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March 30, 2008 2008-0021

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: 2007 Annual Report (Facility License R-83)

To Whom It May Concern:

Enclosed please find the 2007 Annual Report for the Texas A&M University Nuclear Science Center. If you have any questions regarding this, please feel free to call Latha Vasudevan or Jim Remlinger at (979) 845-7551.

Sincerely,

W. D. Reece, Director

Enclosure

LV/eb

Xc: 211/Central File
Annual Report File
Jim Remlinger, Associate Director
Latha Vasudevan, Radiological Safety Officer

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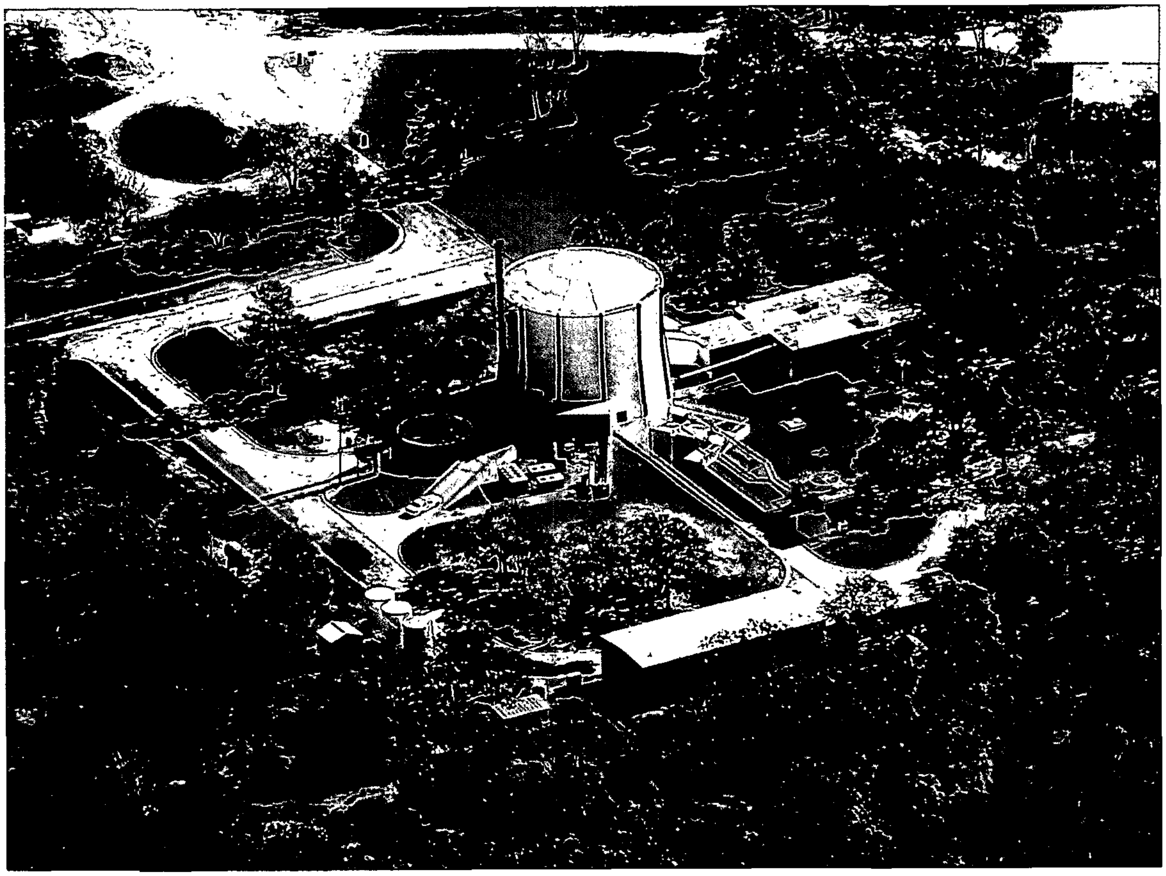
# Texas A&M University

# Nuclear Science Center

*2007 Annual Report*



**Nuclear Science Center**

**Texas Engineering Experiment Station**

**Texas A&M University System**

**College Station, Texas.**

# Texas A&M University System
# Texas Engineering Experiment Station

## 2007 Annual Report

## Facility Operating License R-83

**Nuclear Science Center**
**1095 Nuclear Science Road**
**College Station, Texas 77843-3575**

**Prepared By: Latha Vasudevan, Ph. D**
**NSC Radiological Safety Officer**

**March 2008**

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# I. Introduction

The Texas A&M University (TAMU) Nuclear Science Center (NSC) is a multi-disciplinary research and education center supporting basic and applied research in nuclear related fields of science and technology as well as providing educational opportunities for students in these fields as a service to the Texas A&M University System and the state of Texas. The NSC also provides services to commercial ventures requiring radiation or isotope production services.

The NSC reactor is a 1 MW TRIGA research reactor in a large (108,000-gal.) pool. The size of the NSC reactor pool provides great flexibility in the experiments that may be conducted near the reactor. The Science Center has a calibration facility using a Cs-137 calibrator, a neutron radiography facility, a large-object irradiation cell, hot cells and manipulators, and other supporting facilities.

Laboratory facilities include three counting laboratories with three High Purity Germanium detectors, a three-station pneumatics sample transfer system, a fast neutron irradiation system, a delayed neutron detection system, a film neutron radiography system, a large neutron/gamma irradiation cell, and two neutron beam ports.

