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EA-602; (FONSI) and Environmental Assessment (Building 729) For Operation/testing Of A Prototype (Xls) And Machine Shop For The NSLS at BNL

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U.S. DEPARTMENT OF ENERGY FINDING OF NO SIGNIFICANT IMPACT CONSTRUCTION AND OPERATION OF SUPPORT FACILITY AND OPERATION/TESTING OF A PROTOTYPE ACCELERATOR/STORAGE RING (XLS) FOR THE NATIONAL SYNCHROTRON LIGHT SOURCE (NSLS) AT BROOKHAVEN NATIONAL LABORATORY, NEW YORK

AGENCY: U.S. Department of Energy

ACTION: Finding of No Significant Impact (FONSI)

SUMMARY: The Department of Energy (DOE) has prepared an Environmental Assessment (EA), DOE/EA-0602, for the proposed construction and operation of a support facility, Building 729, at the Brookhaven National Laboratory (BNL), Upton, New York. DOE proposes to construct and test a prototype accelerator/ storage ring (XLS) in this new building. The testing would be done as a work-for-others project for the Defense Advanced Research Projects Agency (DARPA). The testing is expected to last approximately one year at which time the accelerator and storage ring would be removed and a small machine shop would be installed and operated in Building 729. In addition, a 15 Kv substation would be constructed to provide electrical power to the support building. The additional floor space provided by Building 729 is needed at BNL regardless of the XSL test program. The XLS test program would provide information on new cryogenic and magnet technology and would test the effectiveness of the prototypic supercooled storage ring. Based on the findings of the EA, which is available to the public upon request, the DOE has determined that the proposed action is not a major Federal

action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA). Therefore, the preparation of an environmental impact statement is not required.

COPIES OF THE EA ARE AVAILABLE FROM:

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SUPPLEMENTARY INFORMATION:

PROPOSED ACTION: The proposed action is to construct a 5,600 square foot support building, install and operate a prototypic 200 MeV accelerator and a prototypic, supercooled 700 MeV storage ring (XLS) within the support building; and, following

termination of the XLS, construct and operate a small machine shop in the building. In addition, a 15 Kv substation would be constructed and operated to provide electrical power to the support building. Funding for the proposed XLS testing would be provided by the Defense Advanced Research Projects Agency

â (DARPA). DOE would be responsible for providing the site, constructing the support facility, and for assembling and operating the prototype accelerator/storage ring for the one year testing period.

At the end of the testing period, the accelerator/storage ring (the X-ray lithography source or XLS) would be removed from Building 729 and a small machine shop would be installed and operated. The proposed testing would involve injection of electrons from the accelerator through cryogenically cooled superconducting magnets into a prototypic supercooled 700 MeV storage ring. It would require only a few minutes of accelerator operation to fill the storage ring and each fill would be sufficient for four to six hours of testing to determine the effectiveness of the storage ring.

ALTERNATIVES: The following alternatives were considered in the

EA: (1) the proposed action; (2) construction and operation at another location at BNL; (3) conduct of the proposed XLS testing

at a DOE or DOD site other than BNL; and (4) no action. Construction and operation of the support facility and substation at a different location at BNL would result in similar, minor environmental impacts to those described for the proposed action. Conduct of the XLS testing at a site other than BNL would result in operational impacts at that site similar to those described

for such testing at BNL. Under the no action alternative, the support facility would not be constructed at BNL and the minor environmental impacts described for the proposed action would not occur.

ENVIRONMENTAL IMPACTS:

Construction: The proposed support facility and substation would be constructed in developed areas. Consequently, environmental impacts are expected to be minor. During construction, there would be a short term increase in traffic due to workers and material deliveries. Vehicle emissions and dust/particulates from site preparation and construction activities would have an insignificant and temporary impact on air quality. Construction activities would involve minor excavation, stockpiling and regrading of topsoil, mulching, and reseeding. No archeological or historic sites are known from the proposed area of construction. Consequently, no impact to cultural impacts are expected. Since the area for construction has been previously disturbed, there would be negligible impacts to the area's biota. No endangered or threatened plants or

animals or their critical habitat are known from the site. No impact to surface water or groundwater quality would be expected during constuction.

