Department of Energy
Argonne Site Office
9800 South Cass Avenue
Argonne, Illinois 60439

JUL 2 0 2015

Dr. Peter B. Littlewood
Director, Argonne National Laboratory
President, UChicago Argonne, LLC
9700 South Cass Avenue
Argonne, IL 60439

Dear Dr. Littlewood:

SUBJECT: NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) DETERMINATION FOR ARGONNE NATIONAL LABORATORY (ARGONNE)

The Argonne Site Office (ASO) has approved the "Advanced Photon Source Upgrade Project - Multi-Bend Achromat Storage Rings and Superconducting Insertion Devices," ASO-CX-313 as a categorical exclusion (CX) under Appendix B to 10 CFR Part 1021, Subpart D, Integrated DOE NEPA Implementing Procedures, December 1996) under the following two categories:

Category B1.23 Demolition and Disposal of Buildings
Demolition and subsequent disposal of buildings, equipment, and support structures (including, but not limited to, smoke stacks and parking lot surfaces), provided that there would be no potential for release of substances at a level, or in a form, that could pose a threat to public health or the environment; and;

Category B1.31 Installation or Relocation of Machinery and Equipment
Installation or relocation and operation of machinery and equipment (including, but not limited to, laboratory equipment, electronic hardware, manufacturing machinery, maintenance equipment, and health and safety equipment), provided that uses of the installed or relocated items are consistent with the general missions of the receiving structure. Covered actions include modifications to an existing building, within or contiguous to a previously disturbed or developed area, that are necessary for equipment installation and relocation. Such modifications would not appreciably increase the footprint or height of the existing building or have the potential to cause significant changes to the type and magnitude of environmental impacts.

DOE ASO understands that the APS upgrade project scope includes removal of approximately 1900 tons of storage ring magnets, steel support girders, vacuum chamber components, and associated electronics and cabling and replace with new storage ring and associated equipment as described in §9.d of the Environmental Review Form.

To most effectively disposition this material and satisfy the Sustainability Goal of "Waste Diversion" under the Executive Order 13693 (issued April 2015), Argonne is strongly encouraged to establish and employ a property clearance method (Protocol) that supports the APS upgrade's intent to re-cycle certain materials. This Laboratory-level Protocol will need to be reviewed through an Assist Visit led by the DOE Office of Science. This Protocol will likely clear a majority of the removed material enabling Argonne to recycle metal, electronics, and other materials, and will also help Argonne meet the intent of Category B1.23 described above.

DOE ASO will remain engaged and actively support the Laboratory to develop and finalize the property clearance method (Protocol) in consultation with the DOE HQ and other expertise available in the DOE Complex.

Please note that additional NEPA review will be necessary if any modification or an expansion of the scope is made to the above project.

Enclosed please find the approved Environmental Review Form (ERF) for the project. If you have any questions, please contact Kaushik Joshi of my staff at (630) 252-4226.

Sincerely,

Joanna M. Livengood

Joanna M. Livengood
Manager

Enclosure:
As Stated

cc: J. Stauber, ANL, w/encl.
T. Barkalow, ANL, w/encl.
J. Kerby, ANL, w/encl.
M. McKown, SC-CH, w/encl.
P. Siebach, SC-CH, w/encl.
J. Houck, ASO, w/encl.
N. Brachmann, ASO, w/encl.
K. Joshi, ASO, w/encl.