The NSC reactor design allows for easy load/unload of various types of samples. The NSC actively produces a variety of radioisotopes for industry, hospitals, and academic users. The NSC provides nationally recognized neutron activation analysis (NAA) services to many research and academic institutions in the United States. The Nuclear Engineering Department on campus is a major user of the NSC reactor. The NSC is also one of the major attractions on campus. Last year, the NSC hosted 2151 visitors including: elementary, middle school, high school and college students as well as faculty members, national laboratory scientists and industrial clients. Through these tours, the NSC taught people with widely varying backgrounds about nuclear science.

With strong support from the University, the NSC is continuously increasing the diversity of its facilities and services. The NSC continues to perform research on developing a technique for the production of I-125. The NSC and the Nuclear Engineering Department are collaborators of the Innovations in Nuclear Infrastructure and Education Grant. As part of this grant, the NSC has refurbished the delayed neutron counting system and continued to produce the prototype for distance learning modules. With support from the DOE instrumentation grant, NSC is pursuing to install a prompt gamma neutron activation analysis system that will be utilized for research and teaching.

In September of 2006, the Nuclear Science Center completed the conversion of the reactor core from HEU to LEU (30/20) fuel. Following reactor startup testing, the reactor was declared steady-state operational in October 2006 and pulse-operation in November 2006.

Amendment 17 of License R-83 which ordered the conversion of the reactor core, also called for the submittal of a reactor startup report to the NRC within six months following the completion of the conversion. The ordered report was completed and submitted to the NRC in May 2007 in accordance with the amendment and the order to convert.

In July 2007, the NSC, with the assistance of General Atomics, Idaho National Labs and the Department of Energy, undertook the major project of shipping 103 spent HEU and LEU elements. Subsequently, in August of 2007, the fuel meat from an unirradiated HEU fuel element was shipped to Y-12.

In accordance with License R-83 Amendment 17, paragraph II-B.(2) allows the NSC to "*possess, but not use, up to 12.0 kilograms of contained uranium-235 at or equal to or greater than 20 percent enrichment in the form of TRIGA FLIP-type reactor fuel until the existing inventory of this fuel is removed from the facility*". At the completion of the above mentioned shipments, it was determined that the conditions of this amendment were satisfied and the possession of HEU type fuel was no longer authorized.

NSC management is working on the LEU conversion Safety Analysis Report that will be submitted to the NRC as an amendment to the R-83 license renewal process.

This annual report has been prepared to satisfy the reporting requirements of Technical Specification 6.6.1 of the facility operating license R-83 and of the Department of Energy University Reactor Fuel Assistance Program subcontract No C87-101594 (DE-AC07-76ER02426).

### 1.1 Nuclear Science Center Staff

The staff at the Nuclear Science Center consists of four major groups: Reactor Operations, Health Physics/Technical Coordination, Reactor Maintenance, and Administrative Services Personnel directly involved with the operation and maintenance of the reactor are NRC-licensed operators. The NSC is committed to its educational responsibilities and many members of the staff are part or full-time students at Texas A&M University. Appendix A shows the Nuclear Science Center Organization Chart.

The Texas Engineering Experiment Station (TEES) of the Texas A&M University System operates the NSC. The Director of the NSC is responsible to the Deputy Director of the TEES for the administration and the proper and safe operation of the facility. In addition to the internal structure, the Reactor Safety Board (RSB) advises the Deputy Director of the TEES and the Director of the NSC on issues or policy pertaining to reactor safety. The Texas A&M University Environmental Health and Safety Department (EHSD) provide assistance when it is required for emergencies and for special operations as agreed. The Texas A&M University Police Department provides security support on a daily basis and is a key support group in the event of a security incident.

## 2. Reactor Utilization for 2007

The Nuclear Science Center (NSC) reactor has been in operation since 1962. The reactor is a 1-MW MTR-converted TRIGA reactor. Until the refueling in September 2006, the reactor used highly enriched uranium fuel (70%), but now uses low enriched uranium fuel (20%). Core VIII-A is the current core configuration and has been in use since March 1986. The NSC reactor is pulse operational and is pulsed up to powers of approximately 1,100 MW for nuclear engineering laboratories, staff training, and public tours.

The NSC reactor operated for 1835.8 hours in 2007 with a total integrated power of 74.1 MW-days. There were 556 "Requests for Irradiation" processed at the NSC during the reporting period. The NSC provided services to TAMU departments, other universities, research centers, and secondary schools in and outside the state of Texas. The cumulative total energy output since initial criticality of the LEU fuel is 90.23 MW days. Table 2 shows the reactor utilization summary and Figure 2 shows the MW-hrs of operation.

**Table 2: Reactor Utilization Summary in 2007**

| | |
|---|---|
| Days of Reactor Operation | 231 |
| Integrated Power (MW-days) | 74.1 |
| Number of Hours at Steady-State | 1835.8 |
| Number of Pulses | 54 |
| Number of Reactor Irradiations (RFS) | 556 |
| Beam Port/Thermal Column Experiment Hours | 874.1 |
| Hours Irradiation Cell Use | 15.183 |
| Number of Visitors | 1776 |
| Unscheduled Shutdowns | 9 |

