

# **McMaster Nuclear Reactor**

McMaster University, 1280 Main Street West, Hamilton, Ontario L8S 4K1  
NPROL-01.01/2024

## **Annual Compliance Monitoring and Operational Performance 2016**

Summary Data for Public Information

**Approved/Issued by:**

Christopher Heysel, P. Eng, Director Nuclear Operations & Facilities  
McMaster University, Nuclear Research Bldg., Room A332  
Hamilton, Ontario L8S 4K1  
Tel: 905 525-9140 ext. 23278, Fax: 905 524-3994  
[heysel@mcmaster.ca](mailto:heysel@mcmaster.ca)

## Executive Summary

The McMaster Nuclear Reactor (MNR) was operated safely, securely and effectively in 2016.

MNR continued to support the educational and research goals of the University throughout the year specifically in the areas of nuclear science, medical and health physics, engineering physics, health sciences, radio-chemistry, bio-chemistry and radiation biology.

The costs associated with the safe and secure operation and maintenance of the facility were offset through a variety of irradiation services and medical isotope production activities.

Reactor availability was 82% with no major unplanned outages taking place during the year.

There were no Reportable Events at MNR in 2016.

There were no lost time injuries, near misses or major safety findings in 2016.

Doses to workers and releases to the environment remained ALARA throughout the year. Specific radiological and environmental safety goals were met or exceeded in 2016.

As part of MNR's outreach program more than 2000 visitors toured through the facility in 2016. Many visitors were students from local high schools and universities who were given the unique experience of seeing the "blue glow" of an operating reactor core and an introduction to nuclear sciences.

Major activities scheduled for 2017 will include commissioning of beam line for the McMaster Intense Positron Beam Facility (MIPBF) and construction support for the McMaster University Small Angle Neutron Scattering (SANS) facility.

## 1.0 INTRODUCTION

### 1.1 General Introduction

McMaster Nuclear Reactor (MNR) is operated by McMaster University for research, education and commercial service. 2016 was a typical year in terms of operation.

The reactor was operated between 2.5 and 3.0 MW to accommodate production requirements. The standard operating schedule was two shifts per day, Monday to Friday. Start-up took place as soon after 0800 as the scheduled checkout would allow; shutdown was normally scheduled for 2245. Exceptions included short duration low-power runs for researchers and laboratory classes, occasional extra operation for research or production purposes, planned outages for facility modifications, and unscheduled shutdowns.

For a six week period starting on October 17<sup>th</sup> the reactor was operated on a 24-5 operating schedule to assess a continuous operating cycle for the facility. The continuous operating cycle was successfully completed on November 26<sup>th</sup>.

MNR is operated under a CNSC license (NPROL-01.01/2024). Further to that license, the McMaster document AP-1111, "Operating Limits and Conditions", contains statements about the operation of the reactor. These documents and associated specific policies and procedures ensure that MNR is operated in a manner which meets the requirements of the NCSA and associated regulations. Additionally, MNR is operated in accordance with the applicable laws of the province of Ontario.

There were no reportable incidents in 2016.

### 1.2 Facility Operation

Reactor operation proceeded normally throughout 2016. Overall performance continues to be good. There were no significant unscheduled outages as a result of equipment performance or maintenance issues.

There were no significant issues with equipment or systems during 2016. Minor repairs and replacements were performed as required. There was no evidence of any trends or significant changes.

From October 17<sup>th</sup> through November the 26<sup>th</sup> the reactor was operated twenty-four hours a day five days a week to assess a continuous operating cycle at the facility. The assessment was successfully completed without incident.

The reactor was operated at power during 2016 for a total of 3,837 hours, for a total energy output of 10,335 megawatt-hours. At year-end MNR had been operated for 198,821 hours for a life-time energy output of 578,672 megawatt-hours. Reactor availability, defined for MNR as the percentage of operating hours relative to available hours, was 82%. **Figure 1.3-1** shows reactor operation and power output at MNR over the past ten years.