Argonne NATIONAL LABORATORY

Environmental Review Form for Argonne National Laboratory

Project/Activity Title: APS Upgrade Project - MBA Scope

ASO NEPA Tracking No. ASO-CX-313 **Type of Funding**: DOE MIE

B&R

Identifying number: Code PSC1501 SPP proposal # CRADA proposal #

Work Project # ANL accounting # (item 3a in Field Work Proposal)

Other (explain) Proposed DOE MIE Project

Project Manager: James Kerby Signature: Date: 4/1/2015

NEPA Owner: Thomas Barkalow Signature: Date: 3/30/2015

ANL NEPA Reviewer: Joel Stauber Signature: Date: 4/14/15

I. **Description of Proposed Action:** The Advanced Photon Source (APS) is a major national user facility providing high-brilliance x-ray beams for users from Argonne National Laboratory (ANL), other national laboratories, academic institutions, governmental bodies, and industrial firms. Synchrotron radiation emitted by circulating electron beams is used as the source of x-rays for probing the structure of matter and for studying various physical and chemical processes. The APS presently uses a stored circulating electron beam current of 102 mA at an electron energy level of 7.0 GeV (representing a stored energy level of 2630 J) during normal operations. The highest electron energy level achievable is 7.7 GeV. The facility is authorized to operate with a safety limit for stored energy level of 9280 J (representing a maximum stored electron beam current of 327 mA at 7.7 GeV or 360 mA at 7.0 GeV).

The proposed action includes activities involved with removal of the existing storage ring and associated equipment followed by installation of the new storage ring and associated equipment.

Following completion of the APS-U Project as presently envisioned, the APS will use a stored circulating beam of 200 mA and 6 GeV or about 4420 J, well within the present safety envelope. The safety limit for stored energy would correspond to a maximum stored electron beam current of about 380 mA at 6.6 GeV or about 420 mA at 6.0 GeV.

The APS Upgrade (APS-U) Project will take advantage of the recent technological advances in accelerator technology of Multi-bend Achromat (MBA) Storage Rings and Superconducting Insertion Devices. The APS-U project goal is to build the world's leading high-brightness hard x-ray storage ring, incorporating advanced beam line and data technologies to enable

breakthrough mesoscale science and the ability to explore real systems in real time in real environments. To accomplish this, a conceptual design for a hybrid MBA magnetic lattice has been developed which includes seven bending magnets in each of the 40 sectors, in comparison to the present two per sector layout.

Ultimately the APS-U must achieve world leading science, and as such the scope includes the design, procurement, assembly, installation, and testing of the accelerator hardware, beamline instrumentation, cutting edge undulators and enabling technical capabilities required to maintain the APS as a world leading center for hard x-ray synchrotron science. Figure 1 shows a standard sector of the APS today and what is presently envisioned for the APS Upgrade.

