Appendix E

Susquehanna Steam Electric Station Units 1 and 2

Applicant's Environmental Report - Operating License Renewal Stage

PPL Susquehanna, LLC
One Team One Commitment

Appendix E
Applicant's Environmental Report –
Operating License Renewal Stage
Susquehanna Steam Electric Station

PPL Susquehanna, LLC

Unit 1

Docket No. 50-387

License No. NPF-014

Unit 2

Docket No. 50-388

License No. NPF-022

September 2006

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ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
AEC	Atomic Energy Commission
AEPS	Alternative Energy Portfolios Standards Act
BASD	Berwick Area School District
BTU	British Thermal Unit
BWR	Boiling Water Reactor
°C	Degrees Celsius
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act
DEP	[Pennsylvania] Department of Environmental Protection
DSM	Demand-Side Management
EPA	[U.S.] Environmental Protection Agency
EPP	Environmental Protection Plan
EPU	Extended Power Uprate
ESA	Endangered Species Act
°F	degrees Fahrenheit
FES	Final Environmental Statement
fps	feet per second
FSAR	Final Safety Analysis Report
FWS	[U.S.] Fish and Wildlife Service
GE	General Electric
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants
gpd	gallons per day
gpm	gallons per minute
GW	groundwater
HPS	Hunlock Power Station
IPA	Integrated Plant Assessment
kWh	kilowatt hours
KOZ	Keystone Opportunity Zone
MGD	million gallons per day
MM	million
MSA	Metropolitan Statistical Area
MW	Megawatt
MWe	Megawatts-electric
MWt	Megawatts-thermal
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act

NESC	National Electrical Safety Code
NMFS	National Marine Fisheries Services
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	[U.S.] Nuclear Regulatory Commission
PNHP	Pennsylvania Natural Heritage Program
PJM	Pennsylvania, New Jersey, Maryland [power pool]
PM_{10}	particulates with diameters less than 10 microns
$PM_{2.5}$	particulates with diameters less than 2.5 microns
ppt	parts per thousand
PPUC	Pennsylvania Public Utilities Commission
PSDC	Pennsylvania State Data Center
PURTA	Pennsylvania Utility Realty Tax Act
PWS	Public Water Supply
SAMA	Severe Accident Mitigation Alternatives
SCR	Selective catalytic reduction
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SMITTR	Surveillance, Monitoring, Inspections, Testing, Trending, and Recordkeeping
SO_2	sulfur dioxide
SO_x	sulfur oxides
SRBC	Susquehanna River Basin Commission
SSES	Susquehanna Steam Electric Station
SW	surface water
TSP	total suspended particulates
USCB	U.S. Census Bureau

1.0 INTRODUCTION

1.1 PURPOSE OF AND NEED FOR ACTION

The U.S. Nuclear Regulatory Commission (NRC) licenses the operation of domestic nuclear power plants in accordance with the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. PPL Susquehanna, LLC (PPL Susquehanna) operates the Susquehanna Steam Electric Station (SSES) Units 1 & 2, pursuant to NRC Operating Licenses NPF-014 and NPF-022, respectively. The license for Unit 1 will expire July 17, 2022 and the license for Unit 2 will expire March 23, 2024. PPL Susquehanna has prepared this environmental report in conjunction with its application to NRC to renew the SSES operating licenses, as provided by the following NRC regulations:

> Title 10, Energy, Code of Federal Regulations (CFR), Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, Section 54.23, Contents of Application-Environmental Information (10 CFR 54.23) and

> Title 10, Energy, CFR, Part 51, Environmental Protection Requirements for Domestic Licensing and Related Regulatory Functions, Section 51.53, Postconstruction Environmental Reports, Subsection 51.53(c), Operating License Renewal Stage [10 CFR 51.53(c)].

NRC has defined the purpose and need for the proposed action, the renewal of the operating license for nuclear power plants such as SSES, as follows:

> "...The purpose and need for the proposed action (renewal of an operating license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision makers." (NRC 1996a)

The renewed operating licenses would allow an additional 20 years of plant operation beyond the current SSES licensed operating period of approximately 40 years.

1.2 ENVIRONMENTAL REPORT SCOPE AND METHODOLOGY

NRC regulations for domestic licensing of nuclear power plants require environmental review of applications to renew operating licenses. The NRC regulation 10 CFR 51.53(c) requires that an applicant for license renewal submit with its application a separate document entitled Applicant's Environmental Report - Operating License Renewal Stage. In determining what information to include in the SSES Environmental Report, PPL Susquehanna has relied on NRC regulations and the following supporting documents that provide additional insight into the regulatory requirements:

- NRC supplemental information in the Federal Register (NRC 1996a, 1996b, 1996c, and 1999a)
- Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996d and 1999b)
- Regulatory Analysis for Amendments to Regulations for the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses (NRC 1996e)
- Public Comments on the Proposed 10 CFR Part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents: Review of Concerns and NRC Staff Response (NRC 1996f)
- Supplement 1 to Regulatory Guide 4.2, Preparation of Supplemental Environmental Report for Applications to Renew Nuclear Power Plant Operating Licenses (NRC 2000)

PPL Susquehanna has prepared Table 1.2-1 to verify conformance with regulatory requirements. Table 1.2-1 indicates where the environmental report responds to each requirement of 10 CFR 51.53(c). In addition, each responsive section is prefaced by a boxed quote of the regulatory language and applicable supporting document language.

Table 1.2-1. Environmental Report Responses to License Renewal Environmental Regulatory Requirements

Regulatory Requirement	Responsive Environmental Report Section(s)
10 CFR 51.53(c)(1)	Entire Document
10 CFR 51.53(c)(2), Sentences 1 and 2	3.0 Proposed Action
10 CFR 51.53(c)(2), Sentence 3	7.2.2 Environmental Impacts of Alternatives
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(1)	4.0 Environmental Consequences of the Proposed Action and Mitigating Actions
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(2)	6.3 Unavoidable Adverse Impacts
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(3)	7.0 Alternatives to the Proposed Action
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(3)	8.0 Comparison of Environmental Impacts of License Renewal with the Alternatives
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(4)	6.5 Short-Term Use Versus Long-Term Productivity of the Environment
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(5)	6.4 Irreversible and Irretrievable Resource Commitments
10 CFR 51.53(c)(2) and 10 CFR 51.45(c)	4.0 Environmental Consequences of the Proposed Action and Mitigating Actions
10 CFR 51.53(c)(2) and 10 CFR 51.45(c)	6.2 Mitigation
	7.2.2 Environmental Impacts of Alternatives
	8.0 Comparison of Environmental Impacts of License Renewal with the Alternatives
10 CFR 51.53(c)(2) and 10 CFR 51.45(d)	9.0 Status of Compliance

Table 1.2-1. Environmental Report Responses to License Renewal Environmental Regulatory Requirements (continued)

Regulatory Requirement	Responsive Environmental Report Section(s)	
10 CFR 51.53(c)(2) and 10 CFR 51.45(e)	4.0	Environmental Consequences of the Proposed Action and Mitigating Actions
10 CFR 51.53(c)(2) and 10 CFR 51.45(b)(2)	6.3	Unavoidable Adverse Impacts
10 CFR 51.53(c)(3)(ii)(A)	4.1	Water Use Conflicts (Plants with Cooling Ponds or Cooling Towers Using Makeup Water from a Small River with Low Flow)
10 CFR 51.53(c)(3)(ii)(A)	4.6	Groundwater Use Conflicts (Plants Using Cooling Water Towers or Cooling Ponds and Withdrawing Makeup Water from a Small River)
10 CFR 51.53(c)(3)(ii)(B)	4.2	Entrainment of Fish and Shellfish in Early Life Stages
10 CFR 51.53(c)(3)(ii)(B)	4.3	Impingement of Fish and Shellfish
10 CFR 51.53(c)(3)(ii)(B)	4.4	Heat Shock
10 CFR 51.53(c)(3)(ii)(C)	4.5	Groundwater Use Conflicts (Plants Using >100 gpm of Groundwater)
10 CFR 51.53(c)(3)(ii)(C)	4.7	Groundwater Use Conflicts (Plants Using Ranney Wells)
10 CFR 51.53(c)(3)(ii)(D)	4.8	Degradation of Groundwater Quality
10 CFR 51.53(c)(3)(ii)(E)	4.9	Impacts of Refurbishment on Terrestrial Resources
	4.10	Threatened or Endangered Species
10 CFR 51.53(c)(3)(ii)(F)	4.11	Air Quality During Refurbishment (Non-Attainment Areas)
10 CFR 51.53(c)(3)(ii)(G)	4.12	Microbiological Organisms

Table 1.2-1. Environmental Report Responses to License Renewal Environmental Regulatory Requirements (continued)

Regulatory Requirement	Responsive Environmental Report Section(s)
10 CFR 51.53(c)(3)(ii)(H)	4.13 Electric Shock from Transmission-Line-Induced Currents
10 CFR 51.53(c)(3)(ii)(I)	4.14 Housing Impacts
10 CFR 51.53(c)(3)(ii)(I)	4.15 Public Utilities: Public Water Supply Availability
10 CFR 51.53(c)(3)(ii)(I)	4.16 Education Impacts from Refurbishment
10 CFR 51.53(c)(3)(ii)(I)	4.17 Offsite Land Use
10 CFR 51.53(c)(3)(ii)(J)	4.18 Transportation
10 CFR 51.53(c)(3)(ii)(K)	4.19 Historic and Archaeological Resources
10 CFR 51.53(c)(3)(ii)(L)	4.20 Severe Accident Mitigation Alternatives
10 CFR 51.53(c)(3)(iii)	4.0 Environmental Consequences of the Proposed Action and Mitigating Actions
10 CFR 51.53(c)(3)(iii)	6.2 Mitigation
10 CFR 51.53(c)(3)(iv)	5.0 Assessment of New and Significant Information
10 CFR 51, Appendix B, Table B-1, Footnote 6	2.6.2 Minority and Low-Income Populations

1.3 SUSQUEHANNA STEAM ELECTRIC STATION LICENSEE AND OWNERSHIP

Ownership of the station is shared by PPL Susquehanna, LLC, Berwick, PA (90 percent) and Allegheny Electric Cooperative Inc., Harrisburg, PA (10 percent). PPL Susquehanna, LLC, is a subsidiary of PPL Generation, LLC, which is a subsidiary of PPL Energy Supply, LLC, which is a subsidiary of PPL Corporation based in Allentown, PA. PPL Corporation generates electricity at power plants in the northeastern and western United States; markets energy throughout the United States and Canada; provides energy services for businesses in the mid-Atlantic and northeastern U.S.; and delivers energy to customers in Pennsylvania, the United Kingdom and Latin America. PPL Susquehanna is the licensed operator of SSES (PPL 2004).

1.4 REFERENCES

Note to reader: Some web pages cited in this document are no longer available, or are no longer available through the original URL addresses. Hard copies of cited web pages are available in PPL Susquehanna files. Some sites, for example the census data, cannot be accessed through their given URLs. The only way to access these pages is to follow queries on previous web pages. The complete URLs used by PPL Susquehanna have been given for these pages, even though they may not be directly accessible. Also, all references are specific to respective chapter.

NRC (U.S. Nuclear Regulatory Commission). 1996a. "Environmental Review for Renewal of Nuclear Power Plant Operating Licenses." Federal Register. Vol. 61, No. 109. June 5.

NRC (U.S. Nuclear Regulatory Commission). 1996b. "Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Correction." Federal Register. Vol. 61, No. 147. July 30.

NRC (U.S. Nuclear Regulatory Commission). 1996c. "Environmental Review for Renewal of Nuclear Power Plant Operating Licenses." Federal Register. Vol. 61, No. 244. December 18.

NRC (U.S. Nuclear Regulatory Commission). 1996d. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Volumes 1 and 2.* NUREG-1437. Washington, DC. May.

NRC (U.S. Nuclear Regulatory Commission). 1996e. *Regulatory Analysis for Amendments to Regulations for the Environmental Review for Renewal of Nuclear Power Plant Operating Licenses.* NUREG-1440. Washington, DC. May.

NRC (U.S. Nuclear Regulatory Commission). 1996f. *Public Comments on the Proposed 10 CFR Part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents: Review of Concerns and NRC Staff Response. Volumes 1 and 2.* NUREG-1529. Washington, DC. May.

NRC (U.S. Nuclear Regulatory Commission). 1999a. "Changes to Requirements for Environmental Review for Renewal of Nuclear Power Plant Operating Licenses; Final Rule." Federal Register. Vol. 64, No. 171. September 3.

NRC (U.S. Nuclear Regulatory Commission). 1999b. Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS). Section 6.3, "Transportation" and Table 9-1, "Summary of findings on NEPA issues for license renewal of nuclear power plants." NUREG-1437. Volume 1, Addendum 1. Washington, DC. August.

NRC (U.S. Nuclear Regulatory Commission). 2000. Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses; Supplement 1 to Regulatory Guide 4.2. Washington, DC. September.

PPL. 2004. Susquehanna Energy Information Center. Available at: http://www.pplweb.com/community/seic/index.htm. Accessed June 2, 2004.

2.0 SITE AND ENVIRONMENTAL INTERFACES

2.1 LOCATION AND FEATURES

Susquehanna Steam Electric Station (SSES) is located in Salem Township, Luzerne County, Pennsylvania, along the Susquehanna River in an area of open deciduous woodlands, interspersed with grasslands and orchards (PPL 2005). The largest community within 10 miles of the site is the borough of Berwick, Pennsylvania, approximately five miles southwest of SSES. The nearest major metropolitan areas are Wilkes-Barre, Pennsylvania, approximately 20 miles to the northeast; Allentown, Pennsylvania, approximately 50 miles to the southeast; and Harrisburg, Pennsylvania, approximately 70 miles southwest of the SSES site (NRC 1981). Figures 2.1-1 and 2.1-2 are the 50-mile and 10-mile vicinity maps, respectively.

PPL Susquehanna owns 2,355 acres on both sides of the Susquehanna River (Fields 2005). SSES is on the west side of the Susquehanna River on 1,574 acres, that includes the SSES property (1,173 acres) and the Riverlands Recreation Area (401 acres), a strip of land between the power generating facilities and the Susquehanna River (PPL 2004; Figure 2.1-3). Land on the west side of the river is jointly owned with Allegheny Electric Cooperative (10%). The Riverlands Recreation Area includes natural and recreational areas (PPL 2004):

- Riverlands Nature Center. The Nature Center is located in the Susquehanna Energy Information Center at the entrance to the Recreation Area (Figure 2.1-3).
- Riverlands Recreation Area. This recreation area on the west side of the river is a popular spot for picnicking, group outings, hiking, sports, and playing.
- Lake Took-A-While. A 30-acre fishing lake and a restored section of the North Branch Canal provide fishing opportunities and are open to the public. Boating is allowed, but no gasoline engines are permitted.
- Wetlands Nature Area. This 94-acre tract of riverine forest, marsh, swamp, and vernal pools has been set aside as an area for nature study and education. A portion of the long-abandoned North Branch Canal runs north-south across the property.

US Route 11 separates the SSES property from the Riverlands Recreation Area. The developed portion of the SSES property is approximately 487 acres, 233 acres of which are within the Protected Area (see Figure 2.1-3). The Protected Area is surrounded by security fencing; access to this part of the site is through the main entrance off US Route 11 (Fields 2005).

Figure 2.1-1. 50 Mile-Vicinity Map.