Operation: Operation of the XLS would not require the use or storage of any hazardous materials or chemicals. The coolant used for the magnets and the accelerator would be propylene glycol (a non-hazardous coolant) which would be circulated

through a closed loop system and drained periodically for maintenance of the system. The drained coolant would be stored on location and reloaded into the cooling system. Should replacement of the coolant be required, any coolant removed would be tested for activation prior to disposal. Any activated propylene glycol would be either solidified for disposal at the DOE's Richland Field Office, Hanford, Washington, or eliminated through the BNL permitted evaporator.

No chemical, hazardous, or mixed waste would be generated by the XLS project. However, the small machine shop installed after the one year test period of the XLS would generate limited quantities of hazardous waste in the form of oily rags, degreasing solvents, metal shavings, and lubricants. The quantity of hazardous waste generated by the small machine shop is expected to be less than 0.5% of BNL's current hazardous waste volume generated. This increase would not be expected to create a significant impact on BNL's waste handling or disposal operations.

No significant radiation impacts are anticipated with

testing of the XLS. Radiation dose to workers in the immediate area of the XLS from air activation products and/or beam scattering would be controlled by shielding. Radiation levels in uncontrolled and generally unoccupied workspaces adjacent to the shielding walls would be well below the 5 mrem/hr limit specified for posting as a radiation area in DOE Order 5480.11. Based on experience with existing NSLS facility operations, the total dose rate an individual might receive from beam scattering if the

individual occupied the area immediately adjacent to the machine shielding on a continual basis would be approximately 15 mrem/year. This dose would present an additional potential risk to a worker of contracting a fatal cancer of 0.001.

No radioactive liquids would be discharged from the XSL and no activation of soil or groundwater is expected to result from neutrons produced by gamma radiation striking the lead shielding.

The XLS prototype construction and testing would be the initial primary consumer of the additional power supply. Once the XLS testing is completed and the machine removed, electrical use would be primarily by machining operations in the same building. Since this facility does not currently exist, a net increase in BNL energy demands would result. This increase is well within the normal fluctuation of BNL energy use so utility impacts are not anticipated.

DETERMINATION: Based upon the analysis in the Environmental Assessment, DOE has determined that the proposed action will not

significantly affect the quality of the human environment within the meaning of the National Environmental Policy Act, 42 U.S.C. 4321 et seq. Therefore, an environmental impact statement is not required.

Issued in Washington, D.C., this _____ day of _____ 1992.

Paul L. Ziemer, Ph.D.
Assistant Secretary
Environment, Safety and Health

C0NSTRUCTI0N AND OPERATION OF A SUPPORT FACILITIES (BUILDING 729) FOR OPERATION/TESTING OF A PROTOTYPE ACCELERATOR/STORAGE RING (XLS) AND MACHINE SHOP FOR THE NATIONAL SYNCHROTRON LIGHT SOURCE AT BROOKHAVEN NATIONAL LABORATORY UPTON, NEW YORK ENVIRONMENTAL ASSESSMENT