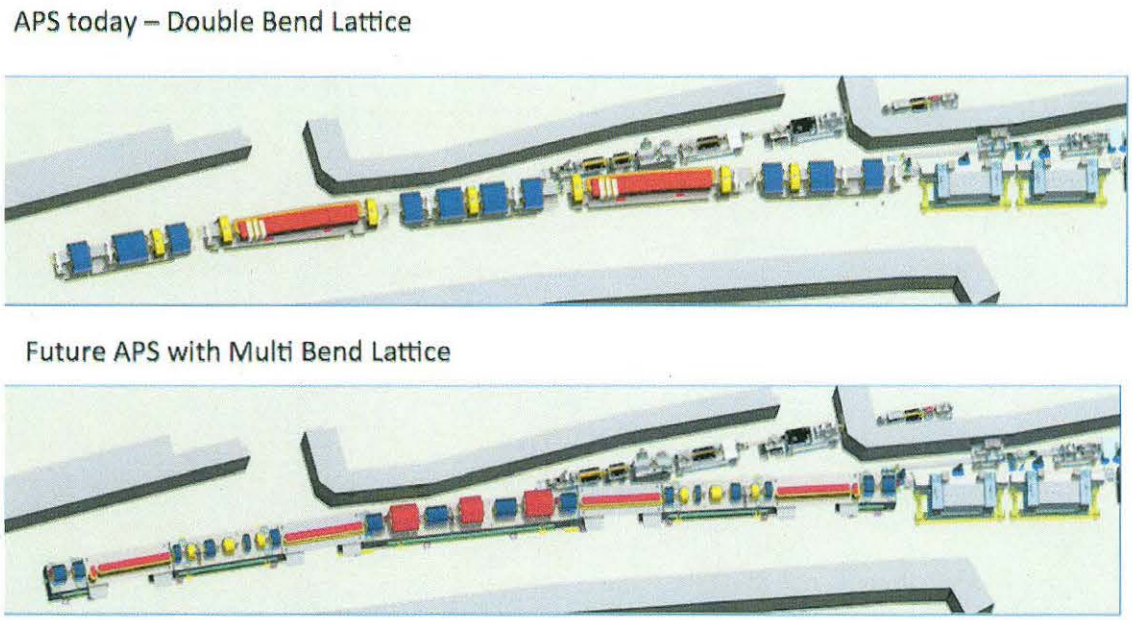

Figure 1. A single sector of the current (top) and MBA (bottom) lattice as implemented at the APS. An insertion device would be located at the left where the graphic ends; two inline devices are shown at the right. Dipoles are red, quadrupoles blue, and sextupoles yellow. The current walls of the storage ring enclosure are shown in both depictions

The existing APS storage ring (SR) tunnel is divided into six zones, A through F, and a total of 40 sectors. Zones A through E (sectors 1 through 35) provide the X-rays for science experiments and contain magnet girders, insertion devices and front ends. Zone F (sectors 36 through 40) is used for injection, extraction, RF power, and diagnostics and as such contains magnet girders, and RF and injection equipment. The area above the SR is called the mezzanine and is where power supplies and controls for the storage ring are located. The existing SR in it's entirety and some of the components on the mezzanine will need to be removed so that the new multi bend achromat lattice configuration can be installed.

The APS Upgrade MBA machine uses the same civil footprint as the existing APS, and as such also has 40 sectors, with sectors 1 through 35 each consisting of ten modules: two quadrupole doublets, four longitudinal-gradient dipoles, two straight multiplets, a curved FODO section, and an insertion device straight section, the remaining 5 sectors serving the same function as those

in zone F, though with new components. For the purposes of the current APS-U planning, we assume all 40 sectors are the same.

Within each standard APS-U sector, as shown in Figure 2, each quadrupole doublet section contains two quadrupole magnets and one combined-function fast horizontal / vertical steering / skew quad corrector. The straight multiplets each contain 4 quadrupole magnets, 3 sextupole magnets and one fast corrector. The curved FODO section contains four strongly focusing quadrupoles, three strongly defocusing dipole bend magnets, and an optional three-pole wiggler magnet to support bending-magnet x-ray beamlines. In sum each sector contains 7 dipoles 16 quadrupoles, 6 sextupoles, 4 fast steering correctors, and a three-pole wiggler, in addition to an insertion device source tailored to beamline requirements. Table 1 shows the beam parameters for APS now and the APS-U
MBA.