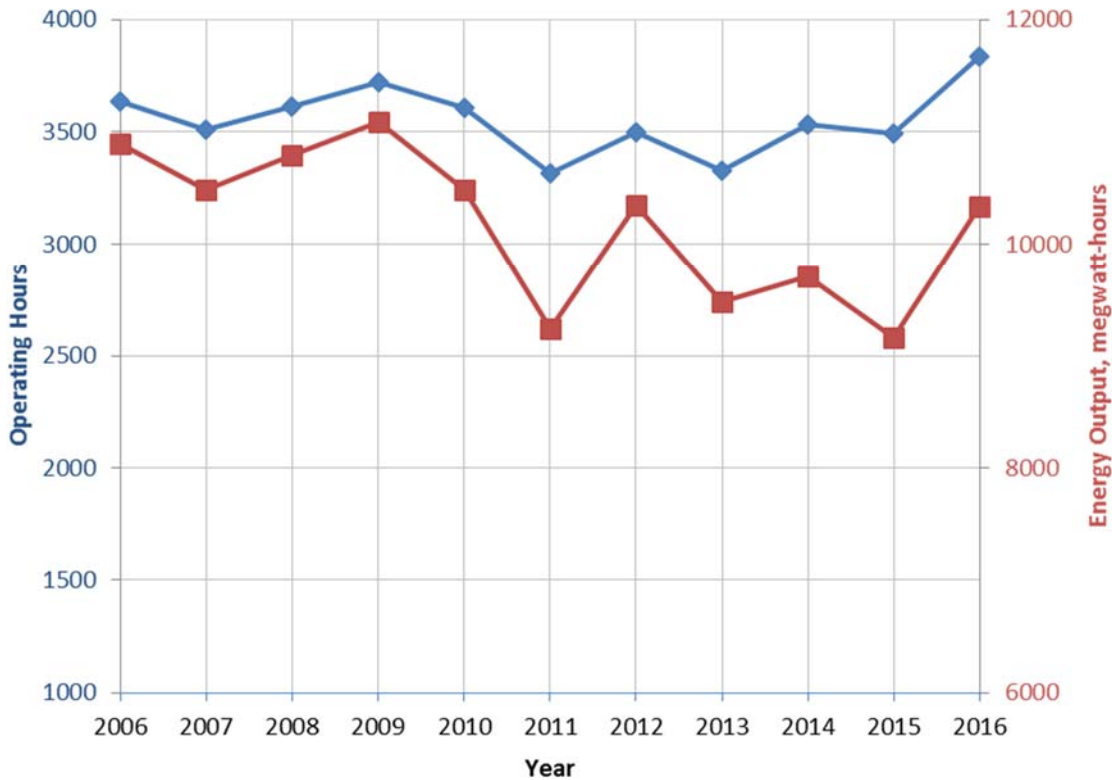


Figure 1.3-1 Reactor Availability and Power Output

Work was completed on the cooling water towers (motor and fan replacements) as part of the campus wide noise abatement program.

### 2.3.1 Radiation Protection

#### Dose Control Data

Three worker groups within MNR regularly receive significant occupational exposures: Operations Personnel, Iodine Production Personnel and NRay Radiographers. In addition, Health Physics personnel occasionally receive annual effective doses in excess of 1 mSv, and this was the case for one Health Physics staff member in 2016. All other personnel associated with the operation of the facility receive annual effective doses of less than 1 mSv.

#### Operations Personnel

Operations Personnel comprise the Director of Nuclear Operations and Facilities, the Manager, Reactor Operations, Reactor Supervisors, Reactor Operators, and Assistant Reactor Operators. Student Operators are also included in this group. The 2016 occupational exposures for the group are presented in **Figure 2.3.1-1**.