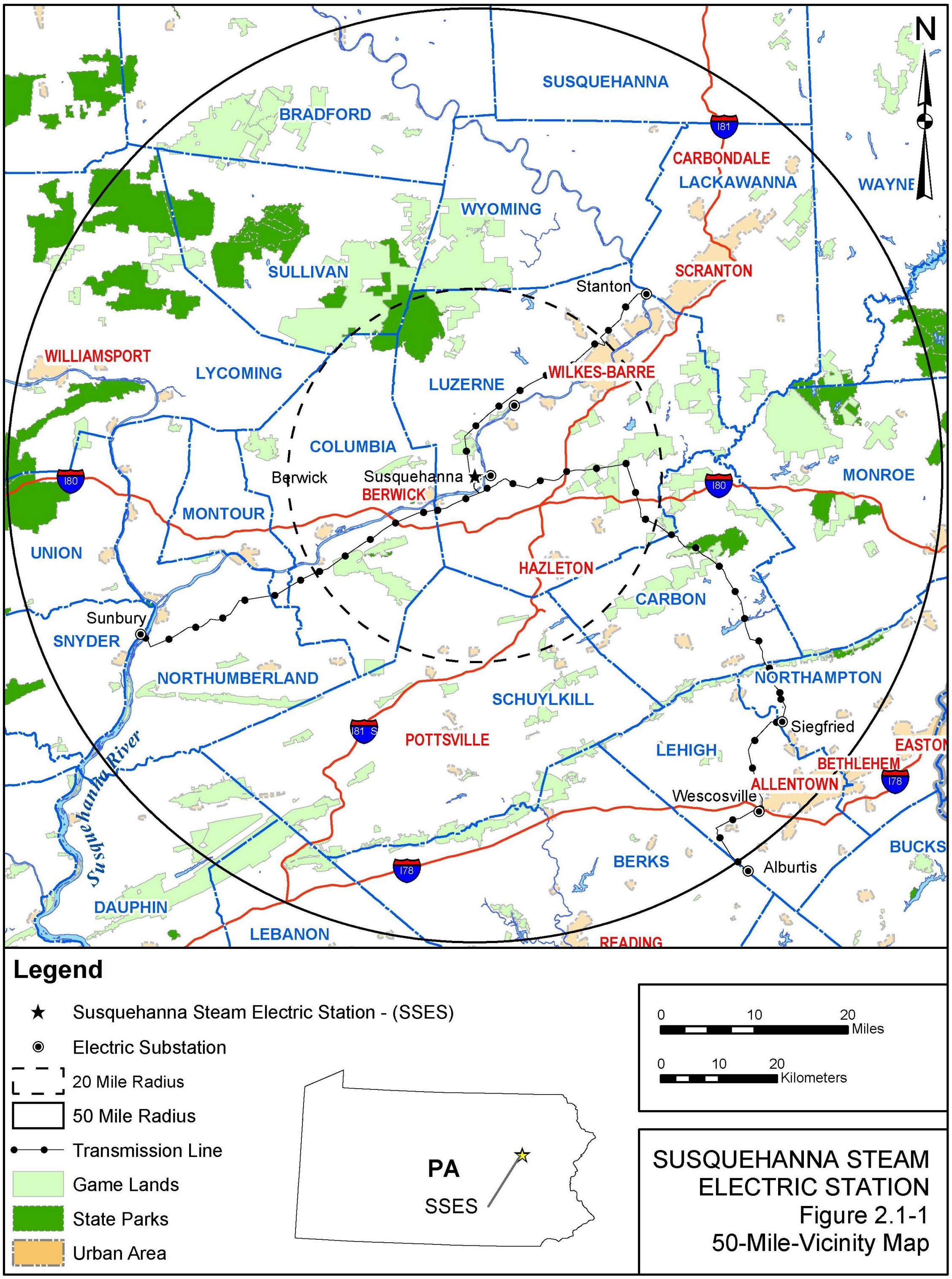


Figure 2.1-2. 10-Mile Vicinity Map

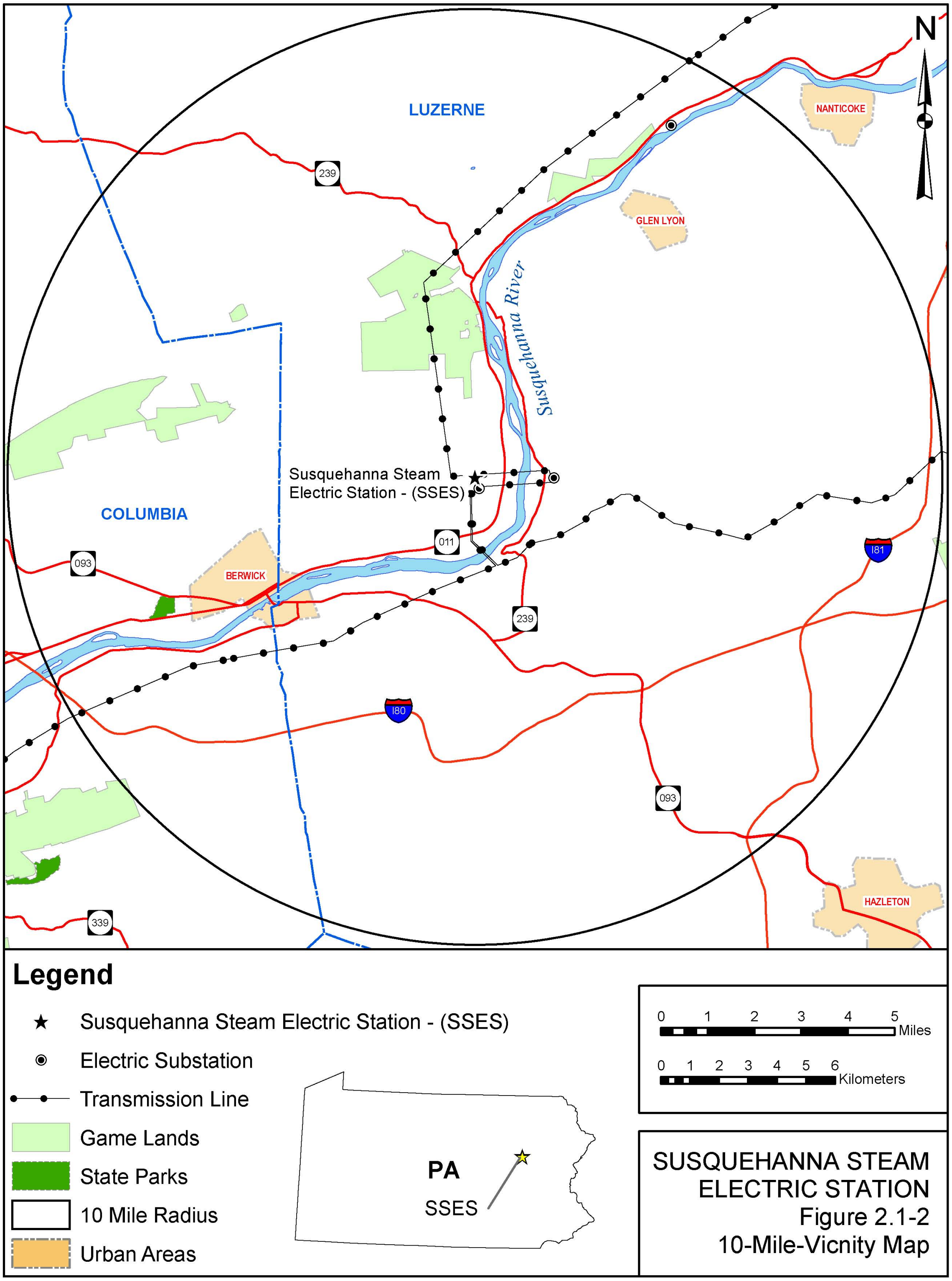
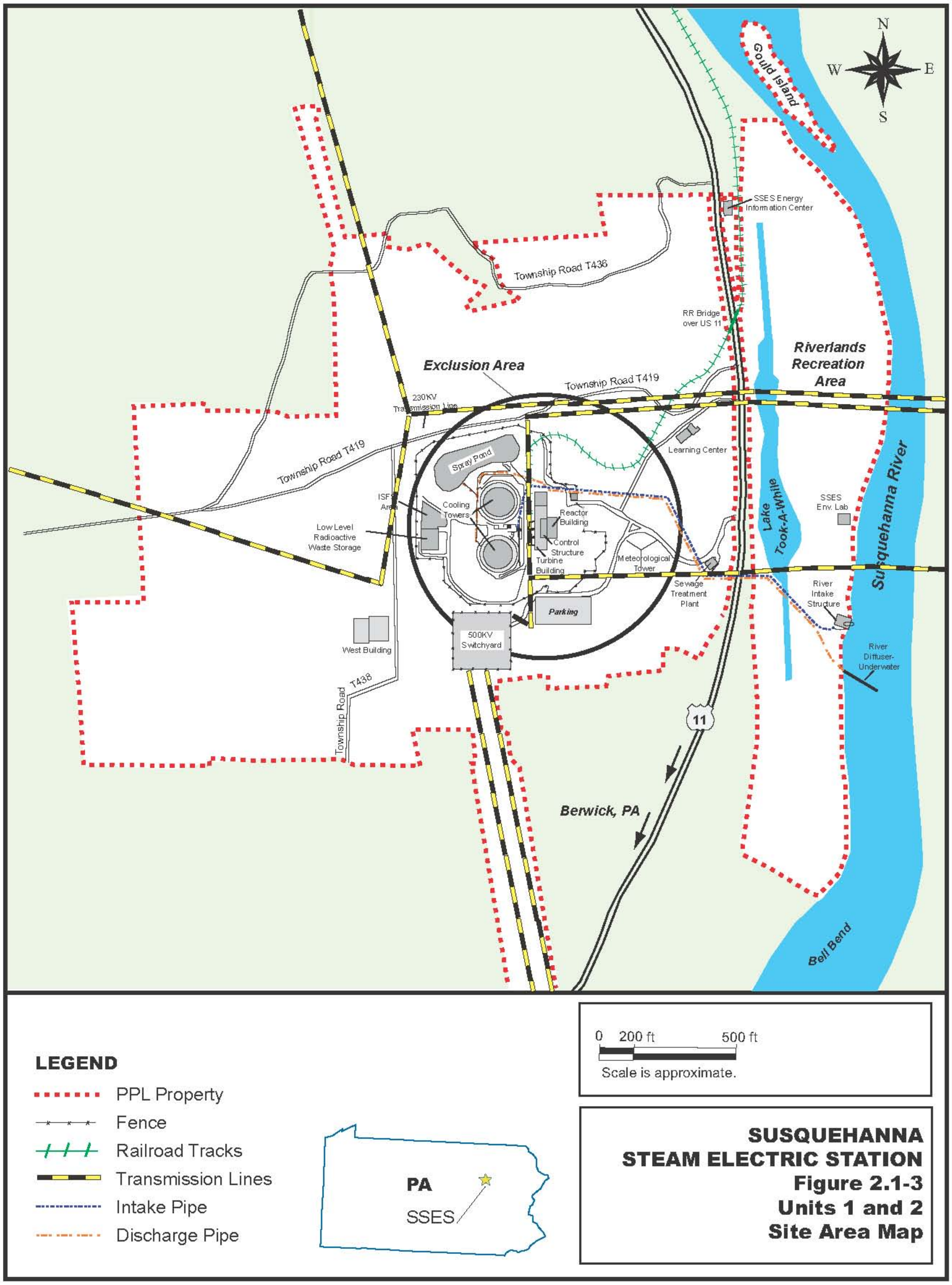


Figure 2.1-3. Site Area Map



The property also includes a 401 acre nature preserve known as the Susquehanna Riverlands. PPL Susquehanna owns 717 of these mostly undeveloped acres on the east side of the Susquehanna River (Fields 2005). This includes approximately 275 acres of natural, recreational, and wildlife lands. Council Cup Scenic Overlook (88 acres), a 700-foot-high bluff that affords a spectacular view of the Susquehanna River Valley, is the dominant natural topographic feature of the Susquehanna Riverlands (PPL 2004). This scenic overlook was used in the past as a lookout and meeting place for Native Americans. Gould Island, a 65-acre island that lies just upstream of the Riverlands Area, is owned by PPL Susquehanna (PPL 2004).

The SSES reactors are on a rolling plateau above the river at an approximate elevation of 675 feet above mean sea level (NRC 1981). SSES consists of two boiling water reactors, Unit 1 and Unit 2, with electrical capability of 1,300 MWe each (PPL 2005; Detamore 2004). The net capacity will be approximately 2,510 MWe for both units after the extended power uprate is approved by the NRC. The units share a common control room, refueling floor, turbine operating deck, radwaste system, and other auxiliary systems (PPL 2005).

Section 3.1 describes key features of SSES, including reactor and containment systems, cooling water system, and transmission system.

2.2 AQUATIC ECOLOGY

PPL Susquehanna has conducted studies of water quality and aquatic organisms in the Susquehanna River up- and downstream of SSES since 1971. This long-term monitoring program has made it possible for PPL Susquehanna to monitor the overall health of the Susquehanna River and its aquatic communities in the vicinity of SSES and to identify any chronic or recurring water quality problems or obvious impacts to aquatic communities that might be traced to operation of SSES. The comprehensive monitoring program that assessed water quality, algae (periphyton and phytoplankton), benthic macroinvertebrates, and fish from 1971 to 1994 was reduced in scope in 1995 to focus on water quality and fish populations as key indicators of possible SSES-related impacts.

2.2.1 Hydrology

The Susquehanna River flows south more than 440 miles from its source, Lake Otsego in south-central New York, to Havre de Grace, Maryland, where it empties into the Chesapeake Bay. It drains an area of about 27,500 square miles and supplies approximately 19 million gallons of fresh water per minute to the Chesapeake Bay, about half of the Bay's total freshwater inflow (Alliance for the Chesapeake Bay undated; Smithsonian Environmental Research Center 2003).

PPL Susquehanna monitors Susquehanna River levels at SSES and uses these measurements to estimate flows at the station, based on established river level – flow relationships. In 2004, Susquehanna River flow was above average every month except February, April and June. It was a year with above average precipitation primarily caused by the remnants of four hurricanes passing through the Susquehanna drainage. Daily mean flow ranged from 2,970 cubic feet per second (cfs) (July 8) to 204,000 cfs (September 19). Average monthly (daily mean) flows ranged from 6,970 cfs (February) to 38,200 cfs (September) (Ecology III 2005).

The Susquehanna River at SSES shows a predictable annual pattern of temperatures, with lowest temperatures in winter and highest temperatures in late summer. River temperature was monitored from February 18 to December 31, 2004. A new recorder was installed on February 18 to replace the old one which was destroyed by a lightning strike. In 2004, daily mean river temperatures ranged from 0.1° C (32.2° F, December 21) to 26.2° C (79.2° F, July 5), while average monthly mean temperatures ranged from 1.6° C (34.9° F) in February to 24.1° C (75.4° F) in July (Ecology III 2005).

2.2.2 Water Quality

Water quality in the Susquehanna River in the area of SSES has improved steadily since PPL Susquehanna began monitoring in 1971. This improvement has been attributed to a reduction in mine drainage pollutants from upstream sources and a reduction in point source pollutants from upstream municipal water treatment plants and industrial facilities following the enactment of the Clean Water Act in 1972. From 1973 through 2004, there was a decreasing trend in levels of turbidity, sulfate, total iron, total solids, and total suspended solids and an increasing trend in pH, total alkalinity, and dissolved oxygen concentrations (Ecology III 2005). The most noticeable change in 32 years of water quality monitoring at SSES has been the reduction in total iron levels in this reach of the Susquehanna River. Most, if not all, of these water quality improvements were associated with the demise of anthracite coal mining in the Wyoming Valley region upriver of SSES in the 1970s (Ecology III 2005).

2.2.3 Aquatic Communities

Prior to 1995, PPL Susquehanna monitored algae (periphyton and phytoplankton) and benthic macroinvertebrates at an upriver control station (SSES) and two downriver indicator stations (Bell Bend and Bell Bend I). In 1994, the last year in which collections were made, totals of 42, 39, and 40 genera of periphyton were found at SSES, Bell Bend, and Bell Bend I locations, respectively (Ecology III 1995). Diatoms comprised 83, 75, and 76 percent, respectively, of all attached algal cells at the three sites. Densities of periphyton at both the control and indicator sites decreased in operational years compared to pre-operational years. Also, the composition of the periphyton shifted from mainly green algae and diatoms during the pre-operational years to mainly diatoms in the operational years. These changes occurred at both control and indicator sites, and were therefore not related to SSES operations (Ecology III 1995).

Benthic macroinvertebrates were monitored at control and indicator locations from 1980 through 1994. Trichopterans (caddisflies) and ephemeropterans (mayflies) dominated collections at the control site in both pre-operational (1980-1982) and operational (1983-1994) years, but ephemeropterans became relatively more abundant in the 1990s (Ecology III 1995). Ephemeropterans made up the bulk of macroinvertebrates (by weight) at indicator sites in most years. Overall, the ephemeropterans made up a “major portion” of the biomass in each year after 1983, when SSES began operating (Ecology III 1995). Ephemeropterans, which dominated collections at both control and indicator sites, are widely regarded as a pollution-sensitive group that is an indicator of good water quality (Michigan State University 1997, Pennsylvania Sea Grant 2003, EPA 2003a).

PPL Susquehanna monitors Susquehanna River fish populations at a control station (two sites, one along the east bank and one along the west bank) upriver of the SSES river intake structure and at an indicator station (east and west bank sites) at Bell Bend downriver of the discharge diffuser. Fish are collected by electrofishing and seining in spring, summer, and fall at study sites established in 1976 and sampled in the same manner since that time.

In 2004, 993 fish of 21 species were collected at control and indicator locations (Ecology III 2005). Quillback was the most abundant species at both control and indicator locations, making up 22 percent and 23 percent of all fish collected, respectively (Ecology III 2005). Smallmouth bass and walleye ranked second and third in abundance at both control and indicator locations. Species richness was higher at the indicator location (20 species) than the control location (17 species) (Ecology III 2005). This was due primarily to a greater diversity of Lepomids (sunfish) at the indicator sites downriver of the SSES discharge diffuser.

Statistical analysis of electrofishing collections (number of fish per sample) indicated that seven species experienced significant post-operational declines at Bell Bend (indicator) sites relative to SSES (control) sites: quillback, white sucker, northern hogsucker, shorthead redhorse, muskellunge, rock bass, and smallmouth bass. Some of these apparent declines were attributed to “greater increases” at control sites, meaning that local populations appeared to expand more rapidly at upriver control sites than downriver indicator sites; others were attributed to “greater decreases” at indicator sites, meaning that local populations appeared to decline more rapidly at downriver indicator sites than upriver control sites.

Seining at control and indicator locations in 2004 collected 897 fish of 12 species (Ecology III 2005). Samples were numerically dominated by bluntnose minnow and two shiner species, the spotfin shiner and the spottail shiner, which together made up 83 percent and 94 percent, of all fish collected by seine at control and indicator locations respectively, (Ecology III 2005). Bluntnose minnow was the most commonly captured species at control sites (37 percent of fish collected), as was spottail shiner at indicator sites (45 percent of fish collected).

Eleven species (of the 12 species collected) were collected at both the control and indicator sites, and at both locations minnows and sunfish dominated samples. The number of fish collected at the SSES control location was approximately one-fourth (24 percent) the number collected at the Bell Bend indicator location, a trend observed for the last several years.

Based on fish studies conducted annually since 1976, the Susquehanna River in the vicinity of SSES supports a diverse assemblage of coolwater and warmwater fishes including Notropids (minnows), Catastomids (suckers), Ictalurids (catfish), Centrarchids (sunfish), and Percids (darters and perch). There is no indication that pollution-tolerant species or groups are predominant or that sensitive or pollution-intolerant species are rare or absent. Water quality improvement in the 1970s and 1980s brought fishermen back to the river in increasing numbers (Ecology III 1987). Creel surveys conducted in 1986 in the vicinity of SSES revealed that muskellunge, smallmouth bass, and walleye were the species most often sought by anglers and walleye, channel catfish, and smallmouth bass were the species most often caught. Although no recent creel data are available, anecdotal information suggests that these same species continue to be sought and harvested by fishermen in the vicinity of SSES. Smallmouth bass fishing appears to be growing in popularity; however, as the quality of the smallmouth bass fishing improves.

2.3 GROUNDWATER RESOURCES

SSES is located in the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. The site is on a relatively flat plateau south of a ridge and overlooking the Susquehanna River floodplain to the east. Both the plateau and the floodplain are underlain by a weathered overburden of glacial till and outwash. This material ranges from gravel-boulders (adjacent to bedrock) to sand and silt nearer the surface (AEC 1973). The depth of overburden varies across the site from 0 to 125 feet (PPL 2005). Beneath the overburden the bedrock consists of the Devonian Mahantango Formation which is a siltstone with a well-developed joint system. The Mahatango bedding is delineated by sandstone stringers and is composed of upper and lower members with the lower unit being more calcareous and resistant to erosion. Beneath the Mahantango Formation are older shale deposits of the Marcellus Formation (PPL 2005) and deeper still is the Onandaga Formation (AEC 1973). These three formations formed in the Devonian period of the Paleozoic era (around 390 million years ago). The Mahatango and Marcellus Formations vary to approximately 1,100 and 400 feet thick, respectively, in the area (PPL 2005). The predominantly siltstone strata of the Mahantango Formation constitutes a limited source of domestic water, but due to its relatively low yield is not considered a local aquifer (PPL 2005). The Onandaga Formation consists of a non-cherty limestone approximately 1,000 feet beneath the site (AEC 1973).

Two general types of aquifers occur in the region. The first consists of the sandstone and occasional limestone strata that occur within the predominant shales of the Paleozoic rock. The second exists in the unconsolidated overburden material that is for the most part Pleistocene stratified drift, till, or kames (laid down within the last 70 million years). Within two miles of SSES most groundwater wells are completed in the bedrock shales (PPL 2005).

SSES is not located in a recharge area for any aquifer; however, recharge to the unconsolidated sand and gravel does occur over the site. Groundwater movement on the site is generally in an easterly direction and ultimately discharges to the Susquehanna River (PPL 2005).

2.4 CRITICAL AND IMPORTANT TERRESTRIAL HABITATS

PPL Susquehanna owns 2,355 acres on both sides of the Susquehanna River. Approximately 487 acres are used for generation facilities and associated maintenance facilities, laydown areas, parking lots, and roads, and approximately 130 acres is leased to local farmers (Fields 2005). The remainder of the site is primarily river floodplain forest, upland forest, and marshes (NRC 1981, Jaquith 1999). The river floodplain forest at SSES is dominated by silver maple, river birch, and Northern red oak. The upland forest is dominated by Virginia pine, sweet birch, flowering dogwood, white oak, Northern red oak, black oak, and yellow poplar. The marsh is dominated by a variety of emergent vegetation such as sedges, bulrush, cattail, and cutgrass (NRC 1981).