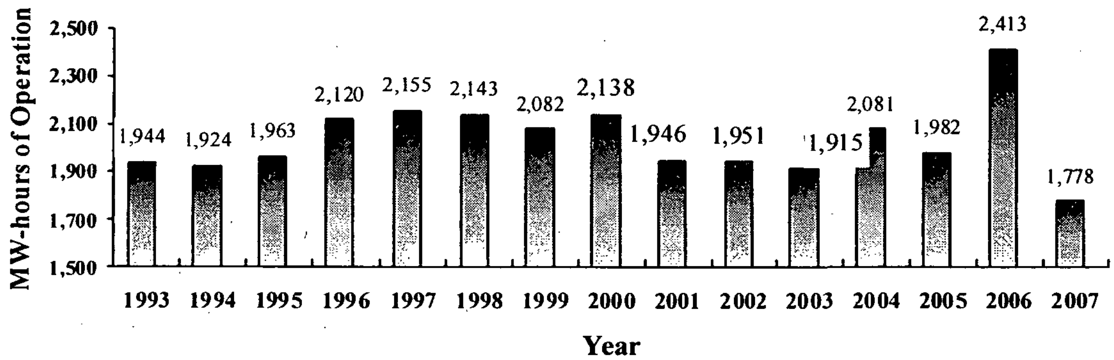



**Figure 2. Annual Reactor Utilization**

## 2.1 TAMU Academic Support Program

Texas A&M University provides funding for the reactor for such academic activities as nuclear engineering laboratories, neutron activation analysis demonstrations and laboratories, graduate student thesis and dissertation research, and undergraduate research projects. The program has been very successful and is crucial for many graduate students who use the NSC reactor for research and have not received research grants. The wide range of academic users from the university reflects in the NSC's reputation as a multi-disciplinary institution.

## 2.2 DOE University Reactor Sharing Program

The DOE University Reactor Sharing Program provides funds for reactor experimentation to those institutions that do not normally have access to a research reactor. The NSC has participated in the program since 1980. During the 2007 contract year, nine research institutions utilized the NSC with the support of the Reactor Sharing Program. Additionally, the funding provided reactor tours and "hands on" projects to many secondary schools. The funding gave several small colleges and universities the opportunity to use the NSC facilities for teaching courses in nuclear processes, specifically neutron activation analysis and gamma spectroscopy. The Reactor Sharing Program supported the use of the Fast Flux Irradiation Device for multiple users at New Mexico Institute of Mining and Technology and the University of Nevada at Las Vegas. This device has near optimum neutron fluxes for $^{39}Ar/^{40}Ar$ dating. The NSC Dry Irradiation Cell was used for gamma irradiation on a variety of samples. The program also supported multiple users within universities utilizing beam port for irradiation of samples as well as neutron radiography.

## 2.3 Commercial Activity and External Research

The NSC provides services to a variety of users that provide their own funding. The majority of commercial activities focus on production of radioactive tracers for the Texas petroleum and chemical industries. Another commercial activity uses the converted Thermal Column area to produce micropore filters used in ultra-pure water systems in the semiconductor industry. Outside research grants fund a significant amount of the NSC's research. The NSC is involved with neutron activation analysis and radioassays for a wide variety of samples for outside customers. The NSC has many years of experience producing radioisotopes and has developed several customer-specific methods for radioactive sample production and handling. The production of radioisotopes generally involves handling radioactive material with high activities. The NSC staff takes precautions to minimize the exposures during the transfer of radioactive materials to shipping shields.

# 3. Facility and Procedure Changes

## 3.1 Facility Modifications

The heating and cooling for the reception room was upgraded with electric valves and thermostat replacing the old pneumatic components. This allowed us to remove the air compressor, which was only serving the Reception Room since the installation of the new heating and cooling system.

A fixed filter continuous air monitor was installed to monitor the thermal column, replacing a heavily modified unit originally was used as the facility air monitor years ago.

In 2007, the NSC performed the following:

- A new stairway was built to the top of the cooling tower.
- The Up Ramp, roof of the lab and office areas were re-coated.
- The driveway and parking areas around the facility were repaired and re-coated.
- The conduit and wiring around the liquid waste tanks were replaced.

## 3.2 Experiment Authorization and Modification Authorization

There were no new Experiment Authorizations covered in 2007, but there was one Modification Authorization (MA#60) that was approved. The following Table 3-2 outlines the description of MA and its current status.

**Table 3-2: Modification Authorization**

| MA# | Title | Description | Status |
|---|---|---|---|
| 60 | Replacement of Heating, Ventilation, and Air Conditioning System | Replacement of the existing HVAC system and the improvement in the central exhaust system | Approved |

# 4. Reactor Maintenance and Surveillance

## 4.1 Scheduled Maintenance

NSC personnel performed regular maintenance on the Fuel Element Temperature Channel, Area Radiation Monitors and the Linear, Log, and Safety Power Channels as required by the Technical Specifications. They also performed all surveillance required by the reactor license. Control rod worth and scram time measurements performed in August 2007 gave the following results. The total rod worth is $14.969. The most reactive control rod is Shim Safety

#4 with a worth of $4.057. The shutdown margin was $3.266 and core excess was $5.768. Scram times on all rods were less than 1.2 seconds. In addition, operators performed calorimetric calibration following each maintenance period, and fuel inspections with no abnormalities noted (as required by the Technical Specification). The cold critical reactivity worth, performed for each reactor experiment, shows the most reactive fixed experiment is the Fast Flux Irradiation Device (-$1.24) with leveling high boron loading the negative worth.

### 4.2 Unscheduled Maintenance

Table 4-2 lists the unscheduled maintenance performed in year 2007.