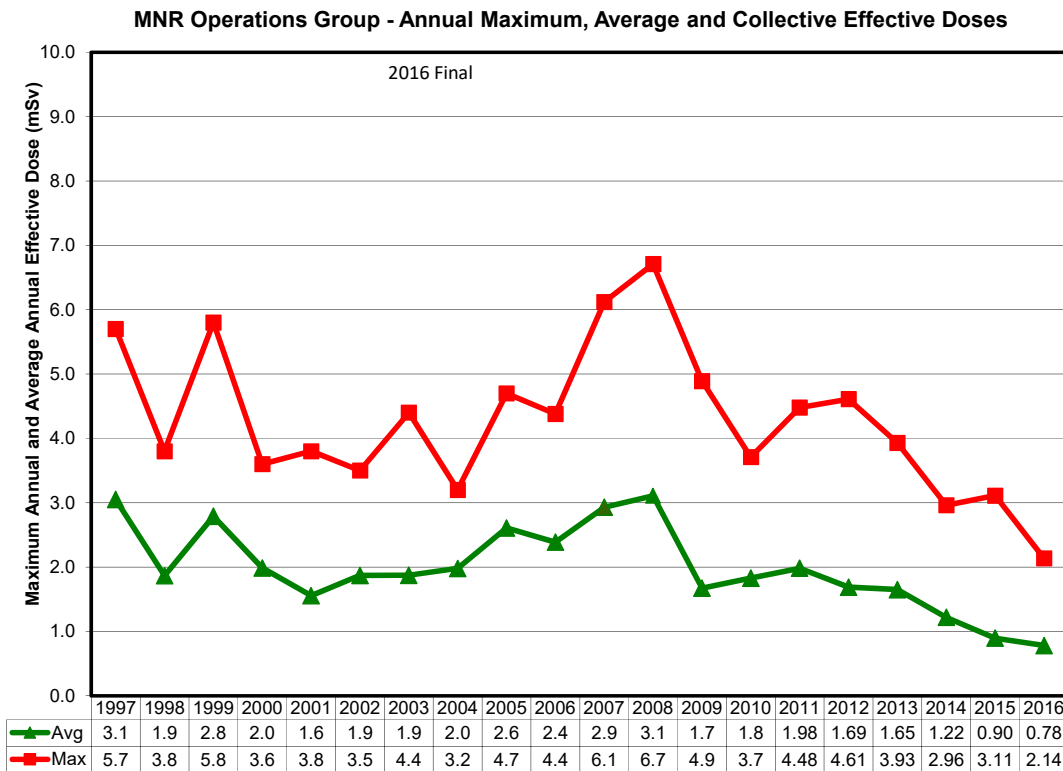


Figure 2.3.1-1

Dose performance goals for the Operations Group are established annually and are based on the collective effective dose per unit output, with output taken as normalized MW-h energy output of the reactor (adjusted by a constant arbitrary normalizing factor). For 2016, the goal was 0.40 person mSv per unit relative output. The result for 2016 was 0.22 person mSv per unit relative

output. The goal was achieved. The recent annual values of this quantity are shown in **Figure 2.3.1-2**. A generally improving trend in this performance is evident.