JUNE 1992

U. S. DEPARTMENT OF ENERGY

BROOKHAVEN NATIONAL LABORATORY

1.0 PROPOSED ACTION

The proposed action is to construct at Brookhaven National Laboratory (BNL) a 5,600 square foot support building, install and operate a prototypic 200 MeV accelerator and a prototypic, supercooled 700 MeV storage ring within the support building and to construct and operate a 15 Kv substation to provide electrical power to the support building. The prototypic accelerator and supercooled storage ring would comprise the X-ray lithography source or XLS. The support facility, which would be designated as building 729, would be an L-shaped, high bay building extended north and east of existing Building 726. The 15 Kv substation would be located to the immediate north of this new building. The XLS testing would be undertaken by BNL for the Defense Advanced Research Project Agency (DARPA) as a work- for-others project. Funding would by provided by DARPA. DOE would be responsible for providing the site, constructing the support facility and for assembling and operating the XLS for a one year testing period. At the end of the one year testing period, the accelerator and storage ring would be decommissioned and dismantled and returned to DARPA. DARPA may use the equipment for additional research elsewhere, should testing provide positive results. The support facilities (i.e. Building 729 and substation) would be retained and used by DOE as a small machine shop to support the adjacent National Synchrotron Light Source (NSLS) project.

Building 729 construction would include dense concrete brick shielding on all exterior and interior walls which house the prototype and accelerator. The accelerator would be cooled using a closed loop system containing a 43% aqueous solution of propylene glycol as the primary coolant. Site work would include pavement removal, excavation, backfilling, and regrading.

The substation would be constructed on a concrete slab surrounded by a gravel buffer and enclosed by a cyclone fence to limit entry. This substation would

provide Building 729 with electric power. An underground feed to the substation would come down a utility right of way adjacent to Railroad Avenue, connecting with a main line adjacent to Cornell Avenue, a run of about 650 feet. Underground feeder lines from the substation would be installed to service Building 729. The substation would utilize non-PCB oil or dry transformers. It would be maintained according to BNL's transformer maintenance practices which include checking the oil quality, inspecting for leaks, maintaining grounds around the substation, and cleaning the insulator.

All other services would be provided by connecting into existing site utilities.

2.0 PURPOSE AND NEED FOR ACTION

Additional support facility floor space is needed near the synchrotron light source (NSLS) at BNL. As a work for others project, DOE needs to test for DARPA new cryogenic and magnet technology as part of a synchrotron machine and to test the effectiveness of the prototypic supercooled storage ring. Electrons produced by the 200 MeV linear accelerator would be directed by

cryogenically cooled superconducting magnets into the 700 MeV storage ring. The accelerator would be turned off while the electrons injected in the storage ring coast until slowly lost. A fill of the ring would require only a few minutes of accelerator operation and each fill would be sufficient for four to six hours. Effectiveness of the storage ring would then be evaluated.

While the initial use of Building 729 would be for the XLS, upon completion of the experiment, Building 729 would be used to support operations of the adjacent NSLS.

3.0 ALTERNATIVES

DOE's decision is whether or not to construct the proposed support facility near the NSLS at BNL and whether to conduct the DARPA work. If DOE chooses the no action alternative, the support facility and substation would not be constructed and the proposed DARPA sponsored research would not be conducted. Space provided by the proposed construction for future BNL use would not be realized as a result of this project. Under the no action alternative, the minor environmental impacts described for the proposed action (see Section 5) would not occur.

The proposed facility and substation could be constructed at a different location at BNL and the work for DARPA conducted in such a facility. The environmental impacts of choosing a different location at BNL would be expected to be similar to those described for the proposed action.

In addition, the work for DARPA could be conducted in a new or existing facility at a DOE or DOD site other than BNL, but the operational impacts would be expected to be similar. The impacts of the proposed XLS testing would not occur at BNL.

4.0 SITE DESCRIPTION

Brookhaven National Laboratory is a multi-disciplinary scientific research center located close to the geographical center of Suffolk County, New York, about 97 kilometers east of New York City (Figure 1). It consists of 21.3 square kilometers of mostly wooded habitats, except for a developed area of about 6.7 square kilometers. The site terrain is gently rolling, with elevations varying between 36.6 and 13.3 meters above sea level. The land lies on the western rim and headwaters of the Peconic River watershed. Freshwater wetlands in the north and east quadrants of the site remain in an area once part of a principle tributary to this river system.

