Report to the Director on the Fermilab Environment
CY1995

1.0 Introduction

The goal of the Fermilab Environmental Monitoring Program is to assist Laboratory management in decision-making by providing data relevant to impacts of Laboratory operations. Line organizations have the responsibility to recognize and understand the environmental aspects of their operations, and to conduct their work in an environmentally sound manner.

Monitoring and surveillance are critical elements of an effective environmental protection program. Fermilab has established and implemented comprehensive environmental monitoring and surveillance programs[1] to ensure compliance with legal and regulatory requirements imposed by Federal, State, and local agencies and to provide for the measurement and interpretation of the impact of Fermilab operations on the public and the environment. The surveillance and monitoring activities are selected to be responsive to both routine and unplanned releases of penetrating radiation and liquid or airborne effluents. The location and frequency of samples are based on established routines, operational considerations, and historic levels of pollutants found in each location. The primary factor in choosing sampling locations is to assign higher priorities to those locations with the greatest potential for adverse impacts.

To evaluate the effects of Fermilab operations on the environment, samples of effluents and environmental media collected on the site and at the site boundary are analyzed and compared to applicable guidelines and standards. The status of environmental protection activities and the progress on environmental restoration and corrective action activities are discussed in this report. There were no abnormal occurrences that had an impact on the public, the environment, the facility or its operation in CY1995[2].

2.0 1995 Laboratory Highlights

The biggest news at Fermilab in 1995 was the announcement of the discovery of the top quark in May 1995 that marked the end of the Collider Run. The Main Injector construction project approached the halfway point by the end of 1995, with a late summer/fall shutdown allowing further progress. The brief shutdown took place as the Lab prepared for the last major run of the 800 GeV fixed-target program to take place in 1996-1997. Construction began in 1995 on a

[1] Details of the Fermilab environmental program can be found in the the Fermilab Environmental Monitoring Strategy (FMS).
[2] Supporting data are available upon request from the Fermilab ES&H Section in electronic or paper form.

new Waste Handling Facility where low-level radioactive waste activities could be consolidated. Other significant achievements were the implementation of a new groundwater model and the removal of two old underground fuel storage tanks from Site 38 as the new gasoline dispensing facility replaced the old one.

During 1995, about 35 acres of prairie were added bringing the total prairie to more than 1000 acres. Despite a loss of funding, the National Environmental Research Park (NERP) program of environmental studies was continued with four major projects by university groups beginning this year. Fermilab received the Department of Energy's 1995 Office of Energy Research NEPA Compliance Officer Quality Award for Environmental Planning, for its Fermilab Main Injector (FMI) wetland mitigation efforts. Significant in its impact on the administration of ES&H at Fermilab was our participation in the Necessary and Sufficient process, which resulted in the adoption of a new set of ES&H Standards known as "Work Smart Standards" into our contract with the Department of Energy (DOE).

3.0 Environmental Monitoring and Surveillance

The goal of the Fermilab Environmental Monitoring Program is to assist Laboratory management in decision-making by providing data relevant to impacts that Fermilab operations have on the surrounding environment. The Environmental Monitoring Program consists of effluent monitoring to confirm compliance with permits, generally at a particular point, and environmental surveillance, conducted at various locations to intercept the pathway of potential pollutants to receptors such as plants, animals or members of the public. We collect environmental data for reporting purposes or whenever it is necessary or useful in conducting the business of the Laboratory.

The pathways available for movement of radioactive materials and chemicals from Fermilab operations to the public are the atmosphere, surface water and groundwater. Environmental surveillance consists of collecting and analyzing samples of various media and measuring penetrating radiation. Samples are collected and radiation is measured from areas within the site boundaries.

Ground and surface waters are sampled at locations near operating areas, potential contamination sources and along potential transport pathways. In addition to air and water surveillance, samples of soil are collected and radiation is measured to determine the effectiveness of effluent controls and to ascertain whether there is any build-up of radioactive materials as a result of long-term operations.

Surface water, air, groundwater, soil, and sediment samples are monitored for radionuclide concentrations. Surface waters are also monitored for potential

chemical constituents. While levels of penetrating radiation are measurable near operational areas on the site, the levels decrease rapidly with distance from the source. External penetrating radiation and airborne emissions are normally below instrument detection levels and must be estimated at the site boundary, to provide information about the maximum potential radiation doses to off-site populations. The results of the environmental surveillance program are interpreted and compared with environmental standards where applicable. The Fermilab Environmental Monitoring Strategy, which is maintained by the ES&H Section, provides more details.