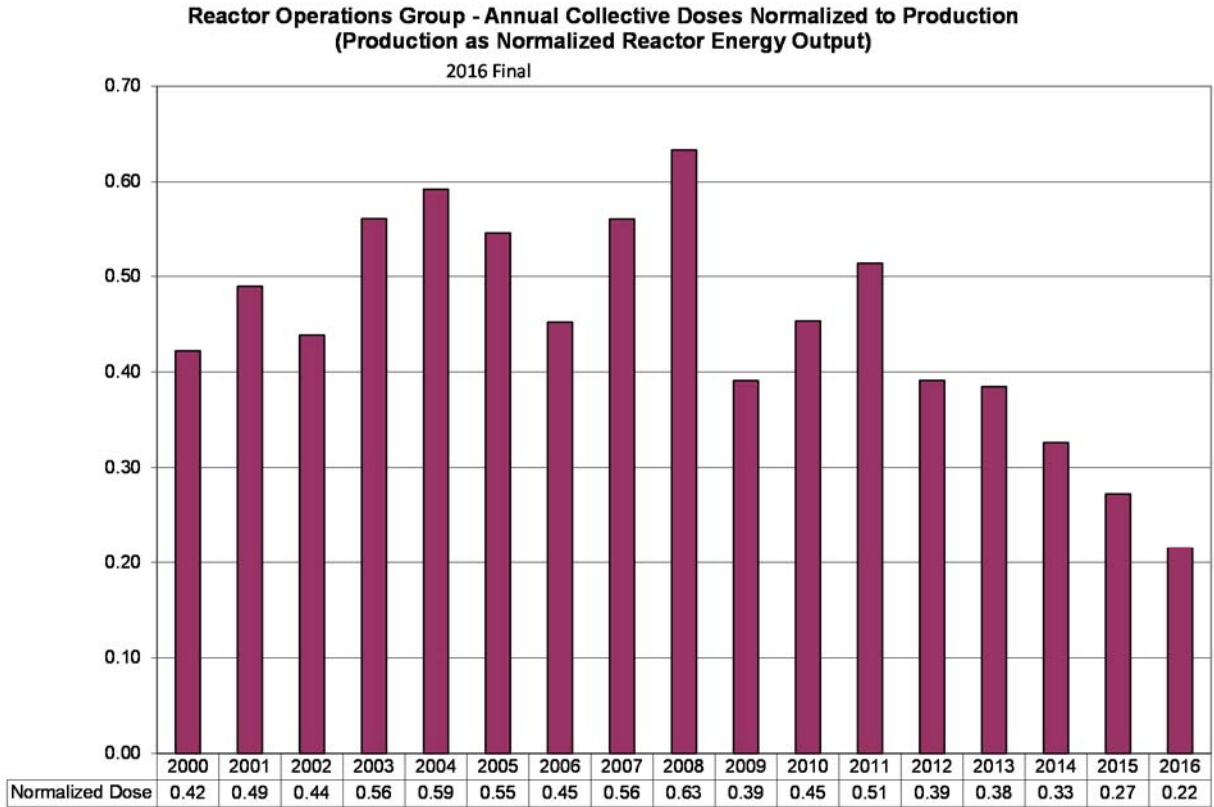


Figure 2.3.1- 2

**Iodine Production Personnel**

Iodine Production Personnel comprise the Production Manager, Production Technologist, the Manager of Laboratory Services and Production Assistants.

The historical values of the annual average and maximum dose for this group are presented in **Figure 2.3.1-3**. No trends of concern are indicated by the data. The average, maximum and collective effective doses are all well within the recent operating experience for the facility.