Ground water in the vicinity of BNL moves predominantly in a southerly direction towards Great South Bay, although the flow becomes somewhat easterly

within the Peconic River watershed. Percolation occurs rapidly into the sandy sediments of the uppermost Pleistocene deposits underlying the Laboratory. The estimated rate of ground-water velocity is 30 to 45 centimeters per day. About half of Long Island's annual precipitation percolates through the soil to recharge ground water. The other half returns to the atmosphere via

evaporation and evapotranspiration. Precipitation for 1990 totaled 135 centimeters, about 12 centimeters above Long Island's 40 year annual average. The aquifer below the facility area is designated a sole source aquifer and represents the only environmentally sensitive area within the facility area.

A variety of fish and wildlife habitats can be found at BNL. The predominant oak/pine forest community offers excellent feeding, resting, and nesting opportunities for many species of migratory songbirds. Small mammals common to the northeast can be found in the grasslands and forest edges. Despite the Laboratory's relatively pristine environment, no New York State or Federally listed or proposed threatened or endangered species occur on site.

New: ref. recharge basin salamander?

The proposed support facility and substation would be constructed in a developed area (Figure 2) which has been previously disturbed. There are no sensitive environmental areas at the proposed site.

5.0 POTENTIAL ENVIRONMENTAL IMPACTS

Environmental concerns associated with this facility fall within the categories of increased utility demands and irreversible commitment of fossil fuel resources, potential ground-water contamination, potential release of air activation products, traffic and waste generation, and potential impacts to archaeological resources.

5.1 LAND USE AND DISTURBANCE

Construction activities would involve minor excavation, stockpiling and regrading of topsoil, mulching, and reseeding. Water would be used to control dust as necessary. Topsoil would be regraded, mulched, and seeded to return the area to pre-project conditions at completion of building construction and cable installations. Seeding and mulching would minimize erosion. No contaminated soil has been identified from the proposed project area. Impacts related to construction activities would be temporary and insignificant.

A short term increase in traffic would occur during construction of the new building. Once construction was completed, no change in existing traffic patterns would be expected since personnel now employed at the NSLS would conduct ~~the~~ XLS testing and operate the future machine shop.

5.2 WATER QUALITY

The proposed test activities are not expected to have any impact on water quality. Any activated propylene glycol (used as the accelerator primary coolant) would be either solidified for disposal at DOE's facility in Hanford, Washington or, if the material is not subject to foaming, eliminated via BNL's permitted evaporator. The evaporator is a compression system evaporator which would produce a water distillate that may contain some tritium. This distillate would be sent through BNL's Sewage Treatment Plant and eventually discharged to the Peconic River at levels below regulatory limits. The current level of tritium found in drinking water at BNL is 26% of the New York State Drinking Water Standard. Any other activation products would be

collected in the bottom of the evaporator and solidified for disposal at Hanford, Washington. This action would produce less than a 0.5% increase in the amount of tritiated water and solidified material generated by BNL for

disposal.

5.3 AIR QUALITY AND NOISE

Since there are no air emissions to the environment from operation of the XLS or the machine shop, no impacts to air quality are anticipated. Noise impacts would be temporary and would be related to the fabrication of the proposed building.

5.4 RADIATION AND RADIONUCLIDES

The XLS storage ring system comprises a 700 MeV electron storage ring and a 200 MeV maximum energy injector linear accelerator (linac) delivering a maximum current of 200 mA peak in 10 nanosecond (nsec) pulses ten times per second to the storage ring. Under the conservative assumption that 20% of these electrons are lost during the injection process, most probably at the copper injection septum of the storage ring, total electron losses would be 1.2 x 10^10 electrons/sec at 200 MeV energy. The remaining electrons would be accelerated to 700 MeV and stored for four to six hours, depending upon the vacuum of the storage ring. During the decay process in the storage ring, electrons interacting with the residual gas would produce bremsstrahlung which are emitted in a narrow cone tangential to the electron beam orbit in the storage ring. A lead belt around this region would stop the bremsstrahlung and produce modest neutron levels from the resonance reaction. At 700 MeV electron energy these neutrons are readily attenuated by a six inch thick concrete wall or equivalent. These conditions almost exactly mirror the operation of the Linac, Booster, and VUV ring of the NSLS where electron losses of 5 x 10^11 electrons/sec occur at an energy of about 100 MeV in a copper momentum defining slit in the Linac to Booster transfer line. The booster capture and acceleration process and stored beams of up to one ampere at 750 MeV in the VUV storage ring have electron losses of 2.5 x 10^11 electrons/sec within lifetimes of a few hours. Ten years experience with the VUV ring at NSLS has produced no observable activation in lead or concrete shielding around the facility. The copper of the momentum slit in the linac-