The PPL Susquehanna property includes the Susquehanna Riverlands a 401 acre nature preserve that is used for outdoor recreation, Wetlands Nature Area, and wildlife habitat on the west bank of the river. On the east side of the river is the Council Cup Scenic Overlook, a 700-foot-high bluff and natural area (PPL 2004). Also, there are approximately 275 acres of natural, recreational, and wildlife lands on the east side of the river.

Numerous wildlife species occur in the forests and marshes at SSES. Common mammals include Eastern cottontail, white-tailed deer, opossum, raccoon, and a variety of small rodents such as the Eastern gray squirrel, meadow vole, and deer mouse. Beavers and muskrats are common in the marshes and along the river shoreline (NRC 1981, Jaquith 1999).

A variety of reptiles and amphibians inhabit SSES. The most commonly observed snakes are the Eastern garter snake, black rat snake, and the Northern water snake. Common turtles in riparian and wetland areas include the Eastern painted turtle, snapping turtle, wood turtle, and spotted turtle. The Eastern box turtle is common in the upland forests. Common amphibians include American toads, spring peepers, Southern leopard frogs, green frogs, red-backed salamanders, slimy salamanders, and red-spotted newts (Jaquith 1999).

The National Audubon Society has designated the Susquehanna Riverlands as an Important Bird Area in Pennsylvania because of the extensive riparian forests and the numerous bird species that utilize the area. Birds characteristic of the river floodplain forests at SSES include the yellow-throated vireo, tufted titmouse, American redstart, and blue-grey gnatcatcher. Birds associated specifically with wetlands at SSES include the swamp sparrow, Virginia rail, and waterfowl such as the wood duck and mallard. Common upland birds species at SSES include the wood thrush, red-eyed vireo, scarlet tanager, eastern wood pewee, blue jay, and red-tailed hawk (Jaquith 1999).

Section 3.1.3 describes the transmission lines that were built to connect SSES to the transmission systems. The principal land-use categories crossed by the transmission corridors are agriculture and hardwood forest (PPL Electric Utilities Corp 2004). The SSES-associated transmission corridors are maintained by trimming or removal of undesirable vegetation from the floor and sides of the corridors, and by use of herbicides (PPL Electric Utilities Corp 2004). Transmission lines are patrolled annually by helicopter. Herbicide application includes stump treatment, basal application, and foliar application, and is done by certified applicators according to label specifications. Small and large shrubs, and small trees such as flowering dogwood, redbud, hawthorn, cedar, and dwarf willow within the transmission corridors are preserved to the greatest extent possible. In addition, taller trees are preserved when on gullies, ravines, or hillsides where topography is such that the trees will never reach the wire security zone (PPL Electric Utilities Corp 2004).

The SSES transmission lines do not cross any national parks or other federal lands, but several State Game Lands are crossed. State Game Lands are publicly owned lands managed by the Pennsylvania Game Commission that are set aside for the protection, propagation, and management of game and wildlife; these lands provide areas for public hunting and trapping. The Sunbury corridor crosses State Game Lands No. 58. The Stanton corridor crosses State Game Lands No. 260. The Alburtis corridor crosses State Game Lands Nos. 187, 149, 141, and 168, and Hickory Run State Park. No areas designated by the US Fish and Wildlife Service (FWS) as “critical habitat” for threatened or endangered species exist at SSES or along or adjacent to transmission lines.

2.5 THREATENED OR ENDANGERED SPECIES

Animal and plant species that are state-or federally-listed as endangered or threatened and recorded in counties within which SSES and its associated transmission lines are located are listed in Table 2.5-1. Counties crossed by the transmission lines are Luzerne (the location of SSES), Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, and Snyder. The species included in Table 2.5-1 are those that meet at least one of the following conditions:

- Records maintained by the U.S. Fish and Wildlife Service (FWS) indicate that the species is known to occur in Luzerne, Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, or Snyder counties, and the species is federally-listed as endangered, threatened, proposed for federal listing, or is a candidate for federal listing (FWS 2004).
- Records maintained by the Pennsylvania Natural Heritage Program (PNHP) indicate that the species has been verified since 1980 to occur in Luzerne, Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, or Snyder counties, and the species is state-listed as endangered or threatened (PDCNR 2004; 2005).
- The species has been observed in the vicinity of SSES by Ecology III biologists while conducting environmental studies at SSES (Ecology III 1995), and is state- or federally-listed.

The Susquehanna River and riparian wetlands near the river at SSES are utilized by several special-status bird species, especially during autumn and spring migrations. Ospreys (*Pandion haliaetus*) and bald eagles (*Haliaeetus leucocephalus*) have become relatively common along the river near SSES during migrations and bald eagles winter along the Susquehanna River in Luzerne and Columbia counties (Ecology III 1995). Peregrine falcons (*Falco peregrinus*), short-eared owls (*Asio flammeus*), American bitterns (*Botaurus lentiginosus*), least bitterns (*Ixobrychus exilis*), and great egrets *(Ardea alba)* are occasionally observed at SSES. The sedge wren (*Cistothorus platensis*), upland sandpiper (*Bartramia longicauda*), and black tern (*Chlidonias niger*) have each been recorded only once at SSES (Ecology III 1995). None of the bird species listed in Table 2.5-1 is known to nest at SSES (Ecology III 1995). Osprey nests have been recorded in Luzerne, Carbon, and Northampton counties, and the upland sandpiper is known to nest in Northumberland County (PCDNR 2004).

Four species in Table 2.5-1 are federally-listed as endangered or threatened. Indiana bats (*Myotis sodalis*), which are federally-listed as endangered; hibernate in Luzerne County with a known hibernaculum within five miles of the site (FWS 2004). Bog turtles (*Clemmys muhlenbergii*), federally-listed as threatened, occur in Lehigh and Northampton counties. Bald eagles, federally-listed as threatened, nest in

Northumberland County. Populations of the Northeastern bulrush (*Scirpus ancistrochaetus*), federally-listed as endangered, are known from Carbon and Lehigh counties (FWS 2004). Other than bald eagles, PPL Susquehanna has not identified any occurrences of these species at SSES.

In addition to the Indiana bat, state-listed mammals in counties crossed by the transmission lines are the Eastern woodrat (*Neotoma magister*), the small-footed myotis (*Myotis leibii*), and the Eastern fox squirrel (*Sciurus niger vulpinus*). The Eastern woodrat is known from Carbon and Snyder counties, and the small-footed myotis has been recorded in Luzerne and Northumberland counties (PDCNR 2004)

In addition to the Northeastern bulrush, state-listed plants recorded in counties crossed by the transmission lines are the variable sedge (*Carex polymorpha*), jeweled shooting star (*Dodecatheon radicatum*), and spreading globeflower (*Trollius laxus laxus*). Variable sedge has been recorded in Luzerne and Carbon counties, jeweled shooting star is known to occur in Columbia, Montour, and Northumberland counties, spreading globeflower is known from Northampton County, wild bleeding-hearts (*Dicentra eximia*), matted spike-rush (*eleocharis intermedia*), and crested dwarf iris (*Iris cristata*) is known from Carbon County, Torrey's rush (*Juncus torreyi*) occurs in Lehigh County, and Carey's smartweed (*Polygonum careyi*) is known from Carbon and Lehigh counties (PDCNR 2004; 2005). PPL has not identified any occurrences of these species at SSES.

Attachment B includes copies of PPL Susquehanna correspondence with FWS, the Pennsylvania Game Commission, Pennsylvania Department of Conservation and Natural Resources, and the Pennsylvania Fish and Boat Commission. FWS and Pennsylvania state agencies have stated that no adverse impacts are expected from activities associated with license renewal.

Table 2.5-1. Endangered and Threatened Species that could Occur in the Vicinity of SSES or in Counties Crossed by SSES Transmission Lines.

Scientific Name	Common Name	Federal Status[a]	State Status[a]
Mammals			
Neotoma magister	Eastern woodrat	-	T
Myotis sodalis	Indiana bat	E	E
Myotis leibii	Small-footed myotis	-	T
Sciurus niger vulpinus	Eastern fox squirrel	-	T
Birds			
Asio flammeus	Short-eared owl	-	E
Bartramia longicauda	Upland sandpiper	-	T
Botaurus lentiginosus	American bittern	-	E
Casmerodius alba	Great egret	-	E
Chlidonias niger	Black tern	-	E
Cistothorus platensis	Sedge wren	-	T
Falco peregrinus	Peregrine falcon	-	E
Haliaeetus leucocephalus	Bald eagle	T	E
Ixobrychus exilis	Least bittern	-	E
Pandion haliaetus	Osprey	-	T
Reptiles			
Clemmys muhlenbergii	Bog turtle	T	E
Plants			
Dicentra eximia	Wild bleeding-hearts	-	E
Carex polymorpha	Variable sedge	-	E
Dodecatheon radicatum	Jeweled shooting star	-	T
Eleocharis intermedia	Matted spike-rush	-	T
Iris cristata	Crested dwarf iris	-	E
Juncus torreyi	Torrey's rush	-	T
Polygonum careyi	Carey's smartweed	-	E
Scirpus ancistrochaetus	Northeastern bulrush	E	E
Trollius laxus stricto	Spreading globeflower	-	E

a. E = Endangered; T = Threatened; - = Not listed.

Source: FWS (2004) and PNHP (2004a, 2004b).

2.6 DEMOGRAPHY

2.6.1 Regional Demography

The GEIS presents a population characterization method that is based on two factors: "sparseness" and "proximity" (NRC 1996, Section C.1.4). "Sparseness" measures population density and city size within 20 miles of a site and categorizes the demographic information as follows:

Demographic Categories Based on Sparseness

		Category
Most sparse	1.	Less than 40 persons per square mile and no community with 25,000 or more persons within 20 miles
	2.	40 to 60 persons per square mile and no community with 25,000 or more persons within 20 miles
	3.	60 to 120 persons per square mile or less than 60 persons per square mile with at least one community with 25,000 or more persons within 20 miles
Least sparse	4.	Greater than or equal to 120 persons per square mile within 20 miles

Source: NRC 1996.

"Proximity" measures population density and city size within 50 miles and categorizes the demographic information as follows:

Demographic Categories Based on Proximity

		Category
Not in close proximity	1.	No city with 100,000 or more persons and less than 50 persons per square mile within 50 miles
	2.	No city with 100,000 or more persons and between 50 and 190 persons per square mile within 50 miles
	3.	One or more cities with 100,000 or more persons and less than 190 persons per square mile within 50 miles
In close proximity	4.	Greater than or equal to 190 persons per square mile within 50 miles

Source: NRC 1996.

The GEIS then uses the following matrix to rank the population category as low, medium, or high.

GEIS Sparseness and Proximity Matrix

Proximity

Sparseness	1	2	3	4
1	1.1	1.2	1.3	1.4
2	2.1	2.2	2.3	2.4
3	3.1	3.2	3.3	3.4
4	4.1	4.2	4.3	4.4

Low Population Area

Medium Population Area

High Population Area

Source: NRC 1996, pg. C-159.

PPL Susquehanna used 2000 census data from the U.S. Census Bureau (USCB) website (USCB 2003a, 2003b, 2004) and geographic information system software (ArcView®) to determine most demographic characteristics in the SSES vicinity. As derived from 2000 USCB information, 330,488 people live within 20 miles of SSES (USCB 2003b). Applying the GEIS sparseness measures, SSES has a population density of 263 persons per square mile within 20 miles and falls into the least sparse category, Category 4 (greater than or equal to 120 persons per square mile within 20 miles).

As estimated from 2000 USCB information, 1,684,794 people live within 50 miles of SSES (USCB 2003b). This equates to a population density of 215 persons per square mile. Applying the GEIS proximity measures, SSES is classified as Category 4 (greater than or equal to 190 persons per square mile within 50 miles). Using the GEIS sparseness and proximity matrix, the SSES ranks of sparseness Category 4 and proximity Category 4, result in the conclusion that SSES is located in a high population area.

All or parts of 22 counties, and the cities of Wilkes-Barre, Scranton, Allentown, Pottsville, Carbondale, and Williamsport, PA, are located within 50 miles of SSES (Figure 2.1-1).

Because more than 89 percent of employees at SSES reside in Luzerne or Columbia Counties, PA, the socioeconomic analysis focuses on these counties. (see Section 3.4).

From 1970 to 2000, Pennsylvania's average annual population growth rate was 0.1 percent (USCB 1995 and USCB 2004). For the same period, Luzerne County's average annual growth rate was -0.2 percent (USCB 1995 and USCB 2004). Columbia County's average annual growth rate was 0.5 percent (USCB 1995 and USCB 2004).

Table 2.6-1 estimates populations and annual growth rates for Luzerne and Columbia Counties through the license renewal term. Between the years 2000 and 2050, the population of Luzerne County is projected to decrease at an average annual rate of -0.25 percent (TtNUS 2005). Between the years 2000 and 2050, the population of Columbia County is projected to increase at an average annual rate of 0.48 percent (TtNUS 2005). The population of Pennsylvania is projected to grow at an average annual rate of 0.10 percent (TtNUS 2005).

Table 2.6-1. Estimated Populations and Annual Growth Rates in Luzerne and Columbia Counties from 1970 to 2050.

	Luzerne County		Columbia County	
Year	Number	Average Annual Percent Change	Number	Average Annual Percent Change
1970[a]	342,301	NA	55,114	NA
1980[a]	343,079	0.02%	61,967	1.24%
1990[a]	328,149	-0.44%	63,202	0.20%
2000[b]	319,250	-0.27%	64,151	0.15%
2010[c]	312,174	-0.22%	68,195	0.63%
2020[c]	303,766	-0.27%	71,030	0.42%
2030[c]	295,357	-0.28%	73,864	0.40%
2040[c]	286,949	-0.28%	76,699	0.38%
2050[c]	278,541	-0.29%	79,533	0.37%

a. USCB 1995.
b. USCB 2004.
c. TtNUS 2005.

2.6.2 Minority and Low-Income Populations

NRC performed environmental justice analyses for previous license renewal applications and concluded that a 50-mile radius could reasonably be expected to encompass any potential environmental impact sites and that the host state was the appropriate geographic area for comparative analysis. PPL Susquehanna has adopted this approach for identifying minority and low-income populations that could be affected by SSES operations.

PPL Susquehanna used ArcView® geographic information system software to combine USCB TIGER line data with 2000 census data to determine the minority characteristics by block group. PPL Susquehanna included all of a block group if any part of it was within 50 miles of SSES. The 50-mile radius includes 1,493 block groups (Table 2.6-2).

2.6.2.1 Minority Populations

The NRC "Procedural Guidance for Preparing Environmental Assessments and Considering Environmental Issues" defines a minority population as: American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; Black races; all other single races; multi-racial; and Hispanic ethnicity (NRC 2001, Appendix D). The guidance indicates that a minority population exists if either of the following two conditions exists:

1. The minority population in the census block group or environmental impact site exceeds 50 percent.
2. The minority population percentage of the environmental impact area is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for comparative analysis.

PPL Susquehanna defines the geographic area for SSES as the Commonwealth of Pennsylvania. NRC guidance calls for using the most recent USCB decennial census data. PPL Susquehanna used 2000 census data from the USCB website (USCB 2003a, 2003b, 2004) to determine the percentage of the total population in Pennsylvania for each minority category, and to identify minority populations within 50 miles of SSES.

PPL Susquehanna divided USCB population numbers for each minority population within each block group by the total population of that block group to obtain the percent of the block group's population represented by each minority. For each of the 1,493 block groups within 50 miles of SSES, PPL Susquehanna compared the result of this calculation to the corresponding geographic area's minority threshold percentages to determine whether minority populations exist.

USCB data (USCB 2003b) (Table 2.6-2) for Pennsylvania characterizes 0.15 percent of the Commonwealth as American Indian or Alaskan Native, 1.79 percent as Asian, 0.03 percent as Native Hawaiian or other Pacific Islander, 9.97 percent as Black races, 1.53 percent as all other single minorities, 1.16 percent as multi-racial, 15.95 percent as an aggregate of minority races, and 3.21 percent as Hispanic ethnicity.

Table 2.6-2 presents the numbers of block groups in each county in the 50-mile radius that exceed the threshold for minority populations. Figures 2.6-1 through 2.6-4 locate the minority block groups within the 50-mile radius.

No census blocks within the 50-mile radius had American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, or multi-racial minority populations that exceeded the State average by at least 20 percent.

Eleven census blocks within the 50-mile radius have Black Races populations that exceed the state average by 20 percent or more (Figure 2.6-1). None of those 11 census blocks have Black Races populations of 50 percent or more.

Twenty-one census blocks within the 50-mile radius, all in Lehigh County, have all other single minority populations that exceed the state average by 20 percent or more (Figure 2.6-2). None exceed the 50 percent criterion.

Fifty-four census blocks within the 50-mile radius have aggregate minority populations that exceed the state average by 20 percent or more (Figure 2.6-3). Of those, 27 have aggregate minority populations of 50 percent or more.

Forty census blocks within the 50-mile radius, all in Lehigh County, have Hispanic Ethnicity populations that exceed the state average by 20 percent or more (Figure 2.6-4). Of those, eight have Hispanic Ethnicity populations of 50 percent or more. PPL Susquehanna's community outreach has identified small yet growing Hispanic populations in the Hazleton, Bethlehem, and Berwick areas. As a general matter there are relatively few census blocks exceeding the threshold for minority populations within a 50-mile radius, and none in close proximity of the station.

2.6.2.2 Low-Income Populations

NRC guidance defines low-income based on statistical poverty thresholds (NRC 2001 Appendix D). PPL Susquehanna divided the number of USCB low-income households in each census block group by the total households in that block group to obtain the percentage of low-income households per block group. USCB data (USCB 2004) characterize 11.0 percent of Pennsylvania households as low-income households. A low-income population is considered to be present if:

1. The low-income households in the census block group or the environmental impact site exceed 50 percent.
2. The percentage of households below the poverty level in an environmental impact area is significantly greater (typically at least 20 percentage points) than the low-

income households percentage in the geographic area chosen for comparative analysis.

Table 2.6-2 identifies the low-income block groups in the region of interest. Figure 2.6-5 locates the low-income block groups.

Fifty census blocks within the 50-mile radius have low-income households that exceed the state average by 20 percent or more. Of those 50 census blocks, 7 have 50 percent or more low-income households. As a general matter there are relatively few census blocks exceeding the threshold for low income populations within a 50-mile radius, and none in close proximity to the station.