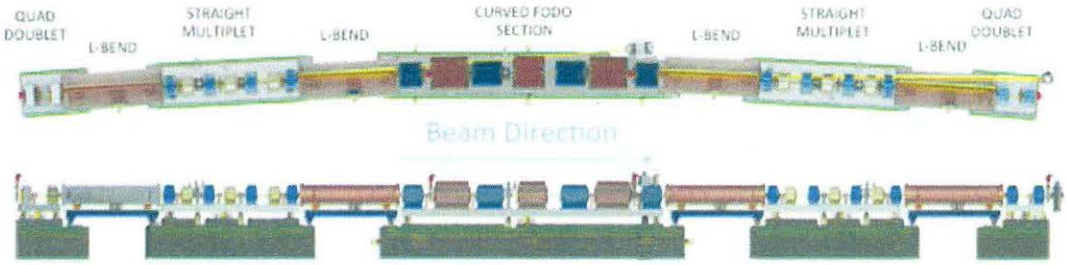

Figure 2: APS-U Standard Sector Layout

Quantity	APS Now	APS MBA Timing Mode	APS MBA Brightness Mode	Units
Beam Energy	7	6	6	GeV
Beam Current	100	200	200	mA
Number of Bunches	24	48	324	
Bunch Duration (rms)	34	67	55	ps
Bunch Spacing	153	77	11	ns
Emittance Ratio	0.013	0.98	0.1	
Horizontal Emittance	3100	47	68	pm-rad
Horizontal Beam Size (rms)	275	18	22	μm
Horizontal Divergence (rms)	11	2.6	3.1	μrad
Vertical Emittance	40	46	6.8	pm-rad
Vertical Beam Size (rms)	10	10.6	4.1	μm
Vertical Divergence (rms)	3.5	4.3	1.7	μrad

Table 1: Present APS and APS-U MBA Beam Parameter Comparison

The modifications envisioned to the APS injector chain are more modest in scope. Currently the APS injector is composed of a 450 MeV electron linac, a particle accumulator ring (PAR), and a 7 GeV synchrotron booster. At present the injector runs at a 2-Hz rate and provides a single bunch with beam charge up to 4 nC. For the APS-U, an axis swap-out injection instead of the present off axis top-off is proposed with the swapped-out bunch hitting a collimator(s) and/or beam absorber(s). Two bunch fill patterns are considered, both with a total beam current of 200mA: a 48-bunch high charge mode with up to 4.2 mA per bunch, and a 324-bunch mode. The high bunch charge in 48 bunch mode requires an increase in the single bunch charge possible in the injector chain, above the current 4nC, but still well within the safety envelope of the APS.

II. Description of Affected Environment:

The baseline description of the affected environment is provided in the Environmental Assessment for Enhanced Operations of the Advanced Photon Source at Argonne National Laboratory-East, Argonne, Illinois, DOE/EA-1455, June 2003.

The APS site areas affected would be expected to be inside Building 400 and various adjoining Laboratory/Office Modules (LOMs). No building construction is presently included in the project, but concrete pads may be poured adjacent to the superdoor locations in the APS infield. These pads would be used to stage equipment into and out of the storage ring enclosure.

III. Potential Environmental Effects:

A. Complete Section A for all projects.

1. Project evaluated for Pollution Prevention and Waste Minimization opportunities and details provided under items 2, 4, 6, 7, 8, 16, and 20 below, as applicable — Yes X No ____

2. Air Pollutant Emissions — Yes X No ____

A low level of air pollutant emissions may result from use of vehicles and mobile lift equipment during removal, assembly and installation. No new types of air pollutant emissions would result from upgrade operation.

Emissions of airborne radionuclides could lead to exposure of the general public outside of the Argonne site. At APS radionuclides are produced as a side effect of accelerator operations (i.e., the purpose of APS is not to produce radionuclides). The main source of airborne radionuclides at APS are the short-lived isotopes N-13 and O-15 and C-11. These emissions are addressed in the existing US EPA Clean Air Act Permit Program (CAAPP) Permit ID: 95090195 and are included in the annual NESHAPS report. The emission quantities are calculated based on the number of operating hours, each accelerator system's beam power level, and the air exhaust from the various accelerator enclosure ventilation systems to the outside atmosphere. Emissions are calculated for three separate areas: (1) LINAC/PAR operations in Buildings 411 and 412, (2) Booster synchrotron operation in Building 415, and (3) storage ring operation in Building 400. The amount of air activation products produced by storage ring operation (~0.03 Ci) is several orders of magnitude lower than the quantities produced by operation of the LINAC/PAR (~14 Ci) and booster synchrotron (~ 16 Ci). Any increase in these values due to the upgrade is not expected to be significant. An increase of even an order of magnitude would have a negligible impact on dose to the general public.

An outcome of the APS Upgrade would be to operate the storage ring at a stored electron

beam power level 1.7x higher than with the existing storage ring. The quantity of air activation products is directly linear to the power level so the storage ring will produce about 1.7x greater air activation products than at present. This linear extrapolation assumes losses similar to the present storage ring. Since the storage ring contributes an insignificant amount (0.1% or less) to the total quantity of APS activated air emissions, an increase of 1.7x is not a concern.