to-booster transfer line in the accelerator system has been the only material found to be activated. Radiation levels for this copper measured at five centimeters from the slit on beam turn-off have been only a few tens of mrem/hour. Since the electron beam of the XLS would be contained within a vacuum chamber at all times, no air activation would occur. Gamma ray induced neutrons generated by the gamma's striking the lead shielding are low in flux and would not give rise to soil or water activation. Ground water is at approximately 33 feet below the facility so no impacts from the facility are anticipated. Detailed information on radiation hazards for similar facilities can be found in BNL's Safety Analysis Report prepared for the existing XLS Synchrotron located within the NSLS (Building 725), across the street from the proposed action.

Shielding has been designed in accordance with DOE Orders 5480.11 and 6430.1A. Uncontrolled and generally unoccupied workspace adjacent to the shielding walls would produce measurable radiation levels well below 5 mrem/hr limits. ? Adjacent building and control room areas would also be several orders of magnitude below regulated permissible dose rates of 0.5 mrem/hr and an annual dose rate of 100 mrem/yr, assuming an eight hour work day. The dose rate attributable to air activation products in the building, in uncontrolled areas adjacent to the shielding walls, and in the control room would be 0.0 mrem/yr. Based upon experience with existing NSLS facility operations, the total dose rate an individual might receive from beam scattering if occupying the area immediately adjacent to machine shielding on a continual basis would be approximately 15 mrem/yr. This dose represents 0.77% of the dose natural background radiation would cause over the same period. Using the International Commission of Radiological Protection and National Academy of Sciences methods to estimate health effects, Report 60, Biological Effects from Ionizing Radiations Report (BEIR-V), this dose would present the potential additional risk to a worker of contracting a fatal cancer of 1

chance in 100,000 or 0.001%. Realistically, given this information no radiation health effects are expected to occur.

5.5 ECOLOGY, CULTURAL, HISTORICAL AND ARCHAEOLOGICAL RESOURCES IMPACTS

The New York State Historic Preservation Officer issued a determination on January 29, 1991, stating that construction and operation of the proposed action would have no effect on cultural resources. Since the proposed area of disturbance is currently developed, no impacts to flora, fauna or sensitive environmental areas are anticipated.

5.6 SOCIOECONOMIC EFFECTS

Socioeconomic impacts of construction and operation of the facility, and testing of the accelerator, are expected to be minimal. The building will be constructed with contract labor with a minimum of manpower due to it's size, and the operations and testing will utilize current employees of the NSLS.

5.7 ABNORMAL EVENTS

Since the XLS and associated support functions utilize electric power to energize the magnet and other equipment in the area during the course of operations, potential personnel hazards can occur during abnormal situations, e.g., shock, fire, etc. The design of the prototype accelerator/storage ring and the associated operations, as well as the support facility, e.g., machine shop equipment, are based to a large extent on the identification and evaluation of the impacts of unusual occurrences to identify safeguards needed to protect personnel, the public, and the environment on- and off-site.