**Table 4-2: Unscheduled Maintenance**

| | |
|---|---|
| 01-03-2007 | The limit switches on the Transient Rod drive were adjusted for proper operation. |
| 01-04-2007 | A blown fuse was replaced on the FAM computer interface board. |
| 01-08-2007 | A rod down indicator switch was replaced on Shim Safety #1. |
| 01-08-2007 | The logic board in the Shim Safety #3 controller was replaced. |
| 01-10-2007 | One of the close buttons for the front gate was found to be sticking and was replaced. |
| 02-23-2007 | Replaced a defective op-amp that prevents withdrawing the Transient Rod while any of the other control rods are being withdrawn. |
| 03-22-2007 | Repaired the wiring from the Transient Rod to the Rod Drop Timer. |
| 03-28-2007 | The Transient Rod rod down indicator switch was repositioned for proper indication. |
| 04-25-2007 | The magnet for Shim Safety #1 was replaced. |
| 05-18-2007 | A broken connection on FAM Channel #1 was repaired. |
| 06-15-2007 | Screws were replaced and tightened on the FAM Channel #4 paper drive. |

| | |
|---|---|
| 07-10-2007 | The blower that cools the circuit breaker boxes in the Heat Exchanger Room was replaced. |
| 08-03-2007 | A broken connection to the Pool Temperature thermal couple was repaired. |
| 08-17-2007 | The Transient Rod rod down switch was replaced. |
| 09-05-2007 | An alarm relay in the Lab-5 ARM was replaced. |
| 09-20-2007 | The power supply for the Down Ramp camera was replaced. |
| 09-28-2007 | The crane control pendant was replaced. |
| 10-01-2007 | The grounding on the Lab #6 smoke detector was repaired. |
| 10-02-2007 | The dial for Safety Channel #1 test current was replaced. |

### 4.3 Unscheduled Shutdowns

There were nine unscheduled reactor shutdowns during 2007. The cause is detailed below in Table 4-3.

**Table 4-3: Unscheduled Shutdowns**

| | |
|---|---|
| 2/22/2007 | Reactor scrammed due to loss of electrical power. Power loss was caused by a breaker opening when a wire was inadvertently moved. |
| 5/3/2007 | Reactor scrammed during startup due to momentary swing of indicated power on Safety Power Channel #2 to over 124%. The swing was caused by electronic noise; actual reactor power was 80% and did not exceed 100%. |
| 6/8/2007 | Reactor scrammed due to reading on Safety Power Channel #2 of over 124%. Safety Power Channel #2 indicated higher than actual power due to neutron reflection from the Thermal Column while operating against the Thermal Column; actual reactor power was 100% and did not exceed 100%. |
| 7/13/2007 | Reactor scrammed due to reading on Safety Power Channel #1 of over 124%. During a power transient from ~50% to 100% a sample swayed on the west face of the core. The sample sway caused a momentary swing of indicated power; actual reactor power was 70% and did not exceed 100%. |

| | |
|---|---|
| 7/24/2007 | Reactor scrammed due to loss of electrical power from offsite. |
| 7/25/2007 | Reactor scrammed due to loss of electrical power from offsite. |
| 8/9/2007 | Reactor scrammed due to loss of electrical power from offsite. |
| 9/4/2007 | Reactor scrammed due to loss of electrical power from offsite. |
| 9/26/2007 | Reactor scrammed due to loss of electrical power from offsite. |
| 10/15/2007 | Reactor scrammed due to loss of electrical power from offsite. |

### 4.4 Emergency Planning and Review

The Nuclear Science Center Management and the RSB reviewed the NSC Security and Emergency Plans. The Emergency Plan is undergoing a re-write to incorporate minor changes in the plan. The update on the Security Plan to include the Compensatory Measures and finger printing requirements were discussed. There has been no mandate to update the security plan by the NRC. Two successful on site emergency drills were conducted in 2007.

### 4.5 Notice of Violation

There was no "Notice of Violation" in 2007.

## 5. Health Physics Surveillance

The purpose of Health Physics surveillance is to ensure safe use of radioactive materials in the Nuclear Science Center's research and service activities and to fulfill the regulatory requirements of U.S. Nuclear Regulatory Commission and State agencies. The NSC maintains a Health Physics group as an integral part of the organization. They are responsible for radiological as well as chemical, and physical safety concerns. The radiation safety team at the TAMU Environmental Health and Safety Department provides additional support to the NSC Health Physics group upon request.

### 5.1 Radioactive Shipments

The Health Physics monitoring and technical support that was provided in 2007 assured minimal exposure during sample handling, shipment of radioactive material, and normal reactor operation. The radiation exposures were maintained ALARA. During 2007, about 409 radioactive samples were handled of which 371 samples were sent to various research facilities including Texas A&M University campus and the rest were retained at the Nuclear Science Center facility. A total of 261 curies were handled in 2007.

### 5.2 Personnel Monitoring

Personnel Monitoring was provided to approximately 34 personnel. All measured doses to personnel were below the limits set forth in 10 CFR 20. Four individuals received whole body dose greater than 10% of the annual limit in10 CFR 20. Their deep dose equivalent (DDE) recorded were 858, 699, 837, and 602 mrem for the year. Airborne monitoring during sample handling continued to show no significant airborne activity. Therefore, total effective dose equivalent will equal deep dose equivalent for 2007. A total of 7.40 manrem was recorded for the year 2007. When total manrem/curie was determined for 2007, the dose per curie equaled 0.0283 (manrem/Ci).

During 2007, about 1776 visitors toured the Nuclear Science Center. Minimal exposures were measured with pocket ion chambers worn by these visitors and the pocket ion chamber readings of their respective tour guides.

NSC employees who were likely to exceed 10% of their total annual dose wore TLDs/film badges and extremity dosimeters that were provided by Landauer, a NVLAP accredited supplier. Landauer also provided the analysis reports of the doses received.