Figure 2.6-1 Black Population Races

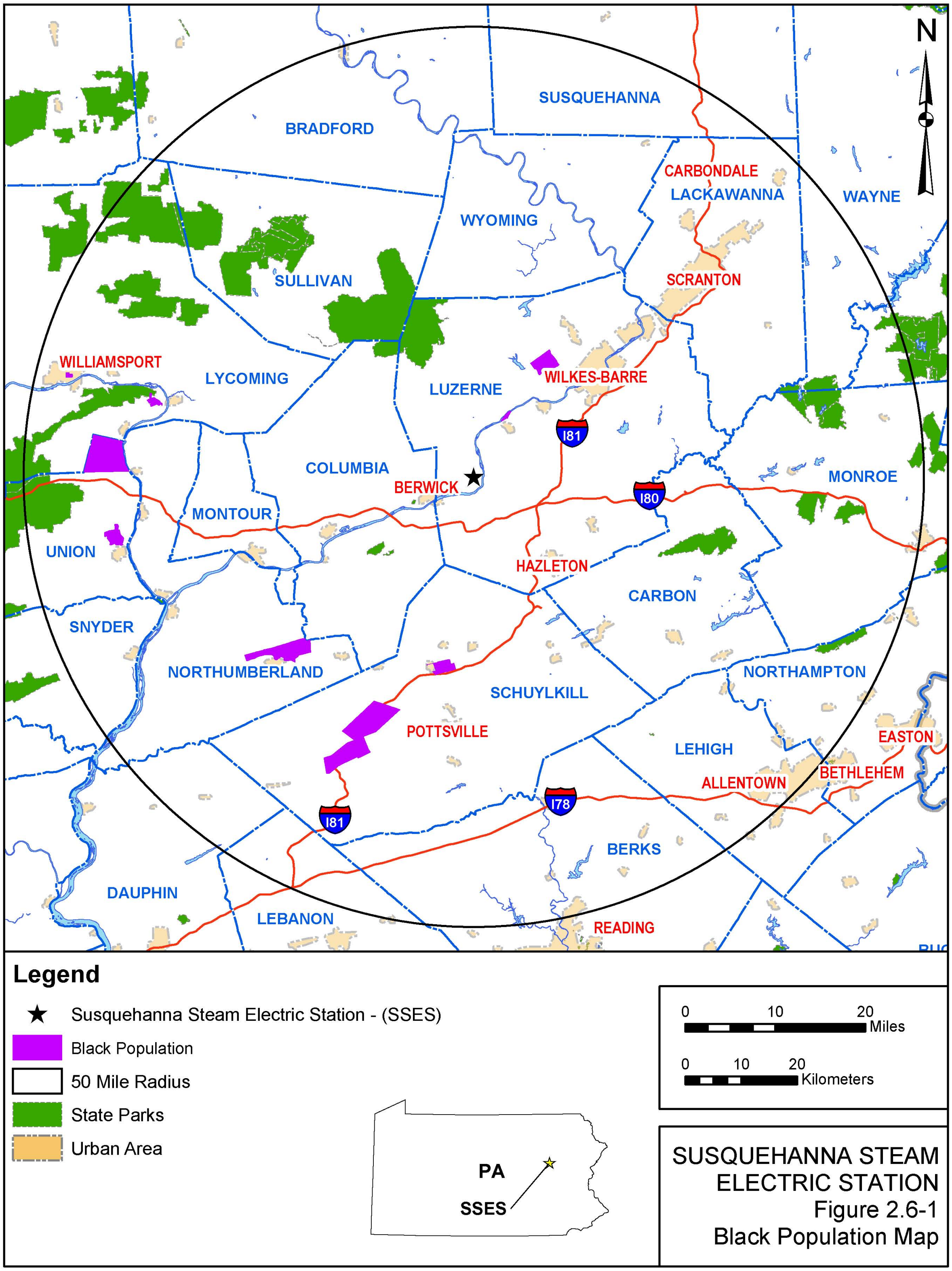


Figure 2.6-2 All Other Single Minorities Population Map

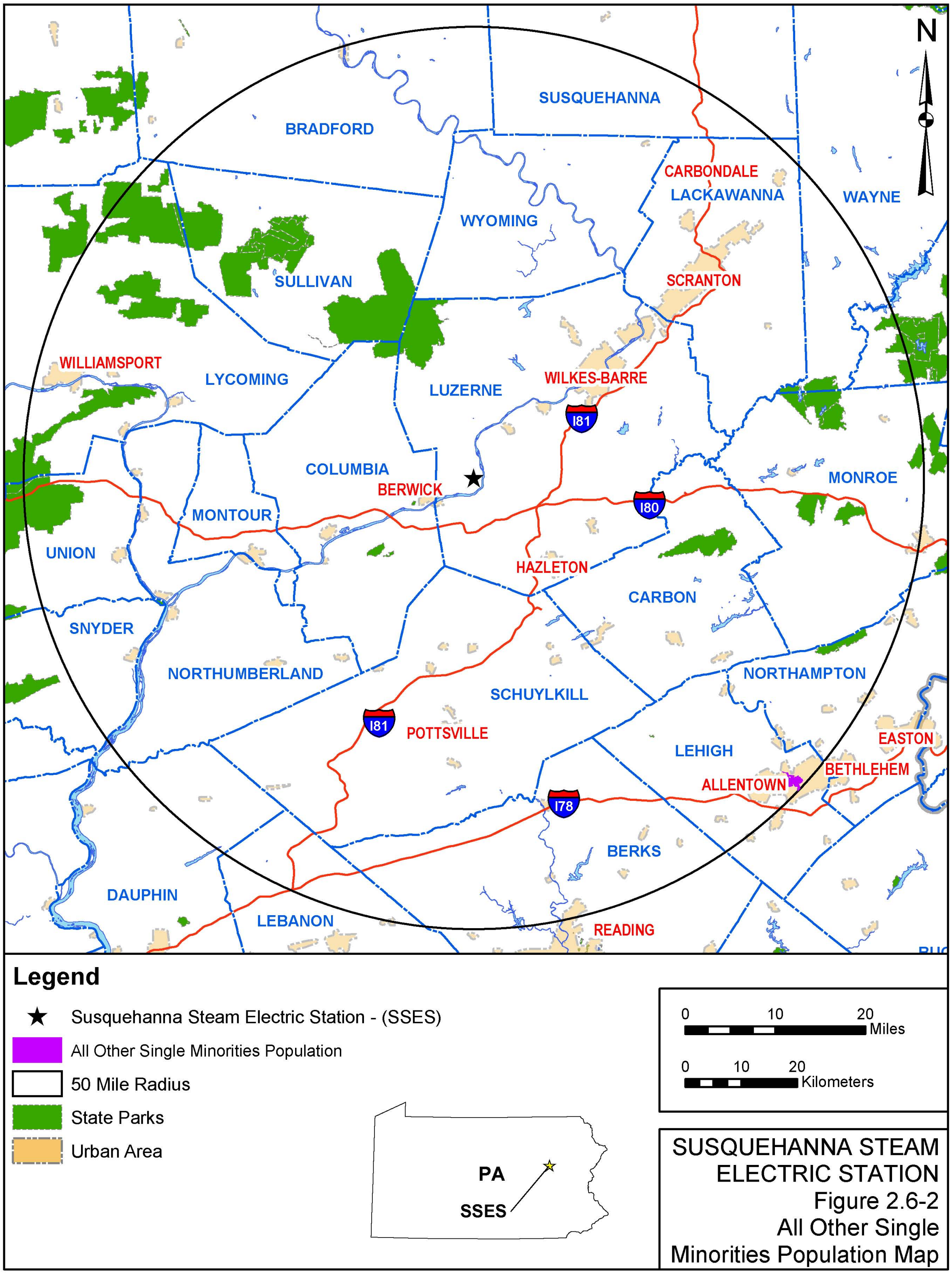


Figure 2.6-3 Aggregate of Minority Races Population Map

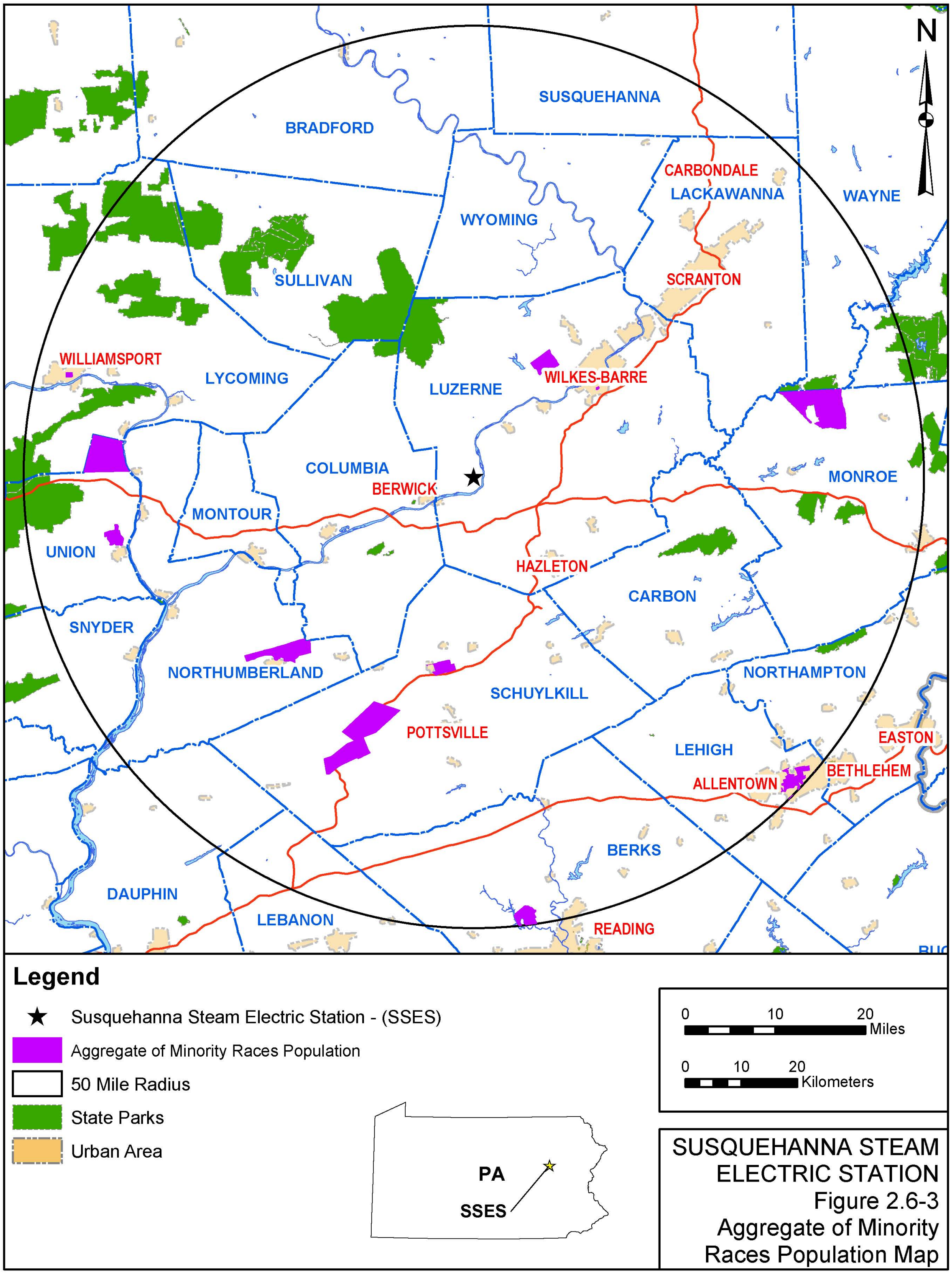


Figure 2.6-4 Hispanic Population Map

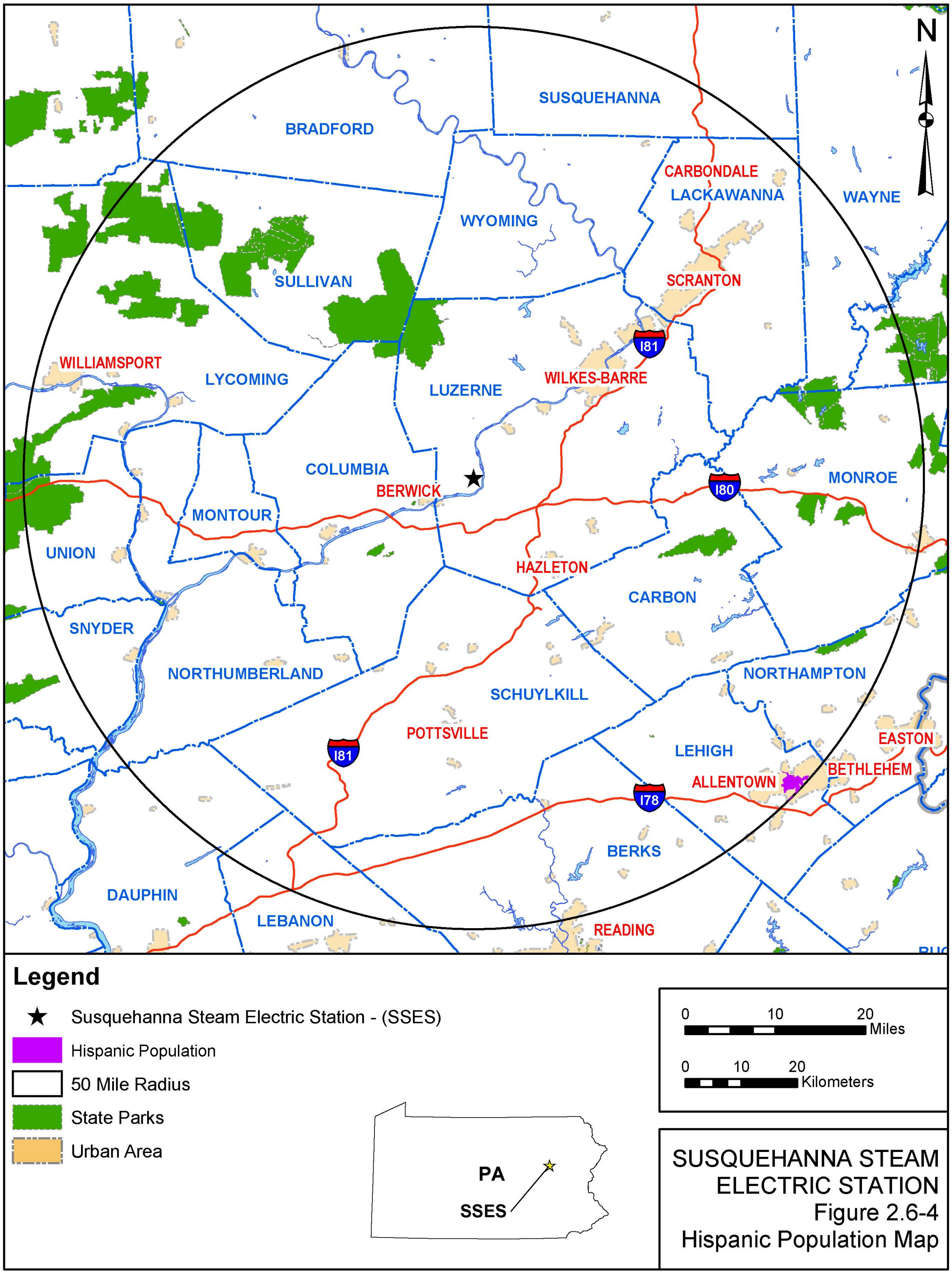


Figure 2.6-5 Low-Income Population

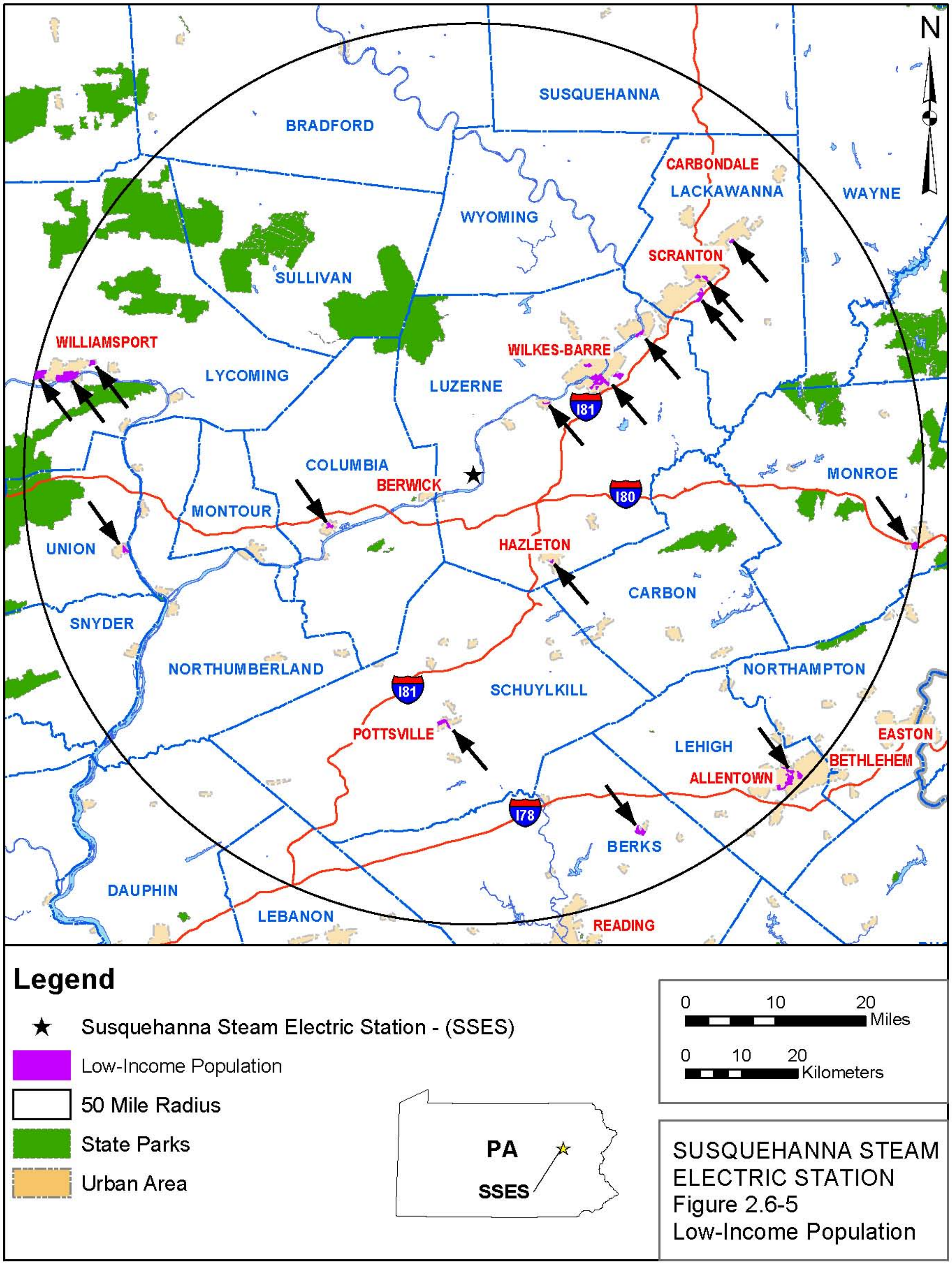


Table 2.6-2. Minority and Low-Income Population Census Blocks within 50-Mile Radius of SSES