Iodine Production Group - Annual Maximum, Average and Collective Effective Doses

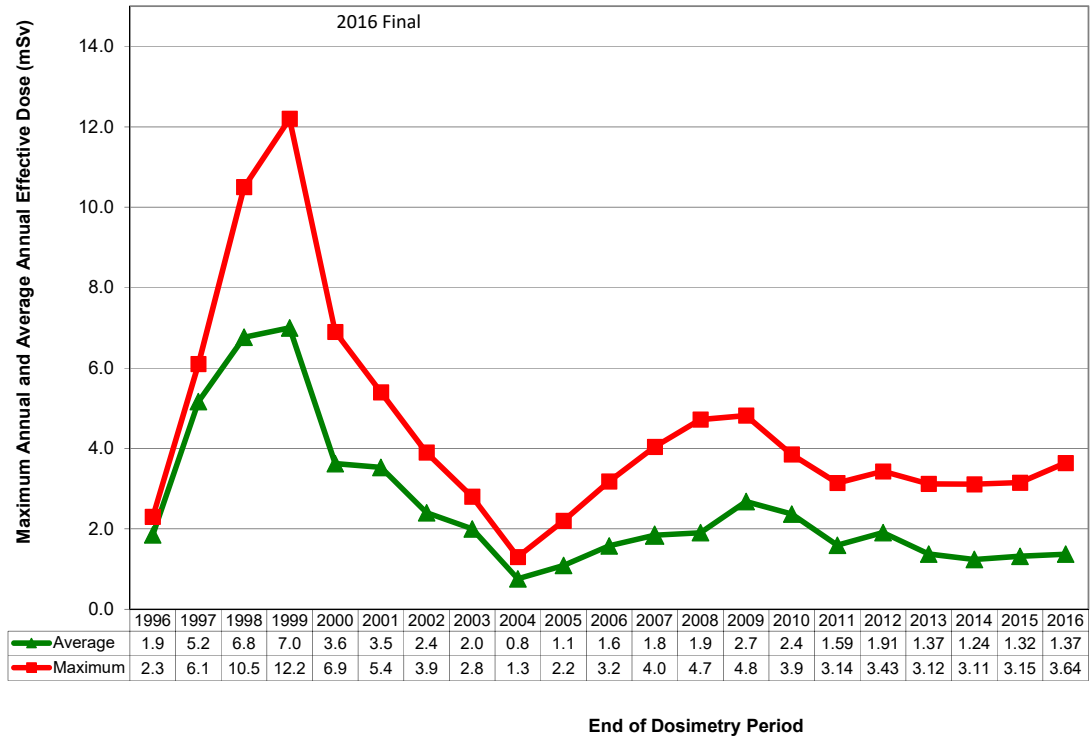


Figure 2.3.1-3

Dose performance goals for the Iodine Production Group are established annually and are based on the collective effective dose per unit output, with output taken as activity of I-125 produced (adjusted by a constant arbitrary normalizing factor). For 2016, the goal was 0.32 person mSv per unit relative output. The result for 2016 was 0.23 person mSv per unit relative output. The goal was achieved. The recent annual values of this quantity are shown in **Figure 2.3.1-4**. A continuing trend of excellent performance, close to the historical minimum, is evident.

### Iodine Production Personnel - Annual Collective Dose Normalized to Production

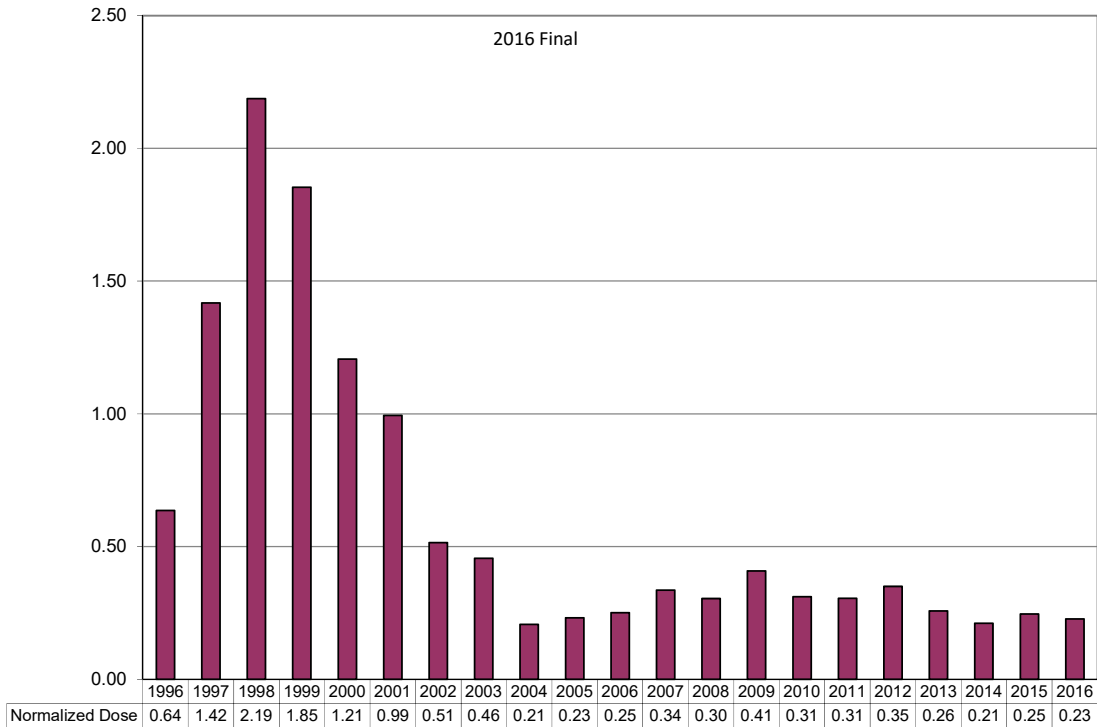


Figure 2.3.1-4

#### NRay Radiographers

The NRay Radiographers group comprises the Operations Manager, the Development Officer, the Radiography Manager, the Radiography Supervisors, and the Material Handlers. All are employees of NRay Inc., a private company that utilizes beam ports in the reactor under contract. There is no distinction for users based on employer under the MNR radiation safety program.