### 5.3 Facility Monitoring

Surveys of the Nuclear Science Center facilities were performed to assess radiological hazards to NSC workers. Radiation levels and sources of radioactive contamination were routinely monitored. Approximately 350 smear samples were collected and evaluated each month. All accessible areas at the NSC are surveyed for radiation and contamination levels monthly. Areas where contamination is expected, access/egress controls are in place and are evaluated on shorter intervals. Area monitors were placed at strategic locations in the reactor facility, this provides dose equivalent (mrem) on a monthly basis. Table 5-3 summarizes the annual accumulated dose equivalent (mrem) recorded on the area monitors for 2007.

**Table 5-3: Total Dose Equivalent (mrem) Recorded on Area Monitors**

| Monitor ID | Location | Accumulated Dose Equivalent (mrem) |
|---|---|---|
| BLDG MNTR 1 | Upper Research Level Mezzanine | 1404 |
| BLDG MNTR 2 | Lower Research Level Mezzanine | 656 |
| BLDG MNTR 3 | Lower Research Level | 21 |
| AREA | Control Room | 236 |
| AREA | Upper Research Level | 790 |
| AREA | Room next to MHA | 1430 |

## 5.4 Particulate Effluent Monitoring

Radioactive particulates were monitored at the base of the central exhaust stack and summarized on a monthly basis. The annual average release concentration was 1.23 E-11 μCi/cc and the diluted concentration was 6.16E-14 μCi/cc. The total radioactivity activity released for 2007 was 1.44 E-03 Ci. Table 5-4 summarizes monthly particulate effluent releases during 2007. The most common isotope noted during particulate effluent releases was Sb-124.

**Table 5-4: Particulate Effluent Releases**

| Quarter | Month | Average Release Conc. *1 (μCi/cc) | Diluted Concentration*2 (μCi/cc) | Exhaust Volume*3 (cc) | Additional Release*4 (Ci) | Total Release*5 (Ci) |
|---|---|---|---|---|---|---|
| I | January | <MDA | <MDA | 9.96E+12 | 0.00E+00 | <MDA |
| | February | 1.57E-11 | 7.83E-14 | 8.99E+12 | 0.00E+00 | 1.41E-04 |
| | March | 1.40E-11 | 7.00E-14 | 9.96E+12 | 0.00E+00 | 1.40E-04 |
| | **Average:** | **9.89E-12** | **4.95E-14** | **9.64E+12** | **0.00E+00** | **9.35E-05** |
| | | | **total:** | **2.86E+13** | **0.00E+00** | **2.80E-04** |
| II | April | 1.41E-11 | 7.06E-14 | 9.64E+12 | 0.00E+00 | 1.36E-04 |
| | May | 1.80E-11 | 8.99E-14 | 9.96E+12 | 0.00E+00 | 1.79E-04 |
| | June | 1.02E-11 | 5.10E-14 | 9.64E+12 | 0.00E+00 | 9.83E-05 |
| | **Average:** | **1.41E-11** | **7.05E-14** | **9.74E+12** | **0.00E+00** | **1.38E-04** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **total:** | **2.93E+13** | **0.00E+00** | **4.13E-04** |
| **III** | July | 1.31E-11 | 6.56E-14 | 9.96E+12 | 0.00E+00 | 1.31E-04 |
| | August | 6.27E-12 | 3.13E-14 | 9.96E+12 | 0.00E+00 | 6.24E-05 |
| | September | 7.08E-12 | 3.54E-14 | 9.64E+12 | 0.00E+00 | 6.83E-05 |
| | **Average:** | **8.82E-12** | **4.41E-14** | **9.85E+12** | **0.00E+00** | **8.71E-05** |
| | | | **total:** | **2.98E+13** | **0.00E+00** | **2.61E-04** |
| **IV** | October | 8.04E-12 | 4.02E-14 | 9.96E+12 | 0.00E+00 | 8.01E-05 |
| | November | 6.54E-12 | 3.27E-14 | 9.96E+12 | 0.00E+00 | 6.51E-05 |
| | December | 3.48E-11 | 1.74E-13 | 9.64E+12 | 0.00E+00 | 3.35E-04 |
| | **Average:** | **1.64E-11** | **8.22E-14** | **9.85E+12** | **0.00E+00** | **1.60E-04** |
| | | | **total:** | **2.96E+13** | **0.00E+00** | **4.80E-04** |
| **Annual** | **Average:** | **1.23E-11** | **6.16E-14** | **9.77E+12** | **0.00E+00** | **1.20E-04** |
| **Summary** | | | **total:** | **1.17E+14** | **0.00E+00** | **1.44E-03** |

**notes:**

1. Average Release Concentration equal to: Concentration released from Channel 1, NSC Form 805
2. Diluted Concentration equal to Average Release Concentration multiplied by 0.005 (Technical Specification 3.5.2, dilution value for release concentration at exclusion boundary)
3. Exhaust Volume equal to: ( # days/month)*( 24hrs/day)*( 60min/hr)*( 7875 cfm)/ 3.53E-5cfm/cc) * Changed Jan 2007
4. Additional Release equal to: (Individual releases calculated from facility air monitoring data)
5. Total Release equal to: (Average Release Concentration)*( Exhaust volume)* (1Ci/ 1E6 uCi)+(Additional Release)

MDA is based on the conversion factor for the Channel 1(Stack particulate detector):
1.03E-13 μCi/cc (January-December).