The propylene glycol solution proposed for use is approved for use in systems that may contact food by the U.S. Food and Drug Administration and is not considered a hazardous material. Should any of this material be spilled, it would be cleaned up following normal safety procedures as in the Brookhaven National Laboratory's Safety Manual. Specifically, any spilled material would

new SBMS Subject Area

be contained, recovered and stored until analytical results could verify the characteristics of the material to be disposed (i.e., is material radioactive, hazardous, and/or nonhazardous in accordance with New York State and Federal regulations). Disposal methods would be dictated by analytical results.

The oil filled transformers at the proposed substation would be incorporated into the BNL Plant Engineering Division's scheduled maintenance program for transformers. This program consists of annual inspections for leaks, annual testing of the oil, on demand cleaning of the insulator, and general ground maintenance. Previously formalized maintenance practices at existing BNL transformers minimize the likelihood of a leak discharging to the environment, therefore, no impacts to the environment including the underlying sole source aquifer are anticipated.

This prototype ring has the same operational parameters and radiation characteristics as the existing XLS Phase I device now operated in Building 725. For the operation of this accelerator and storage ring it was found that the probability of occurrence of an abnormal event is considered to be very low. Experience with this device has also shown that abnormal events would result in no radiological impact.

In an abnormal situation, the electron beam striking any part of the beam pipe or lead shield in the storage ring can produce higher radiation levels than normal in the form of bremsstrahlung. There are several fault modes to be considered for a credible accident. An injection mode fault condition could impinge the beam on unexpected locations within the injection line or ring system. Beam mis-steering or failure of a magnet power supply could cause this condition. The lead shielding around the beam line and storage ring would keep radiation levels at the injection septum for 100% loss of the beam to 5 mr/hr at a distance of 3.5 meters. The radiation levels outside the

shield would be less than 1.5 mr/hr. Instrumentation on the beam line and ring would detect a beam loss almost instantaneously. Therefore, radiation levels would be significantly less than stated. Loss of beam within the bending magnets is attenuated by the thick yoke of the magnets with levels no higher than described above.

Redundant interlocks make operation with an open beam pipe nearly impossible. Radiation levels around the XLS storage ring and beam pipe as well as around the XLS area itself without shielding would yield 300 mr/hr bremsstrahlung. This is attenuated by the surrounding concrete to be less than the allowable 100 mr/yr. Instrumentation on the beam line and ring would detect beam loss almost instantaneously. Therefore, radiation levels would be significantly less than stated. In the event of power failure to the accelerator controls, the beam and storage ring operations would automatically halt, no additional beam would be present, therefore no further radiation hazard would exist. Beam stored in the storage ring would simply decay away in a very rapid fashion.

Maintenance derived abnormal events include the mis-steering of the accelerator beam or the presence of personnel in the XLS cave during operations. To prevent personnel exposures from such events, the system has

been designed with dual redundant interlock systems to exclude personnel from the cave during operation and a beam stop is inserted in the unlikely event interlock systems fail. Beam loss to the building could not penetrate shielding so exposures outside the building would not occur.

No detrimental effects to the employees, public, or environment are expected from an abnormal event.

5.8 HAZARDOUS AND DOMESTIC WASTES

Sanitary wastes generated from this building would be directed to BNL's Sewage Treatment Plant via the existing sanitary lines. Domestic wastes generated by this building can be easily accommodated by the BNL Sewage Treatment Plant which is currently operating at only 60% of its authorized capacity under New York State Pollutant Discharge Elimination System Permit Number 5835. Construction and testing of the XLS prototype would not require the use or storage of hazardous materials or chemicals. Magnet and accelerator cooling would involve closed loop and cryogenic cooling systems. Maintenance of the closed loop system would require occasional system drainage. Drained coolant would be stored on location and reloaded upon completion of maintenance. Should replacement of fluid be required, coolant would be tested for activation prior to disposal to determine whether or not the coolant represents low level radioactive waste. The coolant selected, propylene glycol, is not considered hazardous, so no hazardous waste generation would occur. Activated propylene glycol would be eliminated via BNL's permitted evaporator or transported to Hanford for disposal. No discharge of coolant to the environment would be permitted. Given these circumstances, no impacts to the environment or the underlying sole source aquifer are anticipated.

what about in 1999? → changed?

