0.7266488972E-11
0035100	0.7398477059E-11
0036000	0.7518130600E-11
0036900	0.7626710530E-11
0037800	0.7725314848E-11
0038700	0.7814906703E-11
0039600	0.7896337291E-11
0040500	0.7970364016E-11
0041400	0.8037662377E-11
0042300	0.8098816191E-11
0043200	0.8154246718E-11
0044100	0.8204055517E-11
0045000	0.8247828825E-11
0045900	0.8284508465E-11
0046800	0.8312413768E-11
0047700	0.8329425020E-11
0048600	0.8333271506E-11
0049500	0.8321840202E-11

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

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Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

0050400	0.8293433021E-11
0051300	0.8246932190E-11
0052200	0.8181865951E-11
0053100	0.8098389736E-11
0054000	0.7997208670E-11
0054900	0.7879468182E-11
0055800	0.7746634848E-11
0056700	0.7600382767E-11
0057600	0.7442494404E-11
0058500	0.7274779718E-11
0059400	0.7099014009E-11
0060300	0.6916892923E-11
0061200	0.6730002078E-11
0062100	0.6539798531E-11
0063000	0.6347601436E-11
0063900	0.6154589553E-11
0064800	0.5961803670E-11
0065700	0.5770152401E-11
0066600	0.5580420143E-11
0067500	0.5393276299E-11
0068400	0.5209285100E-11
0069300	0.5028915546E-11
0070200	0.4852551144E-11
0071100	0.4680499216E-11
0072000	0.4512999648E-11
0072900	0.4350233005E-11
0073800	0.4192327968E-11

MAXIMUM AR-41 CONCENTRATION IS: 0.8333668028E-11 mCi/ml
TOTAL AR-41 PRODUCTION IS: 0.2408635586E+02 mCi
TOTAL AR-41 RELEASE: 0.1636378986E+00 mCi

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

100 Hours at Full Power

ARGON-41 FOR POWER= 250.00000 KW FOR 360000 SECONDS
CASE WILL BE RUN UNTIL TIME 0397800 SECONDS
NODE SPACING= 2.00 CM, TIME STEP= 4.00 S, OUTPUT INTERVAL=00900 S

TIME	ACTIVITY IN mCi/ml
0000900	-0.1070969988E-51
0001800	0.5162039140E-32
0002700	0.1867650207E-24
0003600	0.7298393504E-21
0004500	0.1133527619E-18
0005400	0.3519077431E-17
0006300	0.4307693597E-16
0007200	0.2920961679E-15
0008100	0.1327161142E-14
0009000	0.4534726880E-14
0009900	0.1255070334E-13
0010800	0.2958174648E-13
0011700	0.6149204934E-13
0012600	0.1156048686E-12
0013500	0.2002206799E-12
0014400	0.3238812076E-12
0015300	0.4944238875E-12
0016200	0.7178968866E-12
0017100	0.9974553735E-12
0018000	0.1332428969E-11
0018900	0.1717804008E-11
0019800	0.2144349318E-11
0020700	0.2599490629E-11
0021600	0.3068822342E-11
0022500	0.3537924044E-11
0023400	0.3994039746E-11
0024300	0.4427244412E-11
0025200	0.4830925919E-11
0026100	0.5201639490E-11
0027000	0.5538542944E-11
0027900	0.5842658081E-11
0028800	0.6116153837E-11
0029700	0.6361763149E-11
0030600	0.6582369770E-11
0031500	0.6780752161E-11
0032400	0.6959449287E-11
0033300	0.7120709432E-11
0034200	0.7266488972E-11
0035100	0.7398477059E-11
0036000	0.7518130600E-11
0036900	0.7626710530E-11
0037800	0.7725314848E-11
0038700	0.7814906703E-11
0039600	0.7896337292E-11
0040500	0.7970364117E-11
0041400	0.8037665389E-11
0042300	0.8098851363E-11
0043200	0.8154473330E-11
0044100	0.8205030838E-11
0045000	0.8250977572E-11
0045900	0.8292726239E-11
0046800	0.8330652694E-11
0047700	0.8365099491E-11
0048600	0.8396378975E-11
0049500	0.8424776014E-11