## 5.5 Gaseous Effluent Monitoring

Argon-41 is the major gaseous effluent produced and released at the Nuclear Science Center. This effluent is monitored at the central exhaust stack. Total Argon-41 released during 2007 was 6.21 Ci with an annual average release concentration of 4.39E-08 μCi/cc and with a diluted concentration of 2.20E-10 μCi/cc. Table 5-5 summarizes monthly gaseous effluent (Ar-41) releases during 2007.

**Table 5-5: Gaseous Effluent (Ar-41) Releases**

| Quarter | Month | Average Release Conc. *1 (μCi/cc) | Diluted Concentration* 2 (μCi/cc) | Exhaust Volume*3 (cc) | Additional Release*4 (Ci) | Total Release*5 (Ci) |
|---|---|---|---|---|---|---|
| **I** | January | 4.91E-08 | 2.46E-10 | 9.96E+12 | 1.20E-02 | 5.01E-01 |
| | February | 3.91E-08 | 1.96E-10 | 8.99E+12 | 6.00E-02 | 4.12E-01 |
| | March | 4.85E-08 | 2.42E-10 | 9.96E+12 | 4.63E-02 | 5.29E-01 |
| | **Average:** | **4.56E-08** | **2.28E-10** | **9.64E+12** | **3.94E-02** | **4.81E-01** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **total:** | **2.86E+13** | **1.46E-01** | **1.44E+00** |
| **II** | April | 2.24E-08 | 1.12E-10 | 9.64E+12 | 4.98E-01 | 7.14E-01 |
| | May | 5.80E-08 | 2.90E-10 | 9.96E+12 | 7.87E-02 | 6.56E-01 |
| | June | 5.53E-08 | 2.76E-10 | 9.64E+12 | 1.26E-01 | 6.58E-01 |
| | **Average:** | **4.52E-08** | **2.26E-10** | **9.74E+12** | **2.34E-01** | **6.76E-01** |
| | | | **total:** | **2.93E+13** | **4.39E-01** | **2.03E+00** |
| **III** | July | 1.83E-08 | 9.16E-11 | 9.96E+12 | 4.73E-02 | 2.30E-01 |
| | August | 3.95E-08 | 1.97E-10 | 9.96E+12 | 6.77E-03 | 4.00E-01 |
| | September | 4.63E-08 | 2.32E-10 | 9.64E+12 | 1.28E-02 | 4.59E-01 |
| | **Average:** | **3.47E-08** | **1.73E-10** | **9.85E+12** | **2.23E-02** | **3.63E-01** |
| | | | **total:** | **2.96E+13** | **6.69E-02** | **1.09E+00** |
| **IV** | October | 6.37E-08 | 3.18E-10 | 9.96E+12 | 4.70E-02 | 6.81E-01 |
| | November | 4.02E-08 | 2.01E-10 | 9.64E+12 | 1.14E-01 | 5.02E-01 |
| | December | 4.67E-08 | 2.33E-10 | 9.96E+12 | 0.00E+00 | 4.65E-01 |
| | **Average:** | **5.02E-08** | **2.51E-10** | **9.96E+12** | **4.70E-02** | **5.49E-01** |
| | | | **total:** | **2.96E+13** | **1.61E-01** | **1.65E+00** |
| **Annual** | **Average:** | **4.39E-08** | **2.20E-10** | **9.77E+12** | **8.74E-02** | **5.17E-01** |
| **Summary** | | | **total:** | **1.17E+14** | **8.12E-01** | **6.21E+00** |

notes:

1. Average Release Concentration equal to: Concentration released from Channel 3, NSC Form 805
2. Diluted Concentration equal to: Average Release Concentration multiplied by 0.005 (Technical Specification 3.5.2, dilution value for release concentration at exclusion boundary)
3. Exhaust Volume equal to: ( # days/month)*( 24hrs/day)*( 60min/hr)*( 7875cfm)/ 3.53E-5 cfm/cc) *changed Jan2007
4. Additional Release equal to: (Individual releases calculated from facility air monitoring data)
5. Total Release equal to: (Average Release Concentration)*( Exhaust volume)* (1Ci/ 1E6 uCi)+(Additional Release)

MDA is based on the conversion factor for the Channel 3 (Stack gas detector):
3.07E-09 μCi/cc (January-June) and 2.86E-09 μCi/cc (July-December).

### 5.6 Liquid Effluent Monitoring

Radioactive Liquid effluents are maintained in collection tanks before release from the confines of the Nuclear Science Center. Sample activity concentrations and isotope identifications were determined before each release. There were 22 releases in 2007, totaling 8.56E+05 gallons including dilution. The total radioactivity released was 3.06E-03 Ci with an annual average concentration of 9.4E-07 μCi/cc. The annual dose to the public calculated from liquid effluents is 10.8 mrem. Summary of the release data are presented in the following Table 5-6. Radioactivity concentrations for each isotope found were below the Effluent Concentration limits specified in 10 CFR 20, Appendix B. Some of the major radionuclides identified in the waste stream were $Na^{24}$, $Cr^{51}$, $Mn^{54}$, $Co^{58}$, $Co^{60}$, $Zn^{65}$, $Sb^{124}$, $Cs^{137}$.