As in previous years, the only contribution to effective dose was external deep dose (Hp(10)). There is no indication of any significant internal exposures from extensive facility air and surface contamination monitoring or from personnel contamination monitoring.

The historical values of the annual average and maximum dose for this group are presented in Figure 2.3.1-5. No trends of concern are indicated by the data. The average, maximum and collective effective doses are all well within the recent operating experience for the facility.



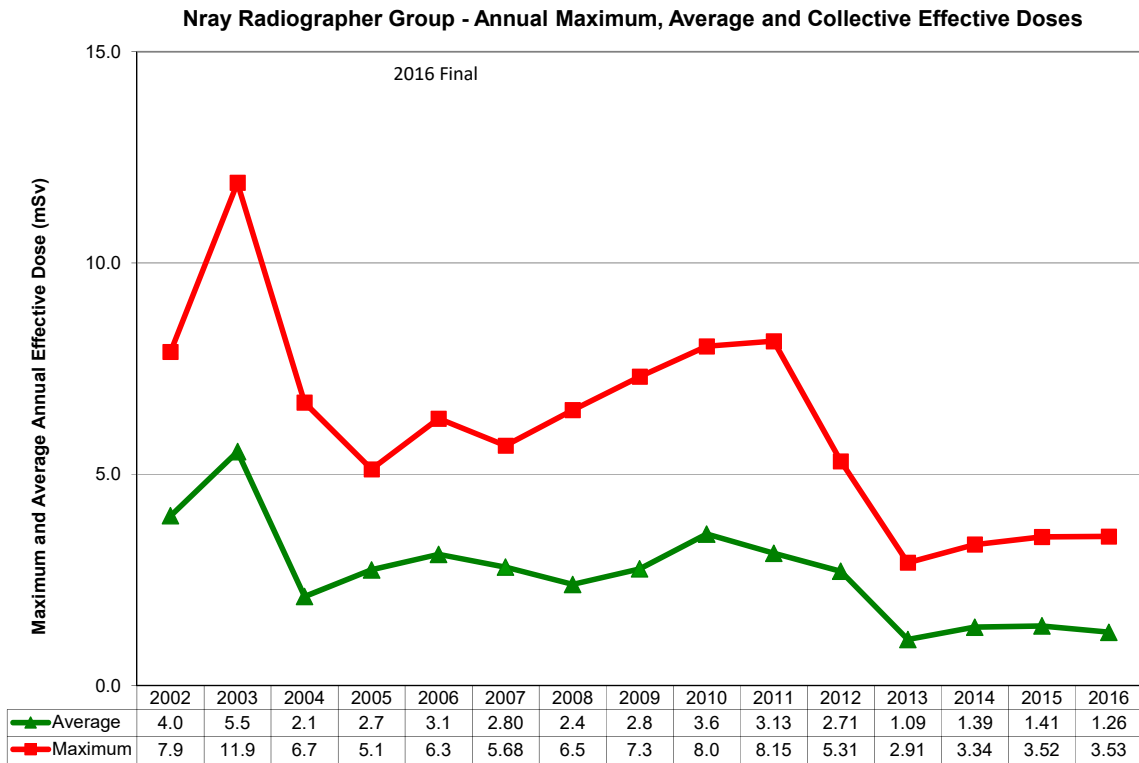


Figure 2.3.1-5

Dose performance goals for the Radiographers Group are established annually and are based on the collective effective dose per unit output, with output taken as the normalized number of radiographs produced (adjusted by a constant arbitrary normalizing factor). For 2016, the goal was 0.20 person mSv per unit relative output. The result for 2016 was 0.13 person mSv per unit relative output. The goal was achieved. The recent annual values of this quantity are shown in **Figure 2.3.1-6**. Performance continues to be excellent, near historically low values.