50 Mile Radius Total Block Groups

County	State	Total Block Groups Within 50 Miles	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Black Races	All Other Single Minorities	Multiracial Minorities	Aggregate of Minority Races	Hispanic Ethnicity	Low-Income Block Groups Within 50 Miles	2000 Population Adjusted for Area Within 50 Miles
Berks	Pennsylvania	74	0	0	0	0	0	0	1	0	1	102687.01
Bradford	Pennsylvania	23	0	0	0	0	0	0	0	0	0	17573.15
Carbon	Pennsylvania	48	0	0	0	0	0	0	0	0	0	58802
Columbia	Pennsylvania	55	0	0	0	0	0	0	0	0	3	64151
Dauphin	Pennsylvania	11	0	0	0	0	0	0	0	0	0	10304.53
Lackawanna	Pennsylvania	195	0	0	0	0	0	0	0	0	6	212479.84
Lebanon	Pennsylvania	14	0	0	0	0	0	0	0	0	0	14138.95
Lehigh	Pennsylvania	181	0	0	0	0	21	0	41	40	11	226047.75
Luzerne	Pennsylvania	314	0	0	0	2	0	0	2	0	12	319249.994
Lycoming	Pennsylvania	101	0	0	0	4	0	0	4	0	9	95471.02
Monroe	Pennsylvania	54	0	0	0	0	0	0	1	0	1	102977.04
Montour	Pennsylvania	14	0	0	0	0	0	0	0	0	0	18236
Northampton	Pennsylvania	59	0	0	0	0	0	0	0	0	0	76011.04
Northumberland	Pennsylvania	97	0	0	0	1	0	0	1	0	4	94080.72
Pike	Pennsylvania	4	0	0	0	0	0	0	0	0	0	2684.58
Schuylkill	Pennsylvania	145	0	0	0	2	0	0	2	0	2	150336.08
Snyder	Pennsylvania	21	0	0	0	0	0	0	0	0	0	22927.94
Sullivan	Pennsylvania	6	0	0	0	0	0	0	0	0	0	6556
Susquehanna	Pennsylvania	14	0	0	0	0	0	0	0	0	0	10674.83
Union	Pennsylvania	24	0	0	0	2	0	0	2	0	1	37393.26
Wayne	Pennsylvania	16	0	0	0	0	0	0	0	0	0	13931.52
Wyoming	Pennsylvania	23	0	0	0	0	0	0	0	0	0	28080
TOTALS		1493	0	0	0	11	21		54	40	50	1684794.254

Table 2.6-2. Minority and Low-Income Population Census Blocks within 50-Mile Radius of SSES. (Continued)

50 Mile Radius ≥ 50% Block Groups

County	State	Total Block Groups Within 50 Miles	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Black Races	All Other Single Minorities	Multiracial Minorities	Aggregate of Minority Races	Hispanic Ethnicity	Low-Income Block Groups Within 50 Miles	2000 Population Adjusted for Area Within 50 Miles
Berks	Pennsylvania	74	0	0	0	0	0	0	0	0	0	102687.01
Bradford	Pennsylvania	23	0	0	0	0	0	0	0	0	0	17573.15
Carbon	Pennsylvania	48	0	0	0	0	0	0	0	0	0	58802
Columbia	Pennsylvania	55	0	0	0	0	0	0	0	0	2	64151
Dauphin	Pennsylvania	11	0	0	0	0	0	0	0	0	0	10304.53
Lackawanna	Pennsylvania	195	0	0	0	0	0	0	0	0	1	212479.84
Lebanon	Pennsylvania	14	0	0	0	0	0	0	0	0	0	14138.95
Lehigh	Pennsylvania	181	0	0	0	0	0	0	23	8	2	226047.75
Luzerne	Pennsylvania	314	0	0	0	0	0	0	1	0	0	319249.994
Lycoming	Pennsylvania	101	0	0	0	0	0	0	0	0	1	95471.02
Monroe	Pennsylvania	54	0	0	0	0	0	0	0	0	0	102977.04
Montour	Pennsylvania	14	0	0	0	0	0	0	0	0	0	18236
Northampton	Pennsylvania	59	0	0	0	0	0	0	0	0	0	76011.04
Northumberland	Pennsylvania	97	0	0	0	0	0	0	0	0	1	94080.72
Pike	Pennsylvania	4	0	0	0	0	0	0	0	0	0	2684.58
Schuylkill	Pennsylvania	145	0	0	0	0	0	0	1	0	0	150336.08
Snyder	Pennsylvania	21	0	0	0	0	0	0	0	0	0	22927.94
Sullivan	Pennsylvania	6	0	0	0	0	0	0	0	0	0	6556
Susquehanna	Pennsylvania	14	0	0	0	0	0	0	0	0	0	10674.83
Union	Pennsylvania	24	0	0	0	0	0	0	2	0	0	37393.26
Wayne	Pennsylvania	16	0	0	0	0	0	0	0	0	0	13931.52
Wyoming	Pennsylvania	23	0	0	0	0	0	0	0	0	0	28080
Total		1493	0	0	0	0	0	0	27	8	7	1684794.254

Table 2.6-2. Minority and Low-Income Population Census Blocks within 50-Mile Radius of SSES. (Continued)

State Percentages

American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Black Races	All Other Single Minorities	Multiracial Minorities	Aggregate of Minority Races	Hispanic Ethnicity	Low-Income
0.15	1.79	0.03	9.97	1.53	1.16	14.63	3.21	10.99

2.7 TAXES

In the past, PPL Susquehanna paid real estate taxes to the Commonwealth of Pennsylvania for their generating, transmission, and distribution facilities. Under authority of the Pennsylvania Utility Realty Tax Act (PURTA), real estate taxes collected from all utilities (water, telephone, electric, and railroads) were redistributed to the taxing jurisdictions within the Commonwealth. In Pennsylvania, these jurisdictions include counties, cities, townships, boroughs, and school districts. The distribution of PURTA funds was determined by formula, and was not necessarily based on the individual utility's effect on a particular government entity.

In 1996, Electricity Generation Customer Choice and Competition Act became law, which allowed consumers to choose among competitive generation suppliers. As a result of utility restructuring, Act 4 of 1999 revised the tax base assessment methodology for utilities from the depreciated book value to the market value of utility property. Additionally, as of January 1, 2000, PPL Susquehanna was required to begin paying real estate taxes directly to local taxing jurisdictions, ceasing payments to the Commonwealth's PURTA fund.

PPL Susquehanna pays annual real estate taxes to the Berwick Area School District (BASD), Luzerne County, and Salem Township.

Luzerne County revenues fund County operations, judicial services, correctional facilities, emergency management services, parks and recreation, public works, social services, public safety, the community college, nursing homes, libraries, and conservation and development projects (Luzerne County 2002). From 2000 through 2004, Luzerne County collected between $48 and $69 million annually in total real estate tax revenues (Table 2.7-1). Between 2000 and 2004, SSES's real estate taxes represented 1.8 to 2.4 percent of Luzerne County's total real estate tax revenues (Table 2.7-1).

From 2000 through 2004, the BASD collected between $28 and $35 million annually in total real estate tax revenues (Table 2.7-1) (BASD 2003 and Martz 2005). Between 2000 and 2004, SSES's real estate taxes represented 5.5 to 6.9 percent of the Berwick Area School District's total tax revenues (Table 2.7-1).

From 2000 to 2004, Salem Township collected between $118,000 and $124,000 in municipal and street taxes (Table 2.7-1). Between 2000 and 2004, SSES's real estate taxes represented 50.3 to 53.9 percent of Salem Township's municipal and street taxes.

Table 2.7-1. Susquehanna Steam Electric Station Real Estate Tax Information 2000-2004.

Year	Berwick Area School District (BASD)			Luzerne County			Salem Township		
	BASD Annual Revenues	Real Estate Tax Paid to BASD by SSES	Percent of Annual BASD Revenues	Real Estate Tax Collections	Real Estate Tax Paid to Luzerne County by SSES	Percent of Luzerne County Real Estate Tax Collections	Salem Township Municipal and Street Taxes	Taxes Paid to Salem Township by SSES	Percent of Salem Township Tax Collections
2000	$28,992,654 [a] (2000-2001)	$1,602,850 (2000-2001)	5.5	$47,635,994[b]	$1,128,775	2.4	NA[e]	NA[e]	NA[e]
2001	$30,888,277 [a] (2001-2002)	$1,703,022 (2001-2002)	5.5	$60,024,566[b]	$1,135,552	1.9	$123,480[f]	$62,140	50.3
2002	$28,534,127[a] (2002-2003)	$1,905,304 (2002-2003)	6.7	$60,643,642[b]	$1,135,552	1.9	$123,480 [f]	$62,140	50.3
2003	$31,724,705 [c] (2003-2004)	$1,906,035 (2003-2004)	6.0	$61,285,895[d]	$1,111,857	1.8	$123,480 [f]	$62,140	50.3
2004	$34,059,674 [c] (2004-2005)	$2,365,363 (2004-2005)	6.9	$68,540,477[d]	$1,217,324	1.8	$118,626[g]	$63,895	53.9

Note: Between years 2003 and 2004 there was a 24% increase in the school tax.

a. BASD 2003
b. Luzerne County 2002
c. Martz 2005
d. Allabaugh 2005
e. Year 2000 numbers are not applicable for Salem Township
f. Fields 2005b
g. Sampson 2005

2.8 LAND USE PLANNING

This section focuses on Luzerne or Columbia Counties because the majority of the permanent SSES workforce lives in Luzerne or Columbia Counties (see Section 3.4). Luzerne County's population has decreased 6.7 percent from 1970 to 2000. Columbia County's population has increased 16.4 percent for the same 30-year period, an average annual increase of 0.5 percent. Regional and local planning officials have shared goals of encouraging expansion and development in areas where public facilities, such as water and sewer systems, have been planned, and discouraging incompatible land use mixes in contiguous areas and strip development.

Luzerne County

Luzerne County is approximately 891 square miles (USCB 2000a) and has 76 municipalities. The County is located in northeastern Pennsylvania, in the heart of the eastern "coal field" region. Anthracite coal mining played a large role in shaping the economy and the landscape of the county. However, there has been a decline in the coal industry over the past 30 to 60 years, as well as in the textile and steel industries, and it has impacted Luzerne County residents. In addition, coal mining has contaminated portions of the land (EPA 2000). The inventory of abandoned and underutilized industrial and commercial properties includes abandoned mine lands (Dooley 2005). Land use in the county is classified as follows: forest – 73.4 percent, pasture – 9.8 percent, residential – 4.3 percent, commercial/industrial/transportation – 3.2 percent, row crops – 3.1 percent, quarry/strip mine – 2.3 percent, open water 2.3 percent, wetlands – 1.5 percent, and transitional – 0.2 percent (King's College 2002).

Two-thirds of the more than 300,000 residents live in urban areas (EPA 2000). Most development (residential, commercial, industrial, recreational, and public/quasi-public) is in the northeast quadrant of the county along the U.S. Route 11 corridor which follows the banks of the Susquehanna River. There is also a significant amount of mining within these developed areas. This quadrant contains the communities of Pittston, Nanticoke, Wilkes-Barre, Dallas, and Kingston and the Frances Slocum State Park. The southeast quadrant of the county contains land that is rural, forested and mined. It also contains Freeland Borough. The northwestern quadrant is composed primarily of forested land and land that is undeveloped, open, or agricultural. It includes part of the Ricketts Glen State Park. The southwestern quadrant is characterized by forests, open, undeveloped, agricultural, mined, and developed land. The developed portions of this quadrant are located in and around the city of Hazleton and the eastern outskirts of Berwick Borough.

From 1970 to 2000, the population of Luzerne County has decreased, overall, with declines in natural growth and net migration. The majority of this reduction occurred in the urban centers. Areas adjacent to urban centers and rural areas experienced population increases, a trend similar to that in many American towns; people migrate from the commercial/industrial centers of town to the suburbs and beyond.

Additionally, although the coal and steel industry and population levels have declined, there have been small expansions in the commercial, industrial, and residential development of the County. Areas surrounding Pittston, Hazleton, and the borough of Warrior Run have experienced an increase in industrial and commercial activity. Areas in and around the Borough of Dallas, Wright Township, Rice Township, and Fairview Township have experienced the largest increase in residential development (Dooley 2005). Luzerne County planners indicated that, in most cases, the expansion of public facilities and infrastructure to meet new commercial, industrial, and residential demand has been costly and slow. County revenues are not sufficient to meet all expansion efforts when they are needed. Often times, private developers are asked to fund infrastructure changes that are required (Dooley 2005).

As stated previously, coal mining has contaminated portions of the land. There is an on-going effort by the government (e.g. EPA, state, and local) and private stakeholders to reclaim the abandoned mine lands and render them useful for residential and commercial/industrial development. Two of the largest economic development initiatives underway in Luzerne County are 1) the development of Keystone Opportunity Zones (KOZs) and 2) the remediation and conversion of mine-contaminated lands by the Earth Conservancy (Lackawanna/Luzerne 2003). Many acres have already been successfully remediated and converted (Dooley 2005 and EPA 2000). In Luzerne County, the largest number of vacant development parcels can be found between Interstate 81 and the Susquehanna River in the City of Wilkes-Barre, the City of Hazleton, Hanover Township, Nanticoke City, and Newport Township. In Hazleton for example, there are plans to cleanup three unpermitted landfills, abandoned mine lands, and other environmental problems at a 277-acre redevelopment site (PDEP 2005)

Columbia County

Columbia County is approximately 486 square miles (USCB 2000b). According to the Comprehensive Plan for Columbia County (Columbia County 1993), land use falls into 10 categories: agricultural - 40.4 percent; woodland - 52.4 percent; residential - 4.0 percent; mining/quarry - 0.7 percent; public/quasi-public - 0.3 percent; commercial - 0.3 percent; recreation - 0.2 percent; industrial - 0.3 percent; transportation - 1.4 percent; public utilities - 0.2 percent (Columbia County 1993).

Most development (residential, commercial, industrial, recreational, and public/quasi-public) is in the North Central Planning Area. This planning area encompasses the primary county population and the development centers of the Town of Bloomsburg and Berwick Borough, as well as several other municipalities containing substantial development including Briar Creek, Scott, and South Centre Townships, and Briar Creek Borough (Columbia County 1993).

The land adjacent to US Route 11 serves as a high-density mixed-use development corridor within the county. Beyond this corridor, both north and south, the county is dominated by woodlands with large pockets of low-density residential development. Three exceptions to these rural outlying areas are the Millville, Benton, and Catawissa Boroughs. Agricultural land is currently being protected in Columbia County through three incentive programs: differential assessment, agricultural security areas, and purchase of agricultural conservation easements (Columbia County 1993).

Population and employment projections have been used by the county to develop estimates of future land use needs. The county estimates that approximately 3,680 to 16,000 acres will be needed to accommodate future population increases. Columbia County has approximately 67,000 undeveloped acres with no impediments to development and 102,400 undeveloped acres restricted from development because the soil does not provide adequate percolation to meet sewage treatment requirements. The restricted acreage could be developed if a centralized wastewater collection/treatment system were to be constructed. It is evident when comparing future total projected land use acreage needs to the available unrestricted land, that sufficient land area is available to accommodate future growth (Columbia County 1993).

2.9 SOCIAL SERVICES AND PUBLIC FACILITIES

2.9.1 Public Water Supply

Because SSES is in Salem Township (in Luzerne County) and most of the SSES employees reside in Luzerne or Columbia Counties, the discussion of public water supply systems will be limited to Luzerne and Columbia Counties. SSES provides potable water for drinking, pump seal cooling, sanitation, and fire protection through the onsite groundwater well system. Three additional wells provide water to the Energy Information Center, Riverlands Recreation Area, and the West Building (former Emergency Operations Facility) (see Section 3.1.2 for greater detail). SSES does not use municipal water.

Luzerne County

Surface water is the primary source of potable water for the majority of Luzerne County residents. Sources include lakes, rivers, reservoirs, and their tributaries, but not the Susquehanna River. The Susquehanna River is a source for drinking water for residents south of Danville Borough, Montour County, PA (Gavin 2005). Currently, both surface and groundwater sources in the county provide adequate supply for the population. At times, water quality issues have identified in selected surface water bodies and groundwater sources from both point source and non-point source pollution. These issues have included excessive metals concentrations, acid mine drainage, turbidity, excessive sedimentation, sewage contamination, landfill leachate, and excessive volatile chemicals, nitrates/nitrites, pesticides, petroleum products and underground storage tank contamination (PDEP Undated). Although water quality has been an issue at some source locations, most sources and municipal water suppliers are able to provide water yields capable of sustaining both domestic and non-domestic uses.

Table 2.9-1 lists the largest municipal water suppliers (serving greater than 4,500 people) in Luzerne County.

Columbia County

Columbia County has 13 surface water sources and 11 groundwater sources. Water quality issues have been identified in two surface water bodies and some groundwater sources. These include excessive metals concentrations, acid mine drainage, sedimentation, sewage contamination, landfill leachate, and underground storage tank contamination. Columbia County's Comprehensive Plan (Columbia County 1993) states that, although water quality has been an issue in some source locations, most

sources are able to provide water yields capable of sustaining both domestic and non-domestic uses through 2010 estimates of need.

Table 2.9-2 lists the largest municipal water suppliers (serving greater than 4,500 people) in Columbia County.

Table 2.9-1. Major Luzerne County Public Water Suppliers[a]

Water Supplier[b]	Water Source[b]	Average Production (GPD)[c]	Maximum Production (GPD)[c]	Design Capacity (GPD)[c]
Freeland Borough Municipal Water Authority	GW	430,438	709,000	1,613,200
HCA Water System Filter Plant -Hazleton	SW	5,394,000	7,700,000	10,000,000
Pennsylvania American Water Company -Ceasetown[d]	SW	3,500,000	3,950,000	N/A
Pennsylvania American Water Company -Crystal Lake	SW	3,420,000	5,000,000	6,000,000
Pennsylvania American Water Company -Huntsville[e]	SW	N/A	4,500,000	N/A
Pennsylvania American Water Company -Nesbitt[e]	SW	10,000,000	11,000,000	12,000,000
Pennsylvania American Water Company -Watres[d]	SW	10,000,000	16,000,000	16,000,000
United Water Pennsylvania -Dallas	GW	462,000	569,000	1,566,000

GW = Groundwater
SW = Surface water
GPD = Gallons per Day
N/A – Not Applicable or No Information Available.
a. Municipal water suppliers serving populations greater than 4,500.
b. EPA 2004
c. PDEP 2004
d. Ceasetown and Watres are part of the same water system.
e. Huntsville and Nesbitt are part of the same water system.

Table 2.9-2. Major Columbia County Public Water Suppliers[a]

Water Supplier[b]	Water Source[b]	Average Production (GPD)[c]	Maximum Production (GPD)[c]	Design Capacity (GPD)[c]
Pennsylvania American Water Company -Berwick	GW	1,739,000	2,477,000	4,600,000
United Water Pennsylvania -Bloomsburg	SW	2,581,000	3,479,000	4,147,200

GW = Groundwater
SW = Surface water
GPD = Gallons per Day
N/A – Not Applicable or No Information Available.
a. Municipal water suppliers serving populations greater than 4,500.
b. EPA 2004
c. PDEP 2004

2.9.2 Transportation

Road access to SSES is via US Route 11, a two-lane paved road with a northeast-southwest orientation (Figures 2.1-2 and 2.1-3). SSES lies to the west of US Route 11 and the Susquehanna River. Approximately four miles north of SSES, US Route 11 intersects with State Route (SR) 239, which travels in a northwest-southeast direction. East of this intersection, SR 239 crosses the Susquehanna River. Several miles south of SSES, US Route 11 intersects with SR 93. East of this intersection, SR 93 crosses the Susquehanna River. East of the intersection of SR 93 and the Susquehanna River, SR 93 intersects SR 339, which has a northeast-southwest orientation. Five to ten miles south of SSES, SRs 93 and 339 intersect with Interstate 80, which has an east-west orientation. Five to ten miles southeast of SSES, Interstate 80 intersects with Interstate 81, which has a northeast-southwest orientation. Employees traveling from the north or northwest of SSES would use SR 239 and US Route 11 to reach the station. Employees traveling from the northeast would use US Route 11. Employees traveling from the south or southwest of SSES could use varying combinations of the following roads to reach the station: Interstate 80, SR 339, SR 93, and US Route 11. Employees traveling from the east and southeast could use SR 239, Interstates 80 and 81, SR 93, and US Route 11. When nearing SSES, all employees must use US Route 11.