The operation of the LINAC/PAR and booster synchrotron after the upgrade will remain within the present operating envelope.

3. Noise — Yes X No ____

Argonne requirements related to hearing protection will be followed should removal, assembly or installation activities result in noise levels above 85 decibels. Sustaining noise above this level for appreciable lengths of time is not anticipated during normal removal, assembly or installation activities.

4. Chemical/Oil Storage/Use — Yes X No ____

Various cleaning and lubricating compounds will be present during removal, assembly and installation activities. Any oil containers greater than or equal to 55 gallons will be kept within a secondary containment, such as a spill pallet, even if indoors. Chemicals will also be present during beamline operation. Material Safety Data Sheets are required to be readily available during assembly, removal and installation when chemicals are present. The Enhanced Operations EA did not provide information on specific chemicals that may be present during beamline operations. Instead that document took credit for engineered ventilation means that would be used in beamline spaces to minimize chemical exposure and the use of an experiment safety review process to identify chemical hazards and to specify necessary safety measures in experiment designs and safe handling procedures to be followed during the experiments. Some or all of these same means would be used during and following completion of APS beamline upgrades. The upgrade will not result in changes to oil usage or storage at the APS.

5. Pesticide Use — Yes ____ No X

6. Polychlorinated Biphenyls (PCBs) — Yes ____ No X

7. Biohazards — Yes ____ No X

8. Effluent/Wastewater (If yes, see question #12 and contact Gregg Kulma (FMS-SEP) at 2-9147 or gkulma@anl.gov — Yes ____ No X

9. Waste Management

a) Construction or Demolition Waste Yes X No ____

The removal activities for the existing APS storage ring and associated electronics and cabling will generate a total of 1900 tons of waste material, most of which will consist of the storage ring magnets and steel support structures. Small quantities of typical construction related wastes may also be generated. See c) and d) below for handling of the various waste types.

b) Hazardous Waste Yes X No ____

Removal of existing storage ring or beamline components may generate a relatively small quantity of lead contaminated waste. Any such waste would be handled in accordance with Argonne and APS hazardous waste requirements. Use of the upgraded beamlines may result in small quantities of hazardous chemical wastes, but these are not expected to be substantially different than existing quantities.

c) Radioactive Mixed Waste Yes X No ____

Current APS operations occasionally produce a very small quantity of radioactive mixed waste. Operations following the upgrade could similarly create a very small quantity of radioactive mixed waste. Existing Argonne and APS procedures would be followed if radioactive mixed waste is created.

d) Radioactive Waste Yes X No ____

Items to be removed from the storage ring tunnel will consist mainly of support girders, magnets and vacuum chamber components. All items will be initially surveyed in the tunnel before removal. Regardless of radiological survey readings, all metallic items removed from the tunnel will be handled as Richardson moratorium waste, and cannot be recycled under current DOE rules. This will constitute the vast majority of the waste. Argonne is pursuing relief from the no-recycle requirement by obtaining DOE review and approval of radiological survey methods in accordance with DOE Directive O 458.1, Radiation Protection of the Public and the Environment, and use of the pre-authorized release limits from that same directive. A small percentage of the waste could be contaminated or activated and will be handled according to Argonne and APS procedures.

e) PCB or Asbestos Waste Yes ____ No X

f) Biological Waste Yes X No ____

No new biological facilities would be added as part of the upgrade, but biological samples will continue to be used in upgraded beamline experiments. The amount of biological waste generated is not expected to be substantially different in quantity or type than for present biological experiments. The hazards of generated biological

waste and its handling along with any necessary mitigation would be evaluated and provided by the experiment safety review process prior to the samples being used.