**Table 5-6: Liquid Effluent Releases**

| Quarter | Month | Number of Releases | Volume Released (cc) | Total Radioactivity (Ci) | Average Concentration (µCi/cc) |
|---|---|---|---|---|---|
| I | January | * | * | * | * |
| | February | 4 | 5.18E+08 | 1.48E-03 | 2.86E-06 |
| | March | * | * | * | * |
| | **Quarter Total:** | **4** | **5.18E+08** | **1.48E-03** | |
| II | April | 1 | 1.53E+08 | 3.62E-05 | 2.36E-07 |
| | May | 2 | 3.15E+08 | 6.50E-05 | 2.06E-07 |
| | June | 3 | 3.63E+08 | 3.70E-04 | 1.02E-06 |
| | **Quarter Total:** | **6** | **8.32E+08** | **4.71E-04** | |
| III | July | 2 | 3.63E+08 | 2.65E-04 | 1.45E-06 |
| | August | 4 | 6.76E+08 | 4.14E-04 | 2.53E-06 |
| | September | 2 | 1.98E+08 | 1.88E-04 | 1.91E-06 |
| | **Quarter Total:** | **8** | **1.24E+09** | **8.67E-04** | |
| IV | October | 1 | 1.96E+08 | 1.02E-04 | 5.20E-07 |
| | November | 2 | 3.34E+08 | 1.08E-04 | 3.24E-07 |
| | December | 1 | 1.24E+08 | 2.71E-05 | 2.19E-07 |
| | **Quarter Total:** | **4** | **6.54E+08** | **2.37E-04** | |
| **Annual Summary** | **Total:** | **22** | **3.24E+09** | **3.06E-03** | **9.4E-07** |

* No releases

## 6. Environmental Monitoring

In conjunction with representatives from the Texas Department of Health, Bureau of Radiation Control, a quarterly environmental survey is conducted to insure compliance with federal regulations. This program consists of TLD monitors located at various locations on the NSC site and two background monitors; one located at 3.84 miles NW of facility and the other at 0.25 miles SE of facility. The collection, analysis, and evaluation of NSC creek sediment are also included in the program.

## 6.1 Environmental Samples

The environmental samples were collected in accordance with the cooperative surveillance program established between the Texas Department of State Health Services (TDSHS) Environmental Monitoring, Division of Regulatory Services, Austin, Texas, and the Nuclear Science Center. The agreement is for isotopic analysis of NSC creek sediment samples. The creek samples were analyzed using the High Purity germanium detector system at NSC. A second set of sediment samples were analyzed by the TDSHS for comparison. The concentrations of environmental samples determined for each quarter are listed below in Table 6-1. The most common isotopes were Mn-54, Co-58, Co-60, Fe-59, Zn-65, Pb-214, Tl-208 etc. The concentrations were less than 1E-6 μCi/g.

**Table 6-1: Environmental Sample Analysis**

| Quarter | Sediment | μCi/g |
|---|---|---|
| I | NSC creek | <1E-06 |
| II | NSC creek | <1E-06 |
| III | NSC creek | <1E-06 |
| IV | NSC creek | <1E-06 |

## 6.2 Site Boundary Dose Rate

The environmental survey program measures the integrated radiation exposures at the exclusion area boundaries. These measurements are made for periods of approximately 91 days using TLDs. Monthly measurements of direct gamma exposure rate in μrem/h are also made at each of the TLD locations. The dosimeters were provided and processed by Texas Department of State Health Services, Environmental Monitoring, Division of Regulatory Services, Austin, Texas.
Total TLD dose is multiplied by the occupancy factor (1/16) to determine total deep dose to the general public. To determine internal exposure to individuals outside the site area the EPA's approved code, COMPLY was used. The exposure calculated via COMPLY was 0.09 mrem/yr. This exposure is added to the calculated total deep dose. This total is the dose received by the general public. Table 6-2 summarizes the site boundary dose rates.

**Table 6-2: Site Boundary Dose Rates**

| Site # | Location | Quarterly Exposure rates (mrem/91 days) | | | | TLD Dose | Deep Dose | Internal Dose (mrem) | Total Dose (mrem) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 300 ft. W of reactor building, near fence corner | 5 | 5.5 | 4.0 | 3.0 | 15.0 | 0.94 | 0.09 | 1.03 |
| 3 | 250 ft WSW of reactor building, on SW chain link fence | 0 | 1.8 | 2.0 | 0 | 4.0 | 0.25 | 0.09 | 0.33 |
| 4 | 200 ft NW of reactor building, on chain link fence, near butane tank | 8 | 5.5 | 5.0 | 2.0 | 16.0 | 1.0 | 0.09 | 1.11 |
| 5 | 225 ft NE of reactor building, on fence N of driveway | 0 | 1.8 | 2.0 | 1.0 | 5.0 | 0.31 | 0.09 | 0.39 |
| 10 | 190 ft SE of reactor building, near fence corner | 0 | 1.8 | 1.0 | 0 | 3.0 | 0.18 | 0.09 | 0.27 |
| 11 | 300 ft NE of reactor building, near fence corner | 0 | 1.8 | 1.0 | 0 | 3.0 | 0.18 | 0.09 | 0.27 |
| 18 | 375 ft NE of reactor building | 3 | 2.7 | 5.0 | 1.0 | 10.0 | 0.63 | 0.09 | 0.72 |
| 19 | 320 ft NE of reactor building | 0 | 0 | 0 | 0 | 0 | 0 | 0.09 | 0.09 |
| *14 | 3 miles NW of facility | 0 | 0 | 0 | 0 | 0 | 0 | 0.09 | 0.09 |
| *23 | 0.25 miles SE of facility | 0 | 0 | 0 | 0 | 0 | 0 | 0.09 | 0.09 |