0050400	0.8450550440E-11
0051300	0.8473939239E-11
0052200	0.8495158533E-11
0053100	0.8514405380E-11
0054000	0.8531859415E-11
0054900	0.8547684346E-11
0055800	0.8562029324E-11
0056700	0.8575030198E-11
0057600	0.8586810660E-11
0058500	0.8597483302E-11
0059400	0.8607150576E-11
0060300	0.8615905682E-11
0061200	0.8623833372E-11
0062100	0.8631010696E-11
0063000	0.8637507681E-11
0063900	0.8643387948E-11
0064800	0.8648709289E-11
0065700	0.8653524177E-11
0066600	0.8657880250E-11
0067500	0.8661820742E-11
0068400	0.8665384879E-11
0069300	0.8668608244E-11
0070200	0.8671523106E-11
0071100	0.8674158724E-11
0072000	0.8676541617E-11
0072900	0.8678695821E-11
0073800	0.8680643115E-11
0074700	0.8682403226E-11
0075600	0.8683994024E-11
0076500	0.8685431689E-11
0077400	0.8686730873E-11
0078300	0.8687904837E-11
0079200	0.8688965587E-11
0080100	0.8689923984E-11
0081000	0.8690789859E-11
0081900	0.8691572103E-11
0082800	0.8692278761E-11
0083700	0.8692917109E-11
0084600	0.8693493727E-11
0085500	0.8694014564E-11
0086400	0.8694485001E-11
0087300	0.8694909900E-11
0088200	0.8695293659E-11
0089100	0.8695640251E-11
0090000	0.8695953268E-11
0090900	0.8696235957E-11
0091800	0.8696491251E-11
0092700	0.8696721801E-11
0093600	0.8696930002E-11
0094500	0.8697118017E-11
0095400	0.8697287801E-11
0096300	0.8697441122E-11
0097200	0.8697579573E-11
0098100	0.8697704596E-11
0099000	0.8697817493E-11
0099900	0.8697919440E-11
0100800	0.8698011498E-11
0101700	0.8698094626E-11
0102600	0.8698169691E-11
0103500	0.8698237475E-11
0104400	0.8698298684E-11
0105300	0.8698353956E-11
0106200	0.8698403867E-11

0107100	0.8698448937E-11
0108000	0.8698489636E-11
0108900	0.8698526389E-11
0109800	0.8698559577E-11
0110700	0.8698589547E-11
0111600	0.8698616612E-11
0112500	0.8698641053E-11
0113400	0.8698663124E-11
0114300	0.8698683056E-11
0115200	0.8698701056E-11
0116100	0.8698717312E-11
0117000	0.8698731993E-11
0117900	0.8698745251E-11
0118800	0.8698757225E-11
0119700	0.8698768039E-11
0120600	0.8698777806E-11
0121500	0.8698786627E-11
0122400	0.8698794593E-11
0123300	0.8698801789E-11
0124200	0.8698808287E-11
0125100	0.8698814157E-11
0126000	0.8698819459E-11
0126900	0.8698824248E-11
0127800	0.8698828573E-11
0128700	0.8698832480E-11
0129600	0.8698836009E-11
0130500	0.8698839197E-11
0131400	0.8698842076E-11
0132300	0.8698844678E-11
0133200	0.8698847027E-11
0134100	0.8698849150E-11
0135000	0.8698851067E-11
0135900	0.8698852799E-11
0136800	0.8698854364E-11
0137700	0.8698855778E-11
0138600	0.8698857055E-11
0139500	0.8698858209E-11
0140400	0.8698859251E-11
0141300	0.8698860193E-11
0142200	0.8698861044E-11
0143100	0.8698861812E-11
0144000	0.8698862507E-11
0144900	0.8698863134E-11
0145800	0.8698863701E-11
0146700	0.8698864214E-11
0147600	0.8698864676E-11
0148500	0.8698865095E-11
0149400	0.8698865473E-11
0150300	0.8698865814E-11
0151200	0.8698866123E-11
0152100	0.8698866401E-11
0153000	0.8698866653E-11
0153900	0.8698866881E-11
0154800	0.8698867087E-11
0155700	0.8698867273E-11
0156600	0.8698867441E-11
0157500	0.8698867592E-11
0158400	0.8698867730E-11
0159300	0.8698867854E-11
0160200	0.8698867966E-11
0161100	0.8698868067E-11
0162000	0.8698868158E-11
0162900	0.8698868241E-11