Operations in the proposed building would initially revolve around the assembly and testing of the XLS prototype. Since no chemicals or other hazardous materials would be used in this operation, none would be generated for disposal. Operation of the small machine shop may generate some hazardous .wastes such as oily rags, degreasing solvents, metal shavings, and used lubricants but quantities would be minimized through compliance with BNL aggressive waste minimization programs. As this facility would not be occupied full time, this would also serve to limit waste generation. No increase in solid waste generation is anticipated since no new employees would be required to carry out this proposal. Hazardous waste generated by machining operations is expected to result in an increase of less than 0.5% of current BNL hazardous waste generation.

Decommissioning and dismantlement of the facility may involve disposal of activated material since a few components of the accelerator may become activated. Disposal of this potential low level activated waste would follow the DOE guidelines delineated in DOE Order 5820.2A. This waste would be stored at BNL's Hazardous Waste Management Facility until it could be shipped for disposal to DOE's facility at Hanford, Washington. The total volume of activated waste generated is estimated to be approximately one cubic foot. This volume can be accommodated at BNL' s HWMF for storage indefinitely if necessary.

Actual off- site disposal of decommissioned equipment would be limited to construction debris. This may consist of wood, plasterboard, and other such materials which are routinely carted to offsite approved landfill locations. The amount expected is minimal (probably less than 30 cubic yards). None of these materials would be activated or constitute hazardous waste.

5.9 UTILITIES

The proposed substation would be constructed to provide power to the new support structure. Once the XLS testing is completed and the accelerator/storage ring removed, the electric power would be used by machining operations in the same building. The increase in electric power usage is within the normal fluctuation of BNL energy use. No utility impacts are anticipated.

5.10 CUMULATIVE AND/OR LONG TERM ENVIRONMENTAL EFFECTS

Minor impacts would be limited to the loss of approximately 0.5 acres of potentially developable land and the loss of fossil fuels used to generate energy for the proposed action.

The total annual offsite dose in 1990 from all BNL operations was 1.1 mrem. There would be no addition to this dose from the one year operation of the

XLS.

6.0 AGENCIES AND PERSONS CONSULTED

1. New York State Historic Preservation Officer

7.0 REFERENCES

[1] Superconducting X-Ray Lithography Source Phase I (XLS) Safety Analysis Report, L. Blumberg, et al., July 1990.

[2] Brookhaven National Laboratory Site Report for Calendar Year 1989, R. P. Miltenberger, B. A. Royce, J. R. Naidu, et al., December 1990.

[3] Brookhaven National Laboratory Site Report for Calendar Year 1990 (DRAFT), R. P. Miltenberger, B. A. Royce, J. R. Naidu, et al., July 1991.

[4] Brookhaven National Laboratory Safety Manual, Revised as of July 10, 1991.

8.0 DEFINITIONS

Bremsstrahlung - A form of X-Ray electromagnetic radiation given off by a high-energy particle (electron), when that particle experiences a sudden change in velocity (deceleration) or change in direction caused by an electromagnetic field.

kVa - kilovolt-ampere - one-thousand volt-amperes

volt-ampere - The unit of apparent power in an alternating current circuit or device containing reactance, equal to the product of the voltage in volts and

the current in amperes without regard to phase.