3.1 Air

The potential for public exposure to air pollution from Fermilab is very low. We have applied for and received an air pollution permit issued under the Clean Air Act, including a "National Emissions Standards for Hazardous Air Pollutants" or NESHAPs element, which covers airborne radionuclides.

Airborne radionuclides are normally released to the atmosphere from target stations operating in the Fixed Target and in the Antiproton Source areas. Monitoring is conducted at targeting areas where air transport is considered to be a significant contributor to the overall transport of radioactive materials offsite. The Magnet Debonding Oven at the Industrial Complex is also a small source of airborne radionuclides.

The radiation doses potentially received off site by the public are calculated from environmental surveillance of the significant onsite sources. The dose for the air pathway is calculated using a Gaussian plume computer simulation model called CAP-88PC. This model was created by U.S. EPA to predict the movement of airborne radionuclides and is required by regulations governing hazardous air pollutants at 40 CFR 61. Maximum calculated concentrations offsite are predicted to be below the level that can be detected by monitoring.

Comment [EA1]: Removed the reference to Òmost radionuclidesÓ. Is this accurate?

Fermilab is not a significant source of chemical air pollution. Our permits cover emissions caused by open burning, operation of various boilers and total organic emissions from vapor degreasing operations. Estimated pollutant levels are calculated based on the knowledge of the processes that generate them and the characteristics of individual pollutants.

3.1.1 Radioactive Air Emissions

During Calendar Year 1995 the Antiproton Source area was the only area to receive beam and thus was the sole emission source for accelerator-produced airborne radioactivity. Airborne radionuclides ^{11}C, ^{13}N, and ^{41}Ar were identified in emissions from the AP0 Stack, which released approximately 19 Ci during CY1995. The operation of the Magnet Debonding Oven resulted in the

release of about 2.1 mCi of ^{3}H to the atmosphere in CY1995. These releases are well within the limits of our current air pollution permit application on file with the Illinois Environmental Protection Agency (IEPA). The application states that our total releases will average no greater than 100 Ci/year with a maximum of 900 Ci/year. These measurements were taken at the sources, and no detectable levels of radionuclides reach the site boundaries.

CAP88PC computer modeling results showed the maximum dose equivalent potentially delivered to a member of the public at the site boundary to be 0.00225 mrem. This is well below the Environmental Protection Agency (EPA) standard of 10 mrem/year to a member of the public and also much less than the EPA's continuous monitoring threshold of 0.1 mrem/year.

The estimated collective dose equivalent delivered to the surrounding public through radioactive air emissions from Fermilab was 1.19×10^{-2} person-rem. Fermilab's CY1995 Radionuclide Air Emissions Annual Report was submitted to DOE in June 1996.

3.1.2 Non-Radioactive Air Emissions

There were no instances of non-compliant emissions in CY1995. The Annual Air Emission Report for Fermilab was submitted to the Illinois Environmental Protection Agency (IEPA) in April 1996. Operations were reviewed this year to ensure that permitted equipment continues to operate and be maintained in accordance with permit conditions.

3.2 Penetrating Radiation

Operation of the Fermilab accelerator and associated beamlines produces ionizing radiation such as muons. Beamlines and experiments are designed so that most of the muons remain under the ground surface, however some remain above the surface and present a small potential for radiation dose. Storage of radioactive materials onsite results in another potential exposure to ionizing radiation. These sources of penetrating radiation are monitored throughout the site with emphasis on source locations.

During the CY1995 Collider run, the potential muon sources were the C0 beam absorber and the AP0 target. No muon fields above background could be measured downstream of the C0 beam absorber. The effective dose equivalent due to Collider operations at the nearest site boundary, approximately 3500 feet away, was estimated to be 0.11 mrem/year. The estimate was based on the number of protons absorbed at AP0.

The maximum site boundary dose (assuming 24 hr/day exposure) from the radioactive material stored at the Railhead was 1.12 mrem in CY1995.