0163800	0.8698868316E-11
0164700	0.8698868383E-11
0165600	0.8698868445E-11
0166500	0.8698868500E-11
0167400	0.8698868550E-11
0168300	0.8698868595E-11
0169200	0.8698868635E-11
0170100	0.8698868672E-11
0171000	0.8698868706E-11
0171900	0.8698868736E-11
0172800	0.8698868763E-11
0173700	0.8698868787E-11
0174600	0.8698868810E-11
0175500	0.8698868830E-11
0176400	0.8698868848E-11
0177300	0.8698868864E-11
0178200	0.8698868879E-11
0179100	0.8698868892E-11
0180000	0.8698868905E-11
0180900	0.8698868916E-11
0181800	0.8698868925E-11
0182700	0.8698868934E-11
0183600	0.8698868943E-11
0184500	0.8698868950E-11
0185400	0.8698868956E-11
0186300	0.8698868962E-11
0187200	0.8698868968E-11
0188100	0.8698868973E-11
0189000	0.8698868977E-11
0189900	0.8698868981E-11
0190800	0.8698868985E-11
0191700	0.8698868988E-11
0192600	0.8698868991E-11
0193500	0.8698868994E-11
0194400	0.8698868996E-11
0195300	0.8698868998E-11
0196200	0.8698869000E-11
0197100	0.8698869002E-11
0198000	0.8698869004E-11
0198900	0.8698869005E-11
0199800	0.8698869006E-11
0200700	0.8698869008E-11
0201600	0.8698869009E-11
0202500	0.8698869010E-11
0203400	0.8698869010E-11
0204300	0.8698869011E-11
0205200	0.8698869012E-11
0206100	0.8698869013E-11
0207000	0.8698869013E-11
0207900	0.8698869014E-11
0208800	0.8698869014E-11
0209700	0.8698869015E-11
0210600	0.8698869015E-11
0211500	0.8698869015E-11
0212400	0.8698869016E-11
0213300	0.8698869016E-11
0214200	0.8698869016E-11
0215100	0.8698869017E-11
0216000	0.8698869017E-11
0216900	0.8698869017E-11
0217800	0.8698869017E-11
0218700	0.8698869017E-11
0219600	0.8698869017E-11

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc-File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

0220500	0.8698869018E-11
0221400	0.8698869018E-11
0222300	0.8698869018E-11
0223200	0.8698869018E-11
0224100	0.8698869018E-11
0225000	0.8698869018E-11
0225900	0.8698869018E-11
0226800	0.8698869018E-11
0227700	0.8698869018E-11
0228600	0.8698869018E-11
0229500	0.8698869018E-11
0230400	0.8698869018E-11
0231300	0.8698869018E-11
0232200	0.8698869018E-11
0233100	0.8698869018E-11
0234000	0.8698869019E-11
0234900	0.8698869019E-11
0235800	0.8698869019E-11
0236700	0.8698869019E-11
0237600	0.8698869019E-11
0238500	0.8698869019E-11
0239400	0.8698869019E-11
0240300	0.8698869019E-11
0241200	0.8698869019E-11
0242100	0.8698869019E-11
0243000	0.8698869019E-11
0243900	0.8698869019E-11
0244800	0.8698869019E-11
0245700	0.8698869019E-11
0246600	0.8698869019E-11
0247500	0.8698869019E-11
0248400	0.8698869019E-11
0249300	0.8698869019E-11
0250200	0.8698869019E-11
0251100	0.8698869019E-11
0252000	0.8698869019E-11
0252900	0.8698869019E-11
0253800	0.8698869019E-11
0254700	0.8698869019E-11
0255600	0.8698869019E-11
0256500	0.8698869019E-11
0257400	0.8698869019E-11
0258300	0.8698869019E-11
0259200	0.8698869019E-11
0260100	0.8698869019E-11
0261000	0.8698869019E-11
0261900	0.8698869019E-11
0262800	0.8698869019E-11
0263700	0.8698869019E-11
0264600	0.8698869019E-11
0265500	0.8698869019E-11
0266400	0.8698869019E-11
0267300	0.8698869019E-11
0268200	0.8698869019E-11
0269100	0.8698869019E-11
0270000	0.8698869019E-11
0270900	0.8698869019E-11
0271800	0.8698869019E-11
0272700	0.8698869019E-11
0273600	0.8698869019E-11
0274500	0.8698869019E-11
0275400	0.8698869019E-11
0276300	0.8698869019E-11