* 14 and 23 are background TLD's

## 7. Radioactive Waste Shipments

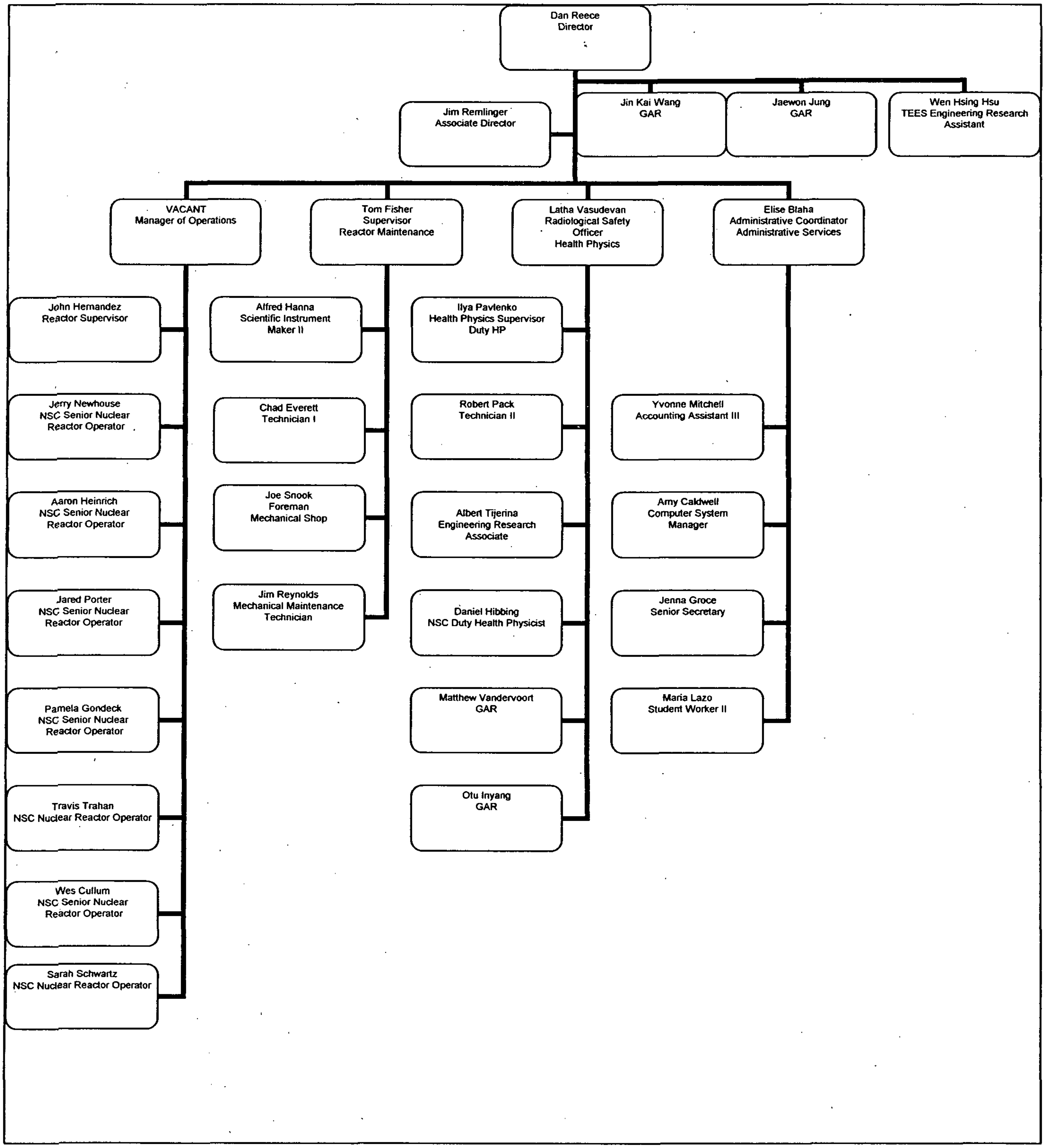
During the year 2007, there were no solid wastes released from the NSC for disposal offsite. However, dry solid wastes with short half-lives (<120 d) were properly stored for decay. These will eventually be segregated, sorted and disposed as non-radioactive waste.

## 8. Reactor Safety Board

The Reactor Safety Board is responsible for providing an independent review and audit of the safety aspects of the NSC reactor. The RSB meets at least once a year to review audit reports, security and emergency plans, new experiments and modifications to the facility. Appendix B provides the reactor safety board membership.

## APPENDIX A

# NSC ORGANIZATION CHART-2007



## APPENDIX B

### Reactor Safety Board Membership (2007)

**Chairman/Licensee:**

Dr. Theresa Maldonado, Deputy Director
Texas Engineering Experiment Station

**Members:**

Dr. John Ford, Assistant Professor
Nuclear Engineering Department

Dr. Marvin Adams, Associate Professor
Nuclear Engineering Department

Dr. Bill Charlton, Associate Professor
Nuclear Engineering Department

Dr. William Dennis James, Research Chemist
Chemistry Department

Dr. John Hardy, Professor
Physics Department

Dr. Teruki Kamon, Professor
Physics Department

Dr. Sean Mc Devitt, Assistant Professor
Nuclear Engineering Department

Dr. Karen Vireaw, Associate Professor
Nuclear Engineering Department

**Ex-Officio Members:**

Dr. Warren Reece, Director
Nuclear Science Center

Dr. Latha Vasudevan, NSC RSO
Nuclear Science Center

Mr. Jim Remlinger, Associate Director
Nuclear Science Center

Dr. John W. Poston, Professor and Interim Head
Nuclear Engineering Department

Mr. Daniel Menchaca
Environmental Health and Safety Department