### Nray Neutron Radiography Group - Collective Doses Normalized to Production

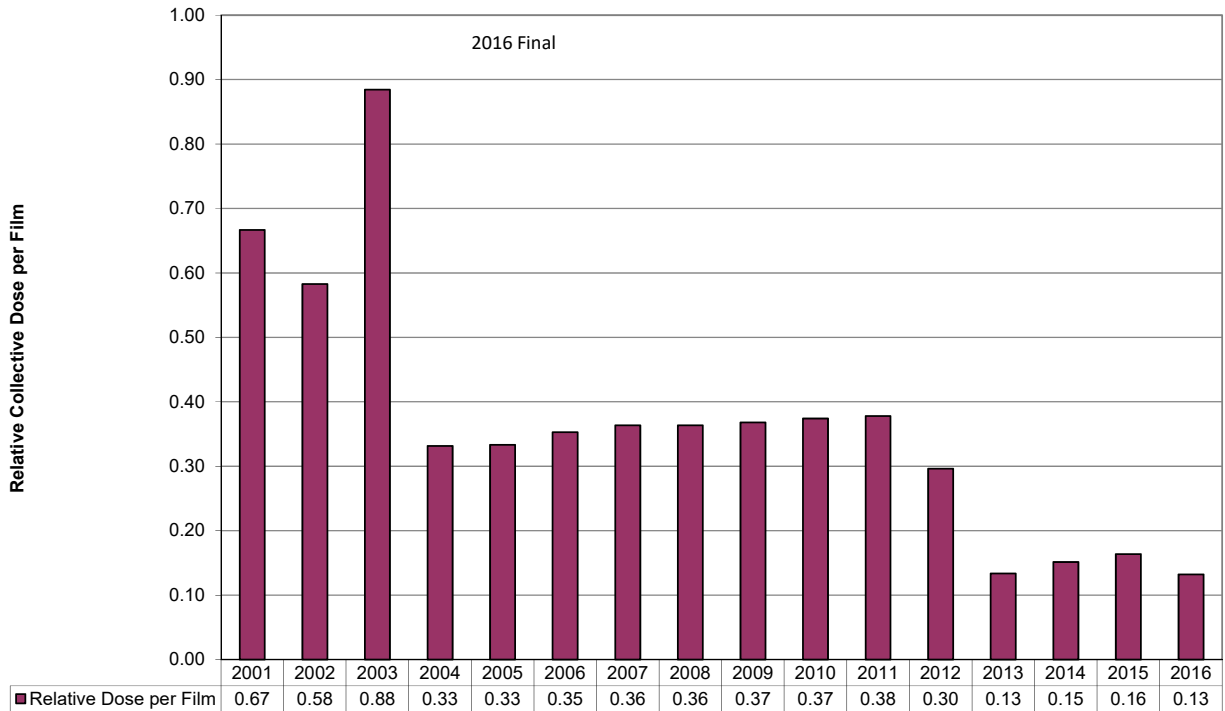


Figure 2.3.1-6

#### Health Physics

One Health Physics Department staff member received an annual effective dose of 1.58 mSv during 2016. The dose was accumulated gradually through the year on various tasks in the Reactor Building and other McMaster facilities. The majority of the dose was associated with the preparation, characterization and shipping of a spent resin waste shipment. That work began in 2015 and carried over into 2016. A second shipment was prepared at the end of 2016 and carried over into 2017.

#### Overall Performance

The historical values of the overall facility collective dose are shown in **Figure 2.3.1-7**. The facility collective dose was comparatively high in 2010 and 2011, largely as a result of extensive maintenance and waste inventory reduction efforts during those years. The value for 2016 is the lowest experienced in the recent operating history of the facility, despite generally higher utilization.

















### **2.3.4 Emergency Management and Response**

#### ***Emergency Preparedness Program***

The annual review of the Type D emergency procedures with University, City and Provincial emergency responders was held in March 2016.

## **4.0 CONCLUDING REMARKS**

The McMaster Nuclear Reactor (MNR) was operated safely, securely and effectively in 2016 and continued to support the educational and research goals of McMaster University.

No Reportable Events occurred at MNR in 2016.

There were no lost time injuries, near misses or major safety findings in 2016.

Doses to workers and releases to the environment remained ALARA throughout the year. Specific radiological and environmental safety goals were met or exceeded in 2016.

Major projects planned for 2017 include the installation of the MIPBF at MNR, the construction of the SANS and the associate guide hall.

The impact of the closure of NRU on the MNR's mission will be extensively evaluated during the upcoming year.