0277200	0.8698869019E-11
0278100	0.8698869019E-11
0279000	0.8698869019E-11
0279900	0.8698869019E-11
0280800	0.8698869019E-11
0281700	0.8698869019E-11
0282600	0.8698869019E-11
0283500	0.8698869019E-11
0284400	0.8698869019E-11
0285300	0.8698869019E-11
0286200	0.8698869019E-11
0287100	0.8698869019E-11
0288000	0.8698869019E-11
0288900	0.8698869019E-11
0289800	0.8698869019E-11
0290700	0.8698869019E-11
0291600	0.8698869019E-11
0292500	0.8698869019E-11
0293400	0.8698869019E-11
0294300	0.8698869019E-11
0295200	0.8698869019E-11
0296100	0.8698869019E-11
0297000	0.8698869019E-11
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0298800	0.8698869019E-11
0299700	0.8698869019E-11
0300600	0.8698869019E-11
0301500	0.8698869019E-11
0302400	0.8698869019E-11
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0304200	0.8698869019E-11
0305100	0.8698869019E-11
0306000	0.8698869019E-11
0306900	0.8698869019E-11
0307800	0.8698869019E-11
0308700	0.8698869019E-11
0309600	0.8698869019E-11
0310500	0.8698869019E-11
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0312300	0.8698869019E-11
0313200	0.8698869019E-11
0314100	0.8698869019E-11
0315000	0.8698869019E-11
0315900	0.8698869019E-11
0316800	0.8698869019E-11
0317700	0.8698869019E-11
0318600	0.8698869019E-11
0319500	0.8698869019E-11
0320400	0.8698869019E-11
0321300	0.8698869019E-11
0322200	0.8698869019E-11
0323100	0.8698869019E-11
0324000	0.8698869019E-11
0324900	0.8698869019E-11
0325800	0.8698869019E-11
0326700	0.8698869019E-11
0327600	0.8698869019E-11
0328500	0.8698869019E-11
0329400	0.8698869019E-11
0330300	0.8698869019E-11
0331200	0.8698869019E-11
0332100	0.8698869019E-11
0333000	0.8698869019E-11

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0334800	0.8698869019E-11
0335700	0.8698869019E-11
0336600	0.8698869019E-11
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0338400	0.8698869019E-11
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0340200	0.8698869019E-11
0341100	0.8698869019E-11
0342000	0.8698869019E-11
0342900	0.8698869019E-11
0343800	0.8698869019E-11
0344700	0.8698869019E-11
0345600	0.8698869019E-11
0346500	0.8698869019E-11
0347400	0.8698869019E-11
0348300	0.8698869019E-11
0349200	0.8698869019E-11
0350100	0.8698869019E-11
0351000	0.8698869019E-11
0351900	0.8698869019E-11
0352800	0.8698869019E-11
0353700	0.8698869019E-11
0354600	0.8698869019E-11
0355500	0.8698869019E-11
0356400	0.8698869019E-11
0357300	0.8698869019E-11
0358200	0.8698869019E-11
0359100	0.8698869019E-11
0360000	0.8698869019E-11
0360900	0.8698869019E-11
0361800	0.8698869019E-11
0362700	0.8698869019E-11
0363600	0.8698869018E-11
0364500	0.8698868918E-11
0365400	0.8698866043E-11
0366300	0.8698834343E-11
0367200	0.8698645961E-11
0368100	0.8697910189E-11
0369000	0.8695776277E-11
0369900	0.8690802033E-11
0370800	0.8680969885E-11
0371700	0.8663860519E-11
0372600	0.8636929173E-11
0373500	0.8597803632E-11
0374400	0.8544534133E-11
0375300	0.8475755572E-11
0376200	0.8390753647E-11
0377100	0.8289448756E-11
0378000	0.8172322084E-11
0378900	0.8040309559E-11
0379800	0.7894685126E-11
0380700	0.7736948470E-11
0381600	0.7568726137E-11
0382500	0.7391690121E-11
0383400	0.7207494591E-11
0384300	0.7017729434E-11
0385200	0.6823888276E-11
0386100	0.6627348334E-11
0387000	0.6429359524E-11
0387900	0.6231040553E-11
0388800	0.6033380072E-11
0389700	0.5837241353E-11

Project: _____ Task: _____ Prepared by: J. E. Floyd Date: 10/30/93

Calc File No: _____ Reviewed by: W. J. Chappas Date: _____

Title: Ar-41 Production Calculations for Annual Report and 10CFR20 Requirements

0390600	0.5643369274E-11
0391500	0.5452398711E-11
0392400	0.5264863641E-11
0393300	0.5081206474E-11
0394200	0.4901787279E-11
0395100	0.4726892648E-11
0396000	0.4556744077E-11
0396900	0.4391505762E-11
0397800	0.4231291772E-11
MAXIMUM AR-41 CONCENTRATION IS:	0.8698869019E-11 mCi/ml
TOTAL AR-41 PRODUCTION IS:	0.2408635586E+03 mCi
TOTAL AR-41 RELEASE:	0.1705623475E+01 mCi