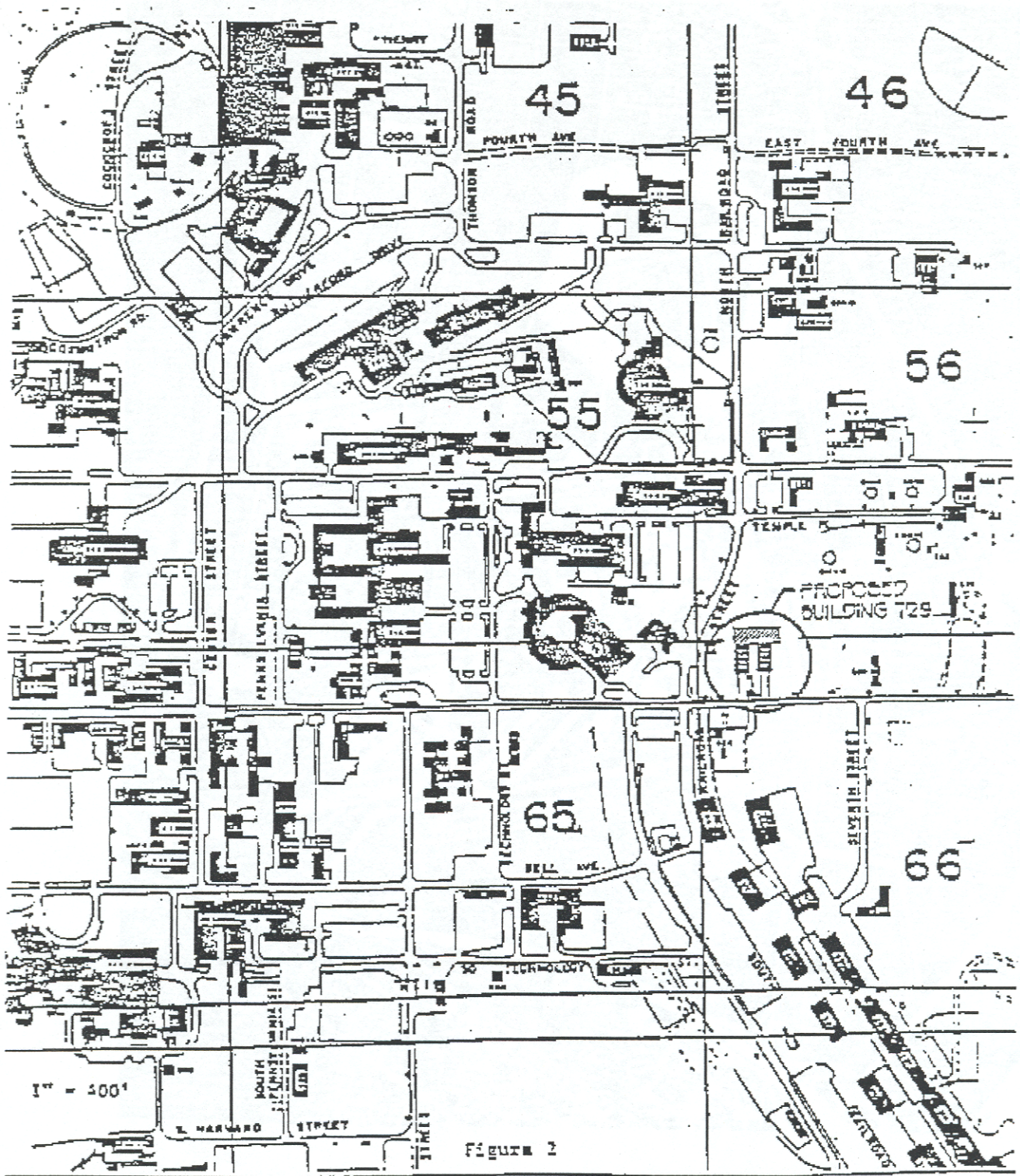
yoke - The surrounding support pieces of a magnet which hold the magnetic cores in place.

Figure (Page 12)

Figure 1. BNL Site

Figure (page 13)

Figure 2. NSLS SHOP ADDIDTION


45
46
55
56
65
66
PROPOSED
BUILDING 725
1" = 400'
Figure 2
NSLS SHOF ADDITION
BROOKHAVEN NATIONAL LABORATO
UNITED STATES DEPARTMENT OF ENERGY
PLANT ENGINEERING

Scale: 1" = 2 '

Figure 1: DOE Site