Luzerne County

Luzerne County has, in conjunction with Lackawanna County, developed a Long Range Transportation Plan (Lackawanna/Luzerne Counties 2003). The Plan depicts the

existing transportation system, proposed modifications, and future projections for the system in these counties. For the purposes of this report, Luzerne County information only will be the focus of this subsection.

The existing Luzerne County highway system provides local access to Scranton, Wilkes-Barre, Hazleton, and regional access to New York City, Philadelphia, and other major northeast cities. Public transit in the Luzerne County Area is based in the cities of Hazleton and Kingston Borough (with the hub located in Wilkes-Barre). The Luzerne County Transportation Authority and the City of Hazleton manage these systems. The Luzerne County Rail Corporation operates rail services within Luzerne County. Services include freight and limited passenger rail. Airports serving Luzerne County include the Wilkes-Barre/Scranton International Airport, Seaman's Field, the Wyoming Valley Airport, and the Hazleton Airport (Lackawanna/Luzerne Counties 2003).

Luzerne County is host to a diverse highway network. Interstate 80 runs east-west through the southern half of Luzerne County providing direct access east to New Jersey and New York City, less than 100 miles away, and access to Ohio and the western states. Interstate 80 is a four-lane divided highway built to accommodate large volumes of passenger vehicles and motor freight. Oriented north-south are Interstates 81 and 476 (the Pennsylvania Turnpike Northeast Extension). Interstate 81 runs north through Hazleton and Wilkes-Barre into upstate New York and south to Harrisburg and the Maryland border. The Pennsylvania Turnpike Northeast Extension is a direct route from Interstate 80 north to Wilkes-Barre and Scranton terminating at Interstate 81. The Extension provides access to regional centers to the south, including Allentown and Philadelphia. U.S. Route 11 runs northeast-southwest through Wilkes-Barre, connecting it with Harrisburg and New York State (Lackawanna/Luzerne Counties 2003).

Traffic volumes are measured in terms of Average Annual Daily Traffic (AADT), which is an average of daily traffic for every day of the year. In Luzerne County, traffic volumes are highest on the interstate highways such as Interstate 81, Interstate 80, and 476. Heavier traffic volumes are especially concentrated around the cities of Wilkes-Barre and Hazleton (Lackawanna/Luzerne Counties 2003).

Between 1992 and 2001, traffic has grown on all interstate highways in Luzerne County. Between 1992 and 2001, increases in traffic volumes on Interstate 80 have ranged from 24 percent to 110 percent or from 4,550 to over 15,000 AADT (Lackawanna/Luzerne Counties 2003). On some roadway segments, truck traffic has increased at a greater rate than passenger vehicle traffic. Historic traffic volume data have shown that this is the case on sections of Interstate 80 in Luzerne County (Lackawanna/Luzerne Counties

2003). In an effort to maintain the ability to accommodate an ever-increasing number of vehicles, state and local authorities have implemented a number of maintenance and improvement projects to alleviate problems (Lackawanna/Luzerne Counties 2003).

Columbia County

Columbia County is well-served by its existing roadways. The two primary east-west corridors are U.S. Route 11 and Interstate 80 which travel through Columbia County's midsection. These primary roadways are intersected by several north-south corridors which provide immediate access to Bloomsburg and Berwick. Interstate 80 is a four-lane divided highway built to accommodate large volumes of passenger vehicles and motor freight. Since the mid-1970s, Columbia County's primary roadway network has experienced a substantial increase in traffic volumes. In an effort to maintain the ability to accommodate an increasing number of vehicles, state and local authorities have implemented a number of maintenance and improvement projects (Columbia County 1993).

In determining the significance levels of transportation impacts for license renewal, the NRC uses the Transportation Research Board's level of service (LOS) definitions (NRC 1996). The Pennsylvania Department of Transportation makes LOS determinations for roadways involved in specific projects. However, there are no current LOS determinations for the roadways analyzed in this document (Luben 2004). Because LOS data are unavailable, AADT volumes were substituted. Table 2.9-3 lists roadways in the vicinity of SSES and the AADT volumes, as determined by the Pennsylvania Department of Transportation.

Table 2.9-3. AADT Counts for Roads in the Vicinity of SSES.

Roadway and Location	Annual Average Daily Traffic (AADT)	Year (Most Current)
US 11 – east of the intersection with Interstate 80	17,000	2002
US 11 – between Secondary Route 4037 and the intersection with SR 93.	11,000	2002
US 11 – between Secondary Route 4037 and the intersection with Secondary Route 4002.	8,300	2002
US 11 – between the intersection with Secondary Route 4002 and the intersection with Secondary Route 4004.	6,600	2002
US 11 – near the intersection with SR 239.	11,000	2002
US 11 -- between the intersection with SR 239 and the intersection with Secondary Route 4016.	7,200	2002
US 11 -- between the intersection with Secondary Route 4016 and the confluence of US 11 and SR 29.	11,000	2002
US 11 -- near the intersection with Secondary Route 0011.	18,000	2002
SR 239 – between the intersection with US 11 and the intersections with Secondary Routes 4010, 4007, and 4012.	5,700	2002
SR 93 -- just south of the intersection with US 11.	12,000	2002
Interstate 80 – near the intersection with SR 93.	32,000	2002
SR 93 – between the intersection with Interstate 80 and the intersection with Secondary Route 3036.	5,500 to 5,900	2002
SR 339 – between the intersection with Interstate 80 and the intersection with SR 93.	2,300 to 6,500	2002

Source: PDOT 2004.
Note: All AADTs represent traffic volume during the average 24-hour day during the year indicated.

2.10 METEOROLOGY AND AIR QUALITY

SSES is located in Luzerne County in east central Pennsylvania. The area is characterized by considerable snow during the winter and relatively hot humid summers with precipitation distributed evenly throughout the year (PPL 2005). Meteorological information relevant to the severe accident mitigation alternatives analysis is provided in Attachment E.

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for six common pollutants. These “criteria pollutants” include nitrogen dioxide, sulfur dioxide, particulate matter, carbon monoxide, lead, and ozone. The EPA has designated all areas of the United States as having air quality better than (attainment) or worse than (non-attainment) the NAAQS.

Luzerne County is part of the Scranton-Wilkes-Barre, Pennsylvania metropolitan statistical area (MSA). With the exception of ozone, this MSA is designated as an attainment area for all NAAQS currently in effect (EPA 2003b).

In July 1997, the EPA issued final rules establishing new annual arithmetic mean and 24-hour standards for fine particulate matter with aerodynamic diameters of 2.5 microns or less (PM-2.5) and a new 8-hour ozone standard. After several years of litigation, the PM-2.5 and 8-hour ozone standards have been upheld.

On April 15, 2004, the EPA issued final rules establishing the air quality designations and classifications under the 8-hour ozone NAAQS for every area in the United States (69 FR 23857). Effective June 15, 2004, the Scranton-Wilkes-Barre MSA was designated as a basic non-attainment area under the 8-hour ozone NAAQS.

On January 5, 2005, the EPA issued final rules establishing the air quality designations and classifications under the PM-2.5 NAAQS for every area in the United States (70 FR 945). Effective April 5, 2005, 22 Pennsylvania counties were designated as non-attainment areas under the PM-2.5 NAAQS. The EPA did not designate any counties in the Scranton-Wilkes-Barre MSA as PM-2.5 non-attainment areas. However, eleven counties in southeastern Pennsylvania, including Berks (32 miles from SSES), Montgomery (49 miles from SSES), and Bucks (48 miles from SSES) counties, were designated as PM-2.5 non-attainment areas.

2.11 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Area History in Brief

Prehistoric

Aboriginal people migrated to Pennsylvania approximately 10,000 to 15,000 or more years ago. Three major cultural traditions dominated the prehistory of Pennsylvania: (1) the Paleo-Indian Tradition (15,000+ to 10,000 years ago); (2) the Archaic Tradition (10,000 to 3,000 years ago); and (3) the Woodland Tradition (3,000 years ago to European contact) (CAI 1981).

The Paleo-Indian period corresponds with the waning of the last glaciers. During glaciation, environmental zones were shifted hundreds of miles to the south, and now-extinct megafauna roamed the landscapes. It is believed that nomadic Paleo-Indians hunted these large animals. This period is characterized by the Clovis point, a distinctive, fluted, lanceolate point that is widely distributed throughout Pennsylvania, especially in the Susquehanna and Delaware River drainages. Pennsylvania Paleo-Indian sites also contain scrapers; spurred-end scrapers; drills; cores; bifaces; microblades; and small uniface, biface, and flake knives.

As the glaciers retreated into Canada, environmental zones shifted northward, eventually assuming positions closely approximating those of today. The largest fauna became extinct and humans adapted to exploit modern flora and fauna, particularly deer, elk, rabbits, and squirrels, and vegetable products of the forest, such as nuts and greens. The Archaic period was concomitant with the retreat of the glaciers and is characterized by the increasing use of a greater diversity of forest products and an apparent population increase. It is subdivided into the Early, Middle, and Late periods, each lasting two to three thousand years, and has several major cultural traditions – particularly the Laurentian, Lamoka, and Piedmont. Warming and the retreat of glaciers led to the succession of vegetation zones, tundra-spruce-fir-pine-mixed deciduous-oak-hickory, passing through Pennsylvania. Tool forms changed and the culture showed stylistic changes and increased diversity of forms. As megafauna became extinct, so did the fluted lanceolate point. It was replaced by forms more locally styled. Knives, scrapers, drills, and other chipped stone tools, as well as bone tools continued as important elements of Archaic assemblages.

The Archaic period was followed by the Woodland period, which is also subdivided into the Early, Middle, and Late periods. The major trait delineating the Woodland from the Archaic is the addition of ceramics. The practice of horticulture, the construction of earthen mounds for burial of the dead and, later, the introduction of the bow and arrow

are also considered Woodland innovations. During this period the Hopewell culture dominated much of the eastern United States. Traces of the Hopewell culture are present in Pennsylvania.

Historic

In the mid 17th century, when the first Europeans came to the area now known as Pennsylvania, they found Late Woodland people, known as the Delaware, Shawnee, Iroquois, and Susquehannock. The Susquehannocks inhabited the area now occupied by SSES. They were an Iroquoian-speaking tribe who lived along the Susquehanna River in Pennsylvania and Maryland. Living in Algonkian-speaking tribes' territory, they engaged in many wars. In the end, they were victims of diseases brought by European settlers, and to attacks by Marylanders and the Iroquois which destroyed them as a nation by 1675. A few descendants were among the Conestoga Indians who were massacred in 1763 in Lancaster County (PGA Undated).

The rise of nation-states in Europe coincided with the gaining of lands in North America. Wars in southern Germany caused many Germans to migrate to Pennsylvania. The struggle in England between the Crown and Parliament and the quest for religious freedom brought Quakers, Puritans, and Catholics from England, and Scot Calvinists via Ireland. Huguenots left France for America (PGA Undated).

The first recorded European contact with present-day Pennsylvania was made by Captain John Smith who journeyed from Virginia up the Susquehanna River in 1608, visiting the Susquehannock Indians. Between 1609 and 1681, the Dutch, Swedes, and English inhabited and fought over the region that would later become eastern Pennsylvania. Ultimately, the English prevailed and the area fell under English rule.

William Penn was born in London on October 24, 1644. As a young man, he converted to the Society of Friends, or Quakers, then a persecuted sect. Seeking a haven in the New World for persecuted Friends, Penn asked the King to grant him land in the territory between Lord Baltimore's province of Maryland and the Duke of York's province of New York. With the Duke's support, Penn's petition was granted. The King signed the Charter of Pennsylvania on March 4, 1681, and it was officially proclaimed on April 2. The King named the new colony in honor of William Penn's father (PHMC Undated a).

Although William Penn was granted all the land in Pennsylvania by the King, he and his heirs chose not to grant or settle any part of it without first buying the claims of Native Americans who lived there. In this manner, all of Pennsylvania except the northwestern third was purchased by 1768. The Commonwealth bought the claims to the remainder of the land by 1789 (PHMC Undated-a).

English Quakers were the dominant settlers, although many of them were Anglican. Thousands of Germans were also attracted to the colony and, by the time of the American Revolution, they comprised a third of the population. Another immigrant group was the Scotch-Irish, who migrated from about 1717 until the American Revolution in a series of waves caused by hardships in Ireland (PHMC Undated-a).

Other Quakers were Irish and Welsh. They, together with the French Huguenots, Jewish settlers, Dutch, Swedes, and other groups, contributed in smaller numbers to the development of colonial Pennsylvania (PHMC Undated-a).

Despite Quaker opposition to slavery, about 4,000 slaves were brought to Pennsylvania by 1730, most of them owned by English, Welsh, and Scotch-Irish colonists. The census of 1790 showed that the number of African-Americans had increased to about 10,000, of whom about 6,300 were free (PHMC Undated-a).

Regional Profile

The area surrounding SSES had a number of prehistoric populations. Remains of their subsistence-settlements are frequently found along major waterways, including the Susquehanna River and its branches. Village sites and trails associated with the Delaware, Nanticoke, Shawnee, Iroquois, Susquehannock, and other Native American tribes were located in the Susquehanna Valley. By the mid-eighteenth century, settlers began to occupy and lay claim to the Luzerne and Columbia County areas, which was then called Wyoming. In the years that followed, periods of unrest and war were frequent as various European, pioneers, and Native American groups sought possession of the Wyoming lands. The nineteenth century marked the beginning of settlement and stabilization in the Luzerne and Columbia County portions of Wyoming. By the beginning of the 20th century, the economic base of the area had shifted from agriculture, fishing, and lumbering to mining and manufacturing centered in three urban areas: Wilkes-Barre, Hazleton, and Pittston (NRC 1981).

Luzerne County

Luzerne County was created on September 25, 1786 from part of Northumberland County and named for the Chevalier de la Luzerne, French minister to the United States. Wilkes-Barre, the county seat, was laid out in 1772 and named for two members of the English Parliament, John Wilkes and Isaac Barre, both advocates of American rights. It was incorporated as a borough on March 17, 1806 and as a city on May 4, 1871 (PHMC Undated-b). Presently, Luzerne County produces about one-fourth of the anthracite coal in the state, mostly by surface operations. Economically, the county has had heavy unemployment since World War II, although new mining machines had made mining labor-efficient long before the market diminished in the

1960s. Only about one-eighth of Luzerne is farmed; harvested crops, especially potatoes, are more valuable than animal products (PHMC Undated-b).

Columbia County

Columbia was created on March 22, 1813 from part of Northumberland County. Bloomsburg, the county seat, was incorporated as a town on March 4, 1870, and is the only incorporated town in the state. Its name comes from Bloom Township, which was named for Samuel Bloom, a commissioner of Northumberland County. Berwick, the borough in Columbia County nearest SSES, was laid out in 1783 (PHMC Undated-b).

In Columbia County's history, boom-bust economics have had an impact. A boom in anthracite mining and the lumber industry occurred, however, similar to Columbia's farming, these industries yielded to competition in the 1930s. Abandoned coal mines are numerous and spread throughout eastern Pennsylvania. Also, a railroad car complex and Bloomsburg's silk and carpet works prospered until the national trend toward deindustrialization began in recent decades (Undated – incomplete reference).

Initial Construction and Operation

The Final Environmental Statement (FES) for construction of SSES listed eight important historic landmarks in Luzerne and Columbia Counties [Atomic Energy Commission (AEC 1973)]. Four were National Historic Register sites: Eckley Historic District, 19 miles southeast of SSES; Denison House, 20 miles northeast in Forty Fort; George Catlin Hall, Wilkes-Barre; McClintock House, Wilkes-Barre. The other sites were: Wapwallopen Native American Village, two miles southeast; Nescopeck Native American Village, five miles southwest; Council Cup Native American meeting place, near Wapwallopen; and the North Branch Canal. The AEC concluded that the construction of SSES would have no effect on any national historical landmarks and reported that Mr. Ira F. Smith, Archeologist at the William Penn Museum, and Mr. William J. Wewer, Executive Director of the Pennsylvania Historical and Museum Commission and State Liaison Officer for Historical Preservation, stated that the SSES project would not adversely impact any known archaeological or historical resources of value (AEC 1973).

In the FES for operation of SSES, the NRC concluded that direct impacts of the Station's operation on cultural resource sites would be expected to be minimal if known prehistoric sites were protected by a well-designed mitigation/avoidance program, and if care was exercised to recognize and protect cultural resources discovered during operational activities involving disruption of topsoil or vegetation (NRC 1981).

The NRC indicated that two Pennsylvania Power and Light Company (PP&L)-funded cultural resource studies of SSES property had taken place since the construction FES (NRC 1981).

The Knouse Site, an Historical Site in Luzerne County, Pennsylvania. 1978.

The first study was conducted in 1978 in response to an effort by PP&L to develop land across the Susquehanna River from the PPL Susquehanna station site. It was a study and subsequent salvage excavation of an historic Native American cemetery in an area called the Knouse site. Twenty-one burials and associated artifactual materials were removed by the Pennsylvania Historical and Museum Commission for further study. (NRC 1981).

Archaeological Investigations at the Susquehanna Steam Electric Station

In 1980, PP&L funded a second archaeological investigation at the SSES site (CAI 1981). The investigation identified prehistoric cultural resources on the floodplain below the site on the west side of the Susquehanna River. Eight sites were identified on SSES property. Of the eight sites, three were considered to be significant and offered possibilities for recommendation to the National Register by the Pennsylvania State Archaeologist. One additional site was considered to be potentially significant. Of the three significant sites, only one was considered to be in danger of adverse impact. Mitigating actions were recommended at site SES-6 and, at the time of publication of the document for this investigation, PP&L was in the process of implementing the recommendations (CAI 1981). The other two significant sites and the potential site required preservation only from future relandscaping and construction activities. In this investigation, it was concluded that, "[n]one of these recommendations should significantly alter PP&L's plans or schedule of activities for completion of the SES project."

A field review of the four archaeological sites of interest at the SSES was conducted on October 11, 2004. These sites have been monitored occasionally since the initial report of 1981 and additional mitigation actions have not been necessary.

The first site (SES 3) is located along the access road to the Environmental Laboratory. The site has not been disturbed and is covered either by the access road or dense shrub vegetation maintained under the power lines. No future disturbance is anticipated.