g) No Path to Disposal Waste Yes ____ No X

h) Nano-material Waste Yes X No ____

There is a small quantity of nano-material waste presently being generated as a result of experiments conducted on nano-material samples. The amount of nano-material waste generated by experiments conducted following beamline upgrades would not be expected to be substantially different in quantity than for the present experiments. The hazards of generated nano-material waste and its handling along with any necessary mitigation would be evaluated and provided by the experiment safety review process prior to the samples being used

10. Radiation Yes X No ____

Ionizing radiation could result in external exposure of personnel, users, and members of the general public. Exposure due to release of airborne radionuclides in the form of air activation products has already been addressed in responding to Item III.A.2 in this ERF. Prompt radiation hazards arising from the loss of beam in targets, beam stops, septum magnets, and accelerator components lead to the production of radiation fields during injector operations. These radiation fields consist mainly of bremsstrahlung (x-rays), gamma rays, and neutrons. Interactions with these radiations leads to activation of accelerator components, which could also represent potential external exposure hazards. As the stored beam circulates in the storage ring, a small fraction of the beam is lost due to collisions with gas molecules, interactions among beam particles, and orbital excursions, which also produce radiation. In addition, the primary purpose of the APS is to produce high-quality synchrotron radiation (x-rays).

The accelerator tunnel shielding for the radiation produced by normal operations of the accelerator system was designed based on operations that produce, accelerate, and store a 7.7 GeV electron beam using an injected beam-power level of 308 W with a stored electron beam energy of 9280 J. The beamline and experiment station shielding was designed for the synchrotron radiation produced by either a bending magnet or an insertion device. For synchrotron-radiation (x-rays) calculations, storage ring energy of 7.5 GeV and storage ring current of 200 mA have been assumed in all cases. These parameters were chosen for the simulation of the synchrotron radiation because they proved to be a worse case than the 7.0-GeV, 300-mA case.

These design parameter values for accelerator tunnels, beamlines, and experiment stations exceed the maximum operating parameters of 6.0 GeV and 200 mA, which will result from the APS-U project. Thus it is anticipated that the presently installed shielding will continue

to be within design parameters, with minor changes in locally shielded areas within the tunnel.

The Enhanced Operations EA provided radiation exposure information based on information from existing Safety Assessment Document (SAD) analyses (which were based on the analyses used for shielding design). The SAD beamline analysis was based on the use of the Monte Carlo radiation transport computer code EGS4 that calculates a gamma radiation dose.

Given the change in the beam energy, brilliance and the use of swap-out versus top-up, radiation safety calculations will be completed to determined loss modes (normal and accident conditions), verify that the present shielding is sufficient and to determine what localized shielding is needed. These calculations will also be used to update the estimated air activation levels and other radiation calculations.

Regardless of the new calculation's results, the actual radiation conditions will be determined by radiological surveys conducted as part of accelerator and beamline commissioning following completion of accelerator and beamline modifications within the APS-U scope and appropriate action taken as a result of these measurements.

11. Threatened Violation of ES&H Regulations or Permit Requirements — Yes ____ No X

12. New or Modified Federal or State Permits — Yes ____ No X

13. Siting, Construction, or Major Modification of Facility to Recover, Treat, Store, or Dispose of Waste — Yes ____ No X

14. Public Controversy — Yes ____ No X

15. Historic Structures and Objects — Yes X No ____

The research conducted at APS using the storage ring being replaced may be of historic significance. Documentation of the storage ring will be maintained and consideration given to retaining a sample of the storage ring (such as the last bending magnet installed as it has signatures of numerous workers and managers).

16. Disturbance of Pre-existing Contamination — Yes ____ No X

17. Energy Efficiency, Resource Conserving, and Sustainable Design Features — Yes X No ____

Electric energy usage for the 400 Area in FY2014, including the CNM and Building 450, during normal operations was a daily average of 16 to 17 megawatt hours based on data collected from existing electric meters. The highest daily average historical usage during

normal operations was 23.5 megawatt hours. Usage decreases during maintenance periods to a daily average of 8 megawatt hours. These values compare to the anticipated daily megawatt hour usage of 25 that is stated in the Enhanced Operations EA with the CNM adding 3.5 MW hour usage for a total of 28.5 MW hour usage for the 400 Area. The energy usage for this same area during and after the upgrade will not increase and therefore electric energy usage will not exceed the value given in the Enhanced Operations EA.