These estimates incorporate the extremely conservative assumptions that a single individual would be exposed for an entire year precisely at the site boundary. Effective dose equivalents obtained due to natural causes (e.g., cosmic rays, terrestrial sources and indoor radon, etc.) average approximately 300 mrem/year. The maximum radiation dose to an individual at the nearest offsite house was calculated as 0.23 mrem during CY1995.

3.3 Surface Waters

Fermilab discharges liquid effluent to surface water bodies and to publicly owned treatment works in Batavia and Warrenville. Fermilab holds an NPDES (National Pollution Discharge Elimination System) permit to discharge commingled non-process, non-contact cooling water and stormwater runoff to surface waters through outfalls to Kress, Indian and Ferry Creeks. Due to the presence of the RCRA-permitted (Resource Conservation and Recovery Act) Hazardous Waste Storage Facility onsite, the permit also addresses stormwater discharges from designated solid waste management units (SWMUs).

A separate NPDES pre-treatment permit allows us to release a treated effluent from the Central Utility Building regeneration process to the City of Batavia sanitary sewer system. In addition to the monitoring required by our NPDES permits, samples of surface water are taken annually from selected bodies of water onsite and analyzed for radionuclides. Surface waters to be sampled are selected on the basis of the potential for contamination. Chemical and physical parameters are not widely sampled in surface waters because Laboratory policies are designed to direct effluents that are not regulated wastes into the sanitary sewers. Maximizing allowable discharges to the sanitary systems limits the opportunity for contamination.

3.3.1 Radioactive Releases to Surface Water

Numerous sumps located throughout the site collect and drain water from building footers and from under beamline tunnels in the Tevatron enclosure and the Experimental Areas. Water collected by these sumps often contains detectable concentrations of radionuclides (primarily tritium, ^{3}H). Radionuclides in water have been leached by rainwater from radioactive soil near beam targets and absorbers or released accidentally to sumps from beamline cooling water systems. Routine sump effluent monitoring conducted during CY1995 showed tritium concentrations in all water released to ditches from monitored sumps to be less than the Department of Energy Derived Concentration Guides for allowable radionuclide releases to surface waters (2000 pCi/ml). There were no detectable levels of any radionuclides observed in fifty samples taken from onsite ditches, ponds and creeks. Three of eleven samples that were sent to off-site laboratories for analysis had detectable tritium concentrations (maximum of 1.48

pCi/ml) but were reanalyzed at the Fermilab Activation Analysis Laboratory and found to be below the detection limit of 1.0 pCi/ml. The standard error for tritium analysis at these levels is approximately 0.4 to 0.8 pCi/ml.

During CY1995, the effluent from the Central Utility Building regeneration process was sampled prior to each discharge and analyzed for accelerator-produced radionuclides. Approximately 1.45 mCi of tritium, 2.45 mCi of ^{7}Be, 1.96 pCi of ^{58}Co, and 0.58 pCi of ^{57}Co were released to the sanitary sewer during the year.

3.3.2 Non-Radioactive Releases to Surface Water

Monitoring for non-radiological chemical constituents in surface water was limited to Kress Creek and the Fox River supply to Fermilab's surface water system[3]. Illinois General Use Water Quality Standards apply to these surface waters. These standards are set to "protect the State's water for aquatic life, wildlife, agricultural use, secondary contact use and most industrial uses and ensure the aesthetic quality of the State's aquatic environment."[4] In CY1995 surface waters met the standards for all potential contaminants with the exception of iron (the standard for iron is 1.0 mg/l). Both the input from the Fox River (2.1 mg/l), and water leaving the Laboratory in Kress Creek (2.7 mg/l) exceeded general water quality standards for iron. The effluent to Kress Creek from Fermilab consists primarily of Industrial Cooling Water. The slight addition of iron to this effluent may be due to its contact with metallic pipes and other equipment.

3.3.2.1 Cooling Water System

Our NPDES permit for the cooling water system requires that water temperature and pH be monitored at all three outfalls and reported to the IEPA on a monthly basis. Chlorine concentration is recorded for the Kress and Indian Creek outfalls. During 1995, the permit limit for total chlorine (0.05 mg/l) was exceeded twice in Kress Creek, and eight times in Indian Creek[5]. Plans for a dechlorination process were initiated. There were no other exceedances during the year.