The second site (SES 6) is located along a drainage way between agricultural fields opposite Lake Took-A-While. Although this area was flooded during Hurricane Ivan in September, 2004, there was no erosion and planted vegetative cover remains in place.

The banks of the cut have been covered with grass after grading pursuant to the recommendations in (CAI 1981). There are no plans to disturb this area.

The third site (SES 8) is located in agricultural fields. At the time of this survey, field corn and potatoes were present (neither had been harvested). This area has been in continuous agriculture, but no disturbance below the plow line is evident.

The fourth site (SES 11) lies in a secondary flood plain forest near the Susquehanna River opposite Gould Island. This area has been undisturbed and is vegetated with a young forest of river birch, silver maple, and black cherry. No disturbance is evident or is planned at this site.

Current Status

As of 2004, the National Register of Historic Places listed 31 locations in Luzerne County and 29 locations in Columbia County, Pennsylvania (U.S. Department of the Interior 2004). Of these 60 locations, five fall within a 6-mile radius of SSES. Table 2.11-1 lists the five National Register of Historic Places sites within the 6-mile radius of SSES.

Table 2.11-1. Sites Listed in the National Register of Historic Places that fall within a 6-mile Radius of SSES

Site Name	Location
Bittenbender Covered Bridge	South of Huntington Mills off of LR 40076, Huntington Township.
Benjamin Evans House	Off of PA 93, Nescopeck.
Berwick Armory	201 Pine Street, Berwick.
Fowlersville Covered Bridge	SR 19039, Fowlersville.
Jackson Mansion and Carriage House	344 Market Street, Berwick.

Source: U.S. Department of the Interior 2004.

PPL Susquehanna has consulted with the State Historic Preservation Officer, who has agreed that the license renewal will have no adverse effect on significant cultural resources within the project area (PHMC 2005).

2.12 KNOWN OR REASONABLE FORSEEABLE PROJECTS IN SITE VICINITY

EPA-Permitted Dischargers to Air, Water, and Soil

PPL Susquehanna has applied for an Extended Power Uprate for SSES. The impacts evaluated in this environmental report consider extended operations at the increased power levels associated with this uprate.

The Safety Light Corporation is a manufacturing facility in Bloomsburg, approximately 17 miles southwest of Berwick. Safety Light Corporation currently uses tritium in the manufacture of self-illuminated signs. In the late 1940s U.S. Radium Corporation began operations at the site and used radium-226, strontium-90, promethium-147, thallium-204, nickel-63, cesium-137, and krypton-85. U.S. Radium buried radioactive wastes on-site, which resulted in the contamination of on-site soils and groundwater. The site has been proposed for listing on the National Priorities List.

Utilities within the Vicinity of SSES

Hunlock Power Station

The Hunlock Power Station (HPS) is approximately 10 miles northeast of SSES. It is a two-unit electric power station with 94 MW net capacity. One unit is a 50 MW coal-fired plant which began operation in 1959 and the other is a 44 MW natural gas-fired plant which began operation in 2000. HPS is owned by UGI Development Company (EIA 2004).

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Note to reader: Some web pages cited in this document are no longer available, or are no longer available through the original URL addresses. Hard copies of cited web pages are available in PPL Susquehanna files. Some sites, for example the census data, cannot be accessed through their given URLs. The only way to access these pages is to follow queries on previous web pages. The complete URLs used by PPL Susquehanna have been given for these pages, even though they may not be directly accessible. Also, all references are specific to respective chapter.

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3.0 PROPOSED ACTION

NRC

"…The report must contain a description of the proposed action, including the applicant's plans to modify the facility or its administrative control procedures…. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment…." 10 CFR 51.53(c)(2)

PPL Susquehanna proposes that the NRC renew the operating licenses for SSES for an additional 20 years. Renewal would give PPL Susquehanna and the Commonwealth of Pennsylvania the option of relying on SSES to meet future electricity needs. Section 3.1 discusses the plant in general. Sections 3.2 through 3.4 address potential changes that could occur as a result of license renewal.

3.1 GENERAL PLANT INFORMATION

General information about SSES is available in several documents. In 1981, the U.S. Nuclear Regulatory Commission published the *Final Environmental Statement related to the operation of Susquehanna Steam Electric Station* (NRC 1981). The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996) describes SSES features and, in accordance with NRC requirements, PPL Susquehanna maintains the Final Safety Analysis Report for SSES (PPL 2005). PPL Susquehanna has referred to each of these documents while preparing this environmental report for license renewal.

3.1.1 REACTOR AND CONTAINMENT SYSTEMS

SSES is a two-unit plant with boiling water reactors (BWR) and generators supplied by General Electric (GE). Bechtel Corporation was the architect-engineer and construction contractor. The original steam turbines supplied by GE were replaced by Siemens-Westinghouse units in 2003 (Unit 2) and 2004 (Unit 1). Commercial operation for SSES Unit 1 began on June 8, 1983 and for Unit 2 on February 12, 1985 (PPL 2005). The rated core thermal power for each unit will be 3,952 megawatts-thermal (MWt). This would increase the potential electrical output of each unit to approximately 1,300 megawatts-electrical (MWe); when NRC approves the Extended Power Uprate (Detamore 2004a, 2004b).

The nuclear steam supply system at SSES is typical of General Electric BWRs. The reactor core produces heat that boils water creating steam which, after drying, is routed to the turbines. The steam yields its energy to the turbines, which are connected to the electrical generator. SSES uses a BWR/4 reactor and a Mark II primary containment (PPL 2005).

The primary containment for each unit consists of a drywell, a steel structure that encloses the reactor vessel and related piping; a pressure suppression chamber containing a large volume of water; and a vent system that connects the drywell to the suppression chamber. The concrete reactor building, which houses the primary containment for both units, serves as a radiation shield and fulfills a secondary containment function.

The reactor fuel is uranium dioxide pellets sealed in Zircalloy-2 tubes. Fuel is enriched to no more than 5 percent, with an average burnup for the peak rod of up to 62,000 megawatt days per metric ton uranium (Fields 2004a).

The containment systems and their engineered safeguards are designed to ensure that offsite doses resulting from postulated accidents are well below the guidelines in 10 CFR 100.

3.1.2 COOLING AND AUXILIARY WATER SYSTEMS

At SSES, the Circulating Water and the Service Water Systems draw from the Susquehanna River and the Cooling Tower blowdown is discharged to the same river, downstream of the intake. Groundwater is withdrawn from five wells for domestic use and for other industrial purposes including seal water for circulating and service water pumps. The following subsections describe water systems at SSES.

3.1.2.1 Surface Water

SSES employs a closed-cycle heat dissipation system designed to remove waste heat from the Circulating Water System which cools the main condensers. The Circulating Water System includes the intake embayment, River Intake Structure, intake pumps, condensers, natural draft Cooling Towers, and an underground discharge pipe with a diffuser in the Susquehanna River. Warm circulating water from the Cooling Towers can be diverted to this intake structure in winter to prevent icing. This deicing system generally operates from November through March. Behind the two entrance chamber openings there is a skimmer wall, a bar screen, trash rack, and traveling screens to prevent large floating debris from clogging the intake.

The makeup water River Intake Structure is located on the west bank of the Susquehanna River (Figure 2.1-3 and 3.1-1). An earthen embankment extends 20 feet above the floodplain to elevation 517.7 feet above mean sea level, which is 1 foot above the maximum water elevation for the postulated Standard Project Flood (NRC 1981).

The intake structure consists of a steel superstructure above the operating floor and a reinforced concrete substructure extending into the rock below the level of the river bottom. The superstructure houses the makeup water pumps and associated equipment, including switchgear, automatic operating equipment for trash–handling screens, motor control centers, screen-wash strainers, and a debris-handling facility. The substructure contains two water entrance chambers (North and South bays) and each houses traveling screens and two pump chambers (NRC 1981).

Liquid effluents (including Cooling Tower blowdown, the spray pond overflow, and other liquid permitted effluents) are discharged to the Susquehanna River through a common discharge structure, approximately 600 feet downstream of the River Intake Structure (Figure 3.1-1). The discharge consists of a buried pipe leading to a submerged discharge structure/diffuser in the Susquehanna River. The diffuser pipe is 200 feet long; the last 120 feet has 72 four-inch portals designed to direct the discharge upward at a 45 degree angle facing downstream. The end of the pipe has a steel plate that can be removed for periodic cleaning of the diffuser (NRC 1981). The treated sewage plant effluent discharges to the Susquehanna River through a concrete outfall structure located between the river intake and discharge structures.

Susquehanna River water is drawn into the two intake bays (North and South) of the River Intake Structure, passes beneath the skimmer wall (in the intake structure) and then through 1 inch on-center vertical bar screens and 3/8-inch mesh traveling screens before entering the basin which houses four intake pumps, each with a pumping capacity of 13,500 gallons per minute (gpm). Prior to future Extended Power Uprate (EPU), three of these pumps normally supply the makeup flow of 40,500 gpm and at certain times of the year, the fourth intake pump is rotated into service. EPU will however, increase the amount of time the fourth pump will be used.

The screen-wash system includes a low-pressure wash to release aquatic organisms and debris impinged on the traveling screens. The screen wash system is operated either automatically by differential pressure sensors or by a timer for periodic cleaning. The screen wash water and debris drain to a pit with debris removal equipment that collects material into a dumpster for offsite disposal. After passing through the screens, water is then pumped to the Cooling Tower basins via underground pipes (NRC 1981).

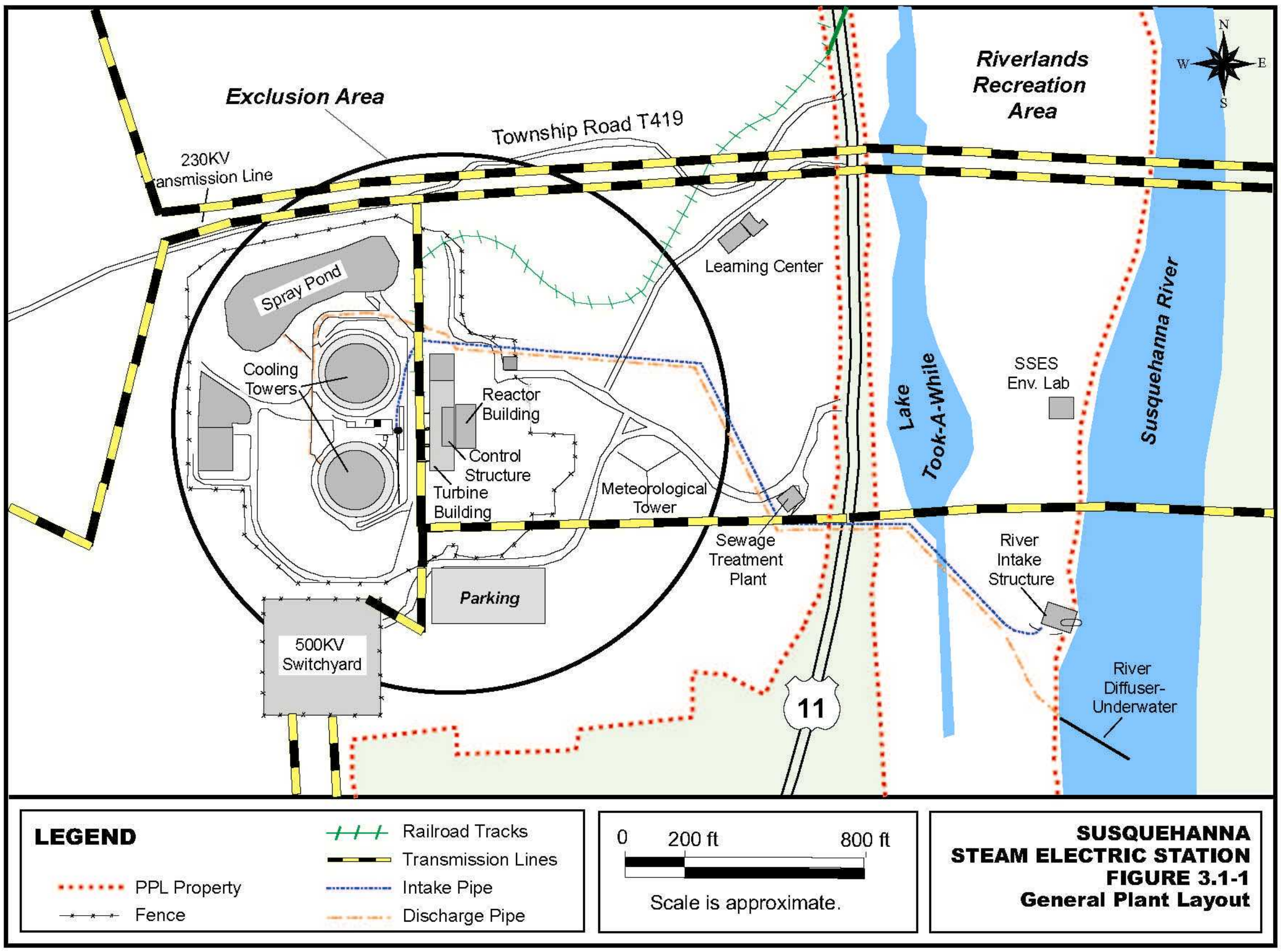
Water is withdrawn from the Cooling Tower basins by the Circulating Water System and is circulated through the main condensers, and returned to the Cooling Towers at the rate of 968,000 gpm (484,000 gpm for each tower). Also, the Service Water System withdraws water from the basins at a rate of approximately 54,000 gpm (27,000 gpm for each tower) for cooling various heat exchangers and equipment and returns the water to the basins (PPL 2005; PPL 2006). Each counterflow natural-draft Cooling Tower is 540 feet tall with a base diameter of 420 feet (NRC 1981). Cooling water evaporated (consumptive use) into the atmosphere is estimated to be 26,800 gpm pre-EPU and is expected to increase to 30,500 gpm at EPU conditions. The remaining water withdrawn from the river is discharged back to the river through the blowdown line. Blowdown is currently discharged at a rate of 10,800 gpm via the underground diffuser system located on the bottom of the Susquehanna River. Blowdown will be increased to about 11,200 gpm with the EPU (NRC 1981; Fields 2005).

Consumptive water use at SSES is regulated by the Susquehanna River Basin Commission (SRBC) in 18 CFR Part 803. Under SRBC's regulations, SSES must compensate for the consumptive use of water from the Susquehanna River. Consumptive use at the SSES is that portion of the water withdrawn from the river that evaporates into the atmosphere mainly through the Circulating Water System's two natural draft Cooling Towers. In 1986 a contract between the SRBC and PP&L provided for SSES's compliance with this requirement through PP&L sharing in the costs of modification and operation by the Army Corps of Engineers of the Cowanesque Lake Reservoir. In 1995 the SRBC issued a docket (Application 19950301) stating that it was approving consumptive use of 40 MGD (monthly average), not to exceed a daily use of 48 MGD at Susquehanna SES. PPL expects that consumptive use at Susquehanna SES will exceed the monthly average stated above by 4 MGD and the daily maximum is estimated to be around 48 MGD after the power uprates described herein are completed. PPL is discussing this matter with the SRBC.

In addition, there is an 8-acre lined concrete spray pond (Figure 3.1-1), containing 25 million gallons of water and it is the station's ultimate heat sink for the Engineered Safeguard Service Water System. This pond provides auxiliary cooling and supplies cooling water for the diesel generators and the Residual Heat Removal Service Water System during unit shutdowns. Makeup water for the spray pond is supplied by the River Water Makeup System (NRC 1981).

Finally, approved water treatment chemicals (e.g., sodium hypochlorite and sodium bromide, non-oxidizing biocides, scale inhibitors, etc.) are injected into the Circulating Water and Service Water Systems to minimize fouling in the pipes and condensers in accordance with NPDES permit requirements (PDEP 2005).

Figure 3.1-1. General Plant Layout



3.1.2.2 Groundwater Resources

SSES has five Public Water Supply (PWS) groundwater wells used for domestic water and for other industrial purposes that do not include condenser cooling: PWS 2400994, Site Water System (TW-1 and TW-2); PWS 2400999, Energy Information Center; PWS 2400995, Riverlands; and PWS 2400938, West Building (former Emergency Operations Facility).

The site's main production wells are TW-1 and TW-2 (PDWS 1989). Well TW-2 is the primary production well for the site's potable and sanitary systems and for plant use. Well TW-1 is 75 feet deep and contained within the same metered water supply system as TW-2, but is rarely used. Well TW-1 can yield 50 gpm (72,000 gallons per day). Well TW-2 is 75 feet deep and can yield 150 gpm (216,000 gpd). The initial average well system withdrawal was between 21 gpm (30,000 gpd) and 31.25 gpm (45,000 gpd). Metered flow data from July 1999 through June 2003 indicate Well TW-2 withdraws groundwater at an average rate of 65.4 gpm (94,000 gpd) (Fields 2004b).

Well system operation began in 1974 at the SSES prior to the SRBC establishing groundwater withdrawal regulations (effective July 13, 1978). The site well system (essentially well TW-2) today withdraws approximately 65.4 gpm (94,000 gpd). With respect to groundwater withdrawals initiated prior to July 13, 1978, any increase of more than 100,000 gpd above the withdrawal amount prior to July 13, 1978 is subject to approval of the SRBC. Thus, at SSES, approval by the SRBC is not required.

The SRBC also requires that any project that results in a consumptive use of groundwater (or surface water) exceeding 20,000 gpd is subject to their approval. Groundwater from production well TW-2 is used for domestic purposes, making demineralized water, for maintaining Service and Circulating Water pump seals, and for the Unit 2 Vacuum Priming Pumps. Consumptive use is estimated to be below 20,000 gpm with most groundwater mixing with surface water and discharged back to the river.

In addition to the site well system there are three nearby wells located at the SSES used for domestic purposes only. Consumptive use combined for all three of these nearby wells is estimated to be well below the SRBC's consumptive use approval requirement of 20,000 gpd. These three wells are:

A well to a depth of 100 feet is located at the Energy Information Center (PDWS 1985a) and produces water for potable and sanitary use for six employees and visitors to the facility. This well is capable of yielding groundwater at a rate of 15 gpm (21,600 gallons per day).

A well installed to a depth of 105 feet is located at the Riverlands Recreational Facility (PDWS 1985b) and provides potable and sanitary water for users of the recreational area from mid-April through October during daylight hours. The water system is not used during cold weather. This well is capable of yielding water at a rate of 30 gpm (43,200 gallons per day).

A fifth well is installed to a depth of 55 feet and is located at the West Building (PDWS 1985c). This well is capable of yielding 30 gpm (43,200 gallons per day). Well-water usage varies at the West Building. Fewer than 10 permanent staff are located at this training facility but as many as 50 individuals can be there when classes are being conducted.

3.1.3 TRANSMISSION FACILITIES

The FESs for construction and operation (AEC 1973; NRC 1981) identified three short 230-kilovolt ties in the vicinity of SSES, one longer 230 kilovolt line (Stanton-Susquehanna #2 line), and two longer 500 kilovolt lines (Sunbury-Susquehanna #2 and Susquehanna-Siegfried) that were built to connect SSES to the electric grid. The three short connections were to provide startup power for SSES from pre-existing 230-kilovolt lines in the immediate vicinity of the plant (Montour and Nanticoke) and to connect the Unit 1 output to the pre-existing 230-kilovolt Susquehanna Switchyard across the Susquehanna River. The Stanton-Susquehanna #2 line was built to 500 kilovolt standards, but was intended to initially operate at 230 kilovolts until Unit 2 became operational. Unit 2 has a new 500 kilovolt switchyard. The construction phase FES also identifies several pre-existing transmission lines that connected to the 230 kilovolt Susquehanna switchyard. These are the Stanton #1, Jenkins, Harwood, and Sunbury #1 lines.