There are no plans to build any significant new structures as part of the APS Upgrade project, however, if any were to be built, improved energy efficiency measures would be incorporated into the designs in accordance with the Argonne Site Sustainability Plan (current version is FY2014). Areas addressed in the plan include lighting, heating, cooling, power metering and energy saving building construction.

B. For projects that will occur outdoors, complete Section B as well as Section A. NOT APPLICABLE

18. Threatened or Endangered Species, Critical Habitats, and/or other Protected Species — Yes ____ No ____
19. Wetlands — Yes ____ No ____
20. Floodplain — Yes ____ No ____
21. Landscaping — Yes ____ No ____
22. Navigable Air Space — Yes ____ No ____
23. Clearing or Excavation — Yes ____ No ____
24. Archaeological Resources — Yes ____ No ____
25. Underground Injection — Yes ____ No ____
26. Underground Storage Tanks — Yes ____ No ____
27. Public Utilities or Services — Yes ____ No ____
28. Depletion of a Non-Renewable Resource — Yes ____ No ____

C. For projects occurring outside of ANL complete Section C as well as Sections A and B. NOT APPLICABLE

29. Prime, Unique, or Locally Important Farmland — Yes ____ No ____
30. Special Sources of Groundwater (such as sole source aquifer) — Yes ____ No ____
31. Coastal Zones — Yes ____ No ____

32. Areas with Special National Designations (such as National Forests, Parks, or Trails) Yes ____ No ____

33. Action of a State Agency in a State with NEPA-type Law Yes ____ No ____

34. Class I Air Quality Control Region Yes ____ No ____

IV. Subpart D Determination: (to be completed by DOE/ASO)

Are there any extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal? Yes ____ No X

Is the project connected to other actions with potentially significant impacts or related to other proposed action with cumulatively significant impacts? Yes ____ No X

If yes, is a categorical exclusion determination precluded by 40 CFR 1506.1 or 10 CFR 1021.211? Yes ____ No ____

Can the project or activity be categorically excluded from preparation of an Environment Assessment or Environmental Impact Statement under Subpart D of the DOE NEPA Regulations? Yes X No ____

If yes, indicate the class or classes of action from Appendix A or B of Subpart D under which the project may be excluded. Appendix B, Category B 1.23 Demolition and disposal of buildings, and Category B 1.31 Installation or relocation of machinery and equipment.

If no, indicate the NEPA recommendation and class(es) of action from Appendix C or D to Subpart D to Part 1021 of 10 CFR.

ASO NEPA Coordinator Review: Kaushik Joshi

Signature: RNJoshi Date: 7-17-2015

ASO NCO Approval of CX Determination:

The preceding pages are a record of documentation that an action may be categorically excluded from further NEPA review under DOE NEPA Regulation 10 CFR Part 1021.400. I have determined that the proposed action meets the requirements for the Categorical Exclusion identified above.

Signature: Date: 7/17/2015

Peter R. Siebach
Acting Argonne Site Office NCO

ASO NCO EA or EIS Recommendation: N/A

Class of Action: _____

Signature: _____ Date: _____

Peter R. Siebach
Acting Argonne Site Office NCO

Concurrence with EA or EIS Recommendation: N/A

CH GLD: _____

Signature: _____ Date: _____

ASO Manager Approval of EA or EIS Recommendation: N/A

An ☐ EA ☐ EIS shall be prepared for the proposed _____ and

_____ shall serve as the document manager.

Signature: _____ Date: _____

Dr. Joanna M. Livengood
Manager