3.3.2.2 Releases to Sanitary Sewers

The pretreatment permit for the Central Utility Building regeneration effluent requires the collection and analysis of composite process effluent samples for metals. Radionuclides are analyzed as well in order to confirm that no

[3] Fermilab has a permit to pump water from the Fox River under certain specified conditions.
[4] Excerpt from Illinois' Administrative Code, Subtitle C "Water Pollution", Section 302.2.
[5] These exceedances of permitted discharge concentrations were later found to be due to naturally high levels of manganese in the surface water. Manganese interferes with the colorimetric analysis for chlorine, yielding higher concentrations than the actual level. It is likely that very few, if any, of the exceedances were actually due to elevated levels of chlorine.

significant amounts of radionuclides are released. These samples were taken at the process release point rather than at the site boundary where Fermilab actually discharges to the municipal sewers, and where concentrations would be greatly diluted. The heavy metal analytical results were submitted to the IEPA. During CY1995, samples from the process effluent were never in exceedance of the Batavia Sanitary Sewage Ordinance Discharge Limits or the Department of Energy Derived Concentration Guide for radionuclide releases.

3.4 Groundwater

Twenty wells determined to be no longer useful for groundwater monitoring were properly sealed this year. Thirty-eight wells were sampled during the year for various radionuclides or chemical species. The applicable regulatory limits for groundwater are water quality standards published by the state. Class I ground water is considered to be a resource and is highly protected. The water that is located in or near the dolomite aquifer 50 to 70 feet below ground surface of Fermilab is considered to be Class I groundwater. Water in the overlying till is considered to be Class II water and has less stringent standards.

Fermilab began to identify and analyze groundwater issues associated with a proposed construction project (Neutrinos at Main Injector, or NuMI), which would necessitate construction within the dolomite aquifer.

3.4.1 Radionuclides

Tritium was detected in one of five shallow Central Utility Building Tile Field wells at approximately 17 feet below ground level (approximately 43 feet above the Class I groundwater level). The detected concentration of 1.12 pCi/ml of tritium is much less than the Department of Energy ground water concentration guide of 20 pCi/ml. Illinois' Class I ground water standard for tritium is also 20 pCi/ml.

Several of the angled monitoring wells drilled into the berm at N01 also showed tritium in measurable concentrations, but well below limits established for Class I ground water. These wells are finished in the till, approximately 30 to 50 feet above the level of the Class I ground water. No other accelerator-produced radionuclides were found in detectable concentrations in Fermilab wells sampled during 1995.

3.4.2 Chemicals

Water samples from some of the wells used to monitor for chlorides and chromates in an old perforated pipe field within the Main Ring continued to yield measurable levels of total chromium and hexavalent chromium in CY1995. Measured concentrations were less than 2% of the IEPA Class II groundwater standards.

Chloride concentrations in the vicinity of the Central Utility Building Tile Field continued to significantly exceed the chloride standard for Class II groundwater. Class II groundwater is not considered by the state to be a resource groundwater, subject to more stringent standards. Samples for these analyses were collected from seven monitoring wells located in the glacial till. These wells are finished from 15 to 40 feet below ground level (20 to 45 feet above the aquifer). A Phase II Workplan for this area is part of the RFI (RCRA Facility Investigation), and will further address any remediation needed at this location.

4.0 A Summary of Compliance With Specific Environmental Regulations

The Endangered Species Act of 1973
No compliance issues were identified in CY1995.

Executive Order 11988, "Floodplain Management"
A public notice, "Floodplain Involvement Notification for the Proposed Casey's Pond Improvement Project," was published in the Federal Register on April 28, 1995.

Executive Order 11990, "Protection of Wetlands"
Evaluation of Fermilab activities in wetlands is accomplished through the NEPA review process. No new compliance issues were identified in CY1995.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
In CY1995, the use of pesticides and herbicides at Fermilab was handled in accordance with FIFRA.

The Migratory Bird Treaty Act
There were no compliance issues identified in CY1995.

National Environmental Policy Act (NEPA)
Fermilab met these requirements by implementing a program of reviewing all of its activities for NEPA compliance. The Environmental Assessment (EA) prepared for the Low-level Radioactive Waste Handling Building resulted in a Finding of No Significant Impact (FONSI). An Environmental Assessment was prepared for the Casey's Pond Improvement Project.

National Historic Preservation Act (NHPA), Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act (NAGPRA) of 1990
Compliance with these Acts was accomplished through the NEPA review process that included an evaluation of all proposed land-disturbing projects in

CY1995 to assess any potential impacts on historic resources. No compliance issues were identified in CY1995.

Resource Conservation and Recovery Act of 1976 (RCRA)
As a condition of our RCRA Part B permit, the IEPA has required Fermilab to undertake a RCRA Facility Investigation (RFI). The purpose of the RFI is to investigate whether hazardous constituents have been released to the environment from identified solid waste management units (SWMUs) located onsite. In addition to requiring the reporting of newly identified SWMUs, the RCRA also requires IEPA be notified of any changes to a previously identified SWMU. In February 1995, the IEPA was notified that the Railhead Storage Yard might contain lead contamination not originally identified and a plan to investigate this concern was submitted to IEPA. The steel pipe and soil stockpile were removed from the SWMU at the Central Utility Building tile field. Soil sample analysis at the tile field was completed in early December.

The IEPA conducted a RCRA inspection of Fermilab on January 19, 1995. It included a review of waste manifests, annual reports, training records, the contingency plan, the closure plans, the Part B permit, and operating records. Satellite waste accumulation areas and the Hazardous Waste Storage Facility were also visited. No deficiencies were cited.

Safe Drinking Water Act
Fermilab provides drinking water to its employees through two Fermilab-operated public water supplies and a satellite supply connected to the City of Warrenville public water supply. In February 1995 the IEPA transferred jurisdiction over the Fermilab public drinking water supplies to the Illinois Department of Public Health.

Monitoring for nitrate and coliform detected no exceedances of the drinking water limits. In actions to follow-up earlier exceedances of the Lead/Copper Action Levels, we conducted further lead, copper and water quality monitoring and submitted an Optimum Corrosion Control Treatment recommendation for the Fermilab systems to the IEPA as required. Because Pb/Cu Action Levels were not exceeded in results obtained in 1995, no further distribution of public education information was required during the year.

SARA TITLE III or Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA)
Under these regulations Fermilab is required to provide the EPA, state, and local officials with an annual accounting of hazardous chemicals and extremely hazardous chemicals used or stored onsite in quantities greater than a given threshold. Annual reports were submitted to the EPA as required. The CY1995

inventory was also submitted to state and local emergency services and disaster agencies in early CY1996.

Toxic Substance Control Act (TSCA)
The application of TSCA requirements to Fermilab involves the regulation of polychlorinated biphenyls (PCBs) and asbestos. Twenty-four transformer sites located at service buildings around the Main Ring are being remediated for PCB contamination of soil. A remediation agreement was arrived at jointly by Fermilab and the U.S. EPA. The contamination occurred as a consequence of past (pre-TSCA) sampling procedures in which transformer oil containing 2-5% PCBs was drained onto the ground to verify that dielectric properties had not deteriorated.

Two of the twenty-four transformer sites were cleaned up during the summer shutdown in CY1995. Soil sampling was initiated in the fall to identify any historic spills that may have occurred in the "truck lanes" between Main Ring Road and the transformer yards and service buildings. The first round of analytical results indicated that measurable contamination (>1 ppm) existed at seventeen of the twenty-two areas investigated. Two additional areas were characterized in a previous study. Budgetary constraints and cold weather delayed further study until the spring of 1996.

In January 1995, it was discovered that the large capacitors in the Linac radio frequency (rf) modulators contained PCBs. These items had been previously thought to be non-PCB, based on information received from the manufacturer. In preparation for shipping forty-four of these capacitors to the warehouse for storage as spares, the manufacturer was contacted to verify the nature of the dielectric oil, and was told that the units probably contained PCBs. Sampling confirmed that the oil was 100% PCB. The surplus capacitors were labeled, dated, and moved to the Fermilab Hazardous Waste Storage Facility to await shipment for offsite disposal. The 176 capacitors that remained in use were added to the site inventory and labeled during the February 1995 shutdown. Additional actions taken included the development of a plan to replace the remaining capacitors with non-PCB equipment, removal of an additional twenty-two capacitors from the single remaining inactive station, and further sampling to detect contamination from any historic or current leaks.

5.0 Conclusion

The operations at Fermilab during CY1995 had no significant adverse impact on the environment or on public safety.