After publication of the operating license FES, several changes were made to the transmission system; namely:

- The 230/500 kilovolt Stanton-Susquehanna #2 line was not changed to operate at 500 kilovolts as planned and remains at 230 kilovolts.
- The Nanticoke line was renamed the Mountain line. Through one of the short 230 kilovolt ties described in the FES, the Mountain line and the Montour line, currently provide power to the T-10 230 kilovolt switchyard, which provides startup power for SSES.

- The Susquehanna-Siegfried line was extended and terminated initially at the Wescosville substation instead of the Siegfried substation. It was ultimately extended to the Alburtis substation and was renamed the Susquehanna-Wescosville-Alburtis 500 kV line.

- A 230-kilovolt E. Palmerton line was constructed to connect to the Susquehanna 230-kilovolt Switchyard (line connects switchyards).

As a result of these system changes, the transmission lines of interest for this report are somewhat different than those described in the FES, as indicated below. Figure 2.1-1 includes the transmission system of interest.

- Short ties in the SSES vicinity – These lines identified in the FES as necessary to connect SSES to the 230-kilovolt electrical system are 2.3 miles long to connect the Montour and Mountain lines to the 230-kilovolt T-10 switchyard, 1.8 miles to connect the Stanton 230/500 kilovolt line to the 230-kilovolt switchyard, and 2.2 miles to connect the Unit 1 main transformer to the 230-kilovolt switchyard across the Susquehanna River. These lines are primarily in areas controlled by SSES and not accessible to the public; however, U.S. Highway 11, Pennsylvania State Highway 239, and other paved roads in the immediate plant vicinity are crossed by the short ties.

- Stanton-Susquehanna #2 230/500 kilovolt Line – Operating at 230 kilovolts, this single circuit runs generally northeast from SSES for approximately 30 miles in a 100- to 400-footwide corridor.

- Susquehanna-Wescosville-Alburtis Line – This 500-kilovolt line connects SSES with the Alburtis substation. It runs generally southeast for approximately 76 circuit miles in a corridor ranging from 100 to 350 feet wide.

- Sunbury-Susquehanna #2 Line – This 500-kilovolt line shares a corridor with the pre-existing Sunbury #1 line and runs west-southwest. The corridor is about 325 feet wide and approximately 44 miles long.

The pre-existing transmission lines are not within the scope of interest because they were not constructed for the specific purpose of connecting SSES to the transmission system. The E. Palmerton line is not included because it is not connected directly to SSES but to a pre-existing substation, and it was not identified in the FES for operation as necessary for connecting SSES to the transmission system.

In total, for the specific purpose of connecting SSES to the transmission system, owned and operated by PPL Electric Utilities has approximately 150 miles of corridor that occupy approximately 3,341 acres. The corridors pass through land that is primarily agricultural or forest land. The areas are mostly remote, with low population densities.

PP&L designed and constructed all SSES transmission lines in accordance with industry standards in effect that were current when the lines were built. Ongoing surveillance and maintenance of SSES-related transmission facilities by PPL Electric Utilities ensures continued conformance to design standards. These maintenance practices are described in Sections 2.4 and 4.13. Section 4.13 examines the conformance of the lines with the National Electrical Safety Code requirements on line clearance to limit shock from induced currents (IEEE 1997).

PPL Electric Utilities plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. Except for the short ties, these transmission lines will remain a permanent part of the transmission system even after SSES is decommissioned.

3.2 REFURBISHMENT ACTIVITIES

NRC

"… The report must contain a description of … the applicant's plans to modify the facility or its administrative control procedures…. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment…." 10 CFR 51.53(c)(2)

"… The incremental aging management activities carried out to allow operation of a nuclear power plant beyond the original 40 year license term will be from one of two broad categories: ... and (2) major refurbishment or replacement actions, which usually occur fairly infrequently and possibly only once in the life of the plant for any given item…." NRC 1996

PPL Susquehanna has addressed refurbishment activities in this environmental report in accordance with NRC regulations and complementary information in the NRC GEIS for license renewal (NRC 1996). NRC requirements for the renewal of operating licenses for nuclear power plants include the preparation of an integrated plant assessment (IPA) (10 CFR 54.21). The IPA must identify and list systems, structures, and components subject to an aging management review. Items that are subject to aging and might require refurbishment include, for example, the reactor vessel piping, supports, and pump casings (see 10 CFR 54.21 for details), as well as items that are not subject to periodic replacement.

In turn, NRC regulations for implementing the National Environmental Policy Act require environmental reports to describe in detail and assess the environmental impacts of refurbishment activities such as planned modifications to systems, structures, and components or plant effluents [10 CFR 51.53(c)(2)]. Resource categories to be evaluated for impacts of refurbishment include terrestrial resources, threatened and endangered species, air quality, housing, public utilities and water supply, education, land use, transportation, and historic and archaeological resources.

The GEIS (NRC 1996) provides helpful information on the scope and preparation of refurbishment activities to be evaluated in this environmental report. It describes major refurbishment activities that utilities might perform for license renewal that would necessitate changing administrative control procedures and modifying the facility. The

GEIS analysis assumes that an applicant would begin any major refurbishment work shortly after NRC grants a renewed license and would complete the activities during five outages, including one major outage at the end of the 40th year of operation. The GEIS refers to this as the refurbishment period.

GEIS Table B.2 lists license renewal refurbishment activities that NRC anticipated generation companies might undertake. In identifying these activities, the GEIS intended to encompass actions that typically take place only once, if at all, in the life of a nuclear plant. The GEIS analysis assumed that a generation company would undertake these activities solely for the purpose of extending plant operations beyond 40 years, and would undertake them during the refurbishment period. The GEIS indicates that many plants will have undertaken various refurbishment activities to support the current license period, but that some plants might undertake such tasks only to support extended plant operations.

The SSES IPA that PPL Susquehanna conducted under 10 CFR 54 has not identified the need to undertake any major refurbishment or replacement actions to maintain the functionality of important systems, structures, and components during the SSES license renewal period, or other facility modifications associated with license renewal that would affect the environment or plant effluents. PPL Susquehanna has included the IPA as part of this application.

3.3 PROGRAMS AND ACTIVITIES FOR MANAGING THE EFFECTS OF AGING

NRC

"…The report must contain a description of … the applicant's plans to modify the facility or its administrative control procedures…. This report must describe in detail the modifications directly affecting the environment or affecting plant effluents that affect the environment…." 10 CFR 51.53(c)(2)

"…The incremental aging management activities carried out to allow operation of a nuclear power plant beyond the original 40 year license term will be from one of two broad categories: (1) SMITTR actions, most of which are repeated at regular intervals …." NRC 1996 (SMITTR is defined in NRC 1996 as surveillance, monitoring, inspections, testing, trending, and recordkeeping.)

The IPA required by 10 CFR 54.21 identifies the programs and inspections for managing aging effects at SSES. These programs are described in the Susquehanna Steam Electric Station License Renewal Application, Appendix B, Aging Management Programs and Activities. Other than implementation of the programs and inspections identified in the IPA, there are no planned modifications of SSES administrative control procedures associated with license renewal.

3.4 EMPLOYMENT

Current Workforce

SSES employs a nuclear-related permanent workforce of approximately 1,200 employees and up to an additional 260 contract and matrixed employees; this is within the range of 600 to 800 personnel per reactor unit estimated in the GEIS (NRC 1996). Approximately 89 percent of SSES's permanent employees live in Luzerne or Columbia Counties, Pennsylvania. The remaining 11 percent are distributed across 14 counties in Pennsylvania with numbers ranging from 1 to 37 employees per county. A very small percentage (less than one percent) of the workforce lives outside of Pennsylvania.

The SSES reactors are on 24-month refueling cycles with Units 1 and 2 refueling on alternate years. During refueling outages, site employment increases above the permanent workforce by as many as 1,400 workers for temporary (25 to 30 days) duty.

License Renewal Increment

Performing the license renewal activities would necessitate increasing SSES staff workload by some increment. The size of this increment would be a function of the schedule within which PPL Susquehanna must accomplish the work and the amount of work involved. Having determined that it would not undertake refurbishment (Section 3.2), PPL Susquehanna focused its analysis of license renewal employment increment on programs and activities for managing the effects of aging (Section 3.3).

The GEIS (NRC 1996, Section 2.6.2.7) assumes that NRC would renew a nuclear power plant license for a 20-year period. The GEIS further assumes that the utility would initiate surveillance, monitoring, inspection, testing, trending, and recordkeeping (SMITTR) activities at the time of issuance of the new license and would conduct license renewal SMITTR activities throughout the remaining life of the plant, sometimes during full-power operation, but mostly during normal refueling and the 5- and 10-year in-service refueling outages (NRC 1996).

PPL Susquehanna has determined that the GEIS scheduling assumptions are reasonably representative of SSES incremental license renewal workload scheduling. Many SSES license renewal SMITTR activities would have to be performed during outages. Although some SSES license renewal SMITTR activities would be one-time efforts, others would be recurring periodic activities that would continue for the life of the station.

The GEIS estimates that the most additional personnel needed to perform license renewal SMITTR activities would typically be 60 persons during the 3-month duration of

a 10-year in-service refueling. Having established this upper value for what would be a single event in 20 years, the GEIS uses this number as the expected number of additional permanent workers needed per unit attributable to license renewal. GEIS Section 4.7 uses this approach in order to "...provide a realistic upper bound to potential population-driven impacts…."

PPL Susquehanna expects that existing "surge" capabilities for routine activities, such as outages, will enable PPL Susquehanna to perform the increased SMITTR workload without adding SSES staff. It is estimated that at most, five non-outage employees may be needed. Therefore, PPL Susquehanna has no plans to add more than five non-outage employees to support SSES operations during the license renewal term. However, for the purposes of evaluating work-force related impacts in this environmental report only, PPL Susquehanna is assuming that SSES would require 60 additional permanent workers to perform all license renewal SMITTR activities.

Adding full-time employees to the plant workforce for the license renewal operating term would have the indirect effect of creating additional jobs and related population growth in the community. PPL Susquehanna has used an employment multiplier appropriate to Luzerne and Columbia Counties, Pennsylvania (2.9535) (Watson 2004), to calculate the indirect jobs in service industries that would be supported by the spending of the SSES workforce. The addition of 60 license renewal employees would generate approximately 117 indirect jobs in Luzerne or Columbia Counties. This number was calculated as follows: 60 (additional employees) × 2.9535 (regional multiplier) = 177 (total employees). Of these, 60 would be direct employees and 117 would be additional jobs created in the community.

3.5 REFERENCES

Note to reader: Some web pages cited in this document are no longer available, or are no longer available through the original URL addresses. Hard copies of cited web pages are available in PPL Susquehanna files. Some sites, for example the census data, cannot be accessed through their given URLs. The only way to access these pages is to follow queries on previous web pages. The complete URLs used by PPL Susquehanna have been given for these pages, even though they may not be directly accessible. Also, all references are specific to respective chapter.

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4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND MITIGATING ACTIONS

NRC

"The report must contain a consideration of alternatives for reducing impacts…for all Category 2 license renewal issues…." 10 CFR 51.53(c)(3)(iii)

"The environmental report shall include an analysis that considers…the environmental effects of the proposed action…and alternatives available for reducing or avoiding adverse environmental effects." 10 CFR 51.45(c) as adopted by 10 CFR 51.53(c)(2)

The environmental report shall discuss the "…impact of the proposed action on the environment. Impacts shall be discussed in proportion to their significance…." 10 CFR 51.45(b)(1) as adopted by 10 CFR 51.53(c)(2)

"The information submitted…should not be confined to information supporting the proposed action but should also include adverse information." 10 CFR 51.45(e) as adopted by 10 CFR 51.53(c)(2)

Chapter 4 presents an assessment of the environmental consequences associated with the renewal of the Susquehanna Steam Electric Station (SSES) operating license. The U.S. Nuclear Regulatory Commission (NRC) has identified and analyzed 92 environmental issues that it considers to be associated with nuclear power plant license renewal and has designated the issues as Category 1, Category 2, or NA (not applicable). NRC designated an issue as Category 1 if, based on the result of its analysis, the following criteria were met:

- the environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic;
- a single significance level (i.e., small, moderate, or large) has been assigned to the impacts that would occur at any plant, regardless of which plant is being evaluated (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent-fuel disposal); and
- mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely to be not sufficiently beneficial to warrant implementation.

If the NRC analysis concluded that one or more of the Category 1 criteria could not be met, NRC designated the issue as Category 2. NRC requires plant-specific analyses for Category 2 issues.

Finally, NRC designated two issues as NA, signifying that the categorization and impact definitions do not apply to these issues.

NRC rules do not require analyses of Category 1 issues that NRC resolved using generic findings (10 CFR 51) as described in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996a). An applicant may reference the generic findings or GEIS analyses for Category 1 issues. Attachment A of this report lists the 92 issues and identifies the environmental report section that addresses each issue.

CATEGORY 1 AND NA LICENSE RENEWAL ISSUES

> **NRC**
>
> "The environmental report for the operating license renewal stage is not required to contain analyses of the environmental impacts of the license renewal issues identified as Category 1 issues in Appendix B to subpart A of this part." 10 CFR 51.53(c)(3)(i)
>
> "…[A]bsent new and significant information, the analyses for certain impacts codified by this rulemaking need only be incorporated by reference in an applicant's environmental report for license renewal…." (NRC 1996b, pg. 28483)

PPL Susquehanna has determined that seven of the 69 Category 1 issues do not apply to SSES because they are specific to design or operational features that are not found at the facility. Because PPL Susquehanna is not planning any refurbishment activities, seven additional Category 1 issues related to refurbishment do not apply. Attachment Table A-1 lists the 69 Category 1 issues, indicates whether or not each issue is applicable to SSES, and if inapplicable provides the PPL Susquehanna basis for this determination. Attachment Table A-1 also includes references to supporting analyses in the GEIS where appropriate.

PPL Susquehanna has reviewed the NRC findings at 10 CFR 51 (Table B-1) and has not identified any new and significant information that would make the NRC findings, with respect to Category 1 issues, inapplicable to SSES. Therefore, PPL Susquehanna adopts by reference the NRC findings for these Category 1 issues.

"NA" License Renewal Issues

NRC determined that its categorization and impact-finding definitions did not apply to Issues 60 and 92; however, PPL Susquehanna included these issues in Table A-1. NRC noted that applicants currently do not need to submit information on Issue 60, chronic effects from electromagnetic fields (10 CFR 51). For Issue 92, environmental justice, NRC does not require information from applicants, but noted that it will be addressed in individual license renewal reviews (10 CFR 51). PPL Susquehanna has included environmental justice demographic information in Section 2.6.2.

CATEGORY 2 LICENSE RENEWAL ISSUES

NRC

"The environmental report must contain analyses of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with license renewal and the impacts of operation during the renewal term, for those issues identified as Category 2 issues in Appendix B to subpart A of this part." 10 CFR 51.53(c)(3)(ii)

"The report must contain a consideration of alternatives for reducing adverse impacts, as required by § 51.45(c), for all Category 2 license renewal issues…." 10 CFR 51.53(c)(3)(iii)

NRC designated 21 issues as Category 2. Sections 4.1 through 4.20 (section 4.17 addresses 2 issues) address the Category 2 issues, beginning with a statement of the issue. Six Category 2 issues apply to operational features that SSES does not have. In addition, four Category 2 issues apply only to refurbishment activities. If the issue does not apply to SSES, the section explains the basis for inapplicability.

For the 11 Category 2 issues that PPL Susquehanna has determined to be applicable to SSES, the appropriate sections contain the required analyses. These analyses include conclusions regarding the significance of the impacts relative to the renewal of the operating license for SSES and, if applicable, discuss potential mitigative alternatives to the extent required. PPL Susquehanna has identified the significance of the impacts associated with each issue as either small, moderate, or large, consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3 as follows:

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.

LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In accordance with National Environmental Policy Act (NEPA) practice, PPL Susquehanna considered ongoing and potential additional mitigation in proportion to the significance of the impact to be addressed (i.e., impacts that are small receive less mitigative consideration than impacts that are large).

4.1 WATER USE CONFLICTS (PLANTS WITH COOLING PONDS OR COOLING TOWERS USING MAKEUP WATER FROM A SMALL RIVER WITH LOW FLOW)

NRC

"If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3 / year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided. The applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow." 10 CFR 51.53(c)(3)(ii)(A)

"…The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 13

The NRC made surface water use conflicts a Category 2 issue because consultations with regulatory agencies indicate that water use conflicts are already a concern at two closed-cycle plants and may be a problem in the future at other plants. In the GEIS, NRC notes two factors that may cause water use and availability issues to become important for some nuclear power plants that use Cooling Towers. First, some plants equipped with Cooling Towers are located on small rivers that are susceptible to droughts or competing water uses. Second, consumptive water loss associated with closed-cycle cooling systems may represent a substantial proportion of the flows in small rivers (NRC 1996a, Section 4.3.2.1).

As discussed in Section 3.1.2, SSES has a natural-draft Cooling Tower heat dissipation system. Circulated cooling water lost to Cooling Tower evaporation and blowdown is replaced by make-up water pumped from the Susquehanna River. Based on data from 1961 to 2002, the annual mean flow of the Susquehanna River at SSES is $4.6\text{x}10^{11}$ cubic feet per year (14,586 cfs) (Ecology III 2003), which means that the Susquehanna River meets the NRC definition of a small river. Therefore, this issue does apply to SSES.

With the Extended Power Uprate, SSES will pump river water to be used as make-up water for the Cooling Towers at an average rate of 42,300 gallons per minute (gpm)

(94 cfs) (NRC 1981; Fields 2005). With the Extended Power Uprate, Cooling Tower blowdown is returned to the river via National Pollutant Discharge Elimination System (NPDES) discharge at a rate of approximately 11,200 gpm (25 cfs) (NRC 1981; Fields 2005). A maximum daily total withdrawal of about 43,200 gpm was estimated at a wet bulb temperature of 77°F and a relative humidity of 65% (PPL 2006).

If one assumes a discharge to the Susquehanna River of 11,200 gpm (25 cfs) and an average withdrawal rate of approximately 42,300 gpm (94 cfs), then the net consumptive loss to the Susquehanna River is approximately 31,100 gpm (69 cfs). Consumptive use represents approximately 0.47 percent of the average river flow at SSES over the past 42 years. However, the Susquehanna River Basin has a consumptive water use regulation administered by the SRBC as described in Section 3.1.2 and SSES has met the requirements of this regulation by providing another source of water during low-flow conditions. PPL Susquehanna and SRBC entered into a contract for low-flow augmentation. Negotiations are ongoing with the SRBC for additional low-flow augmentation due to Extended Power Uprate. The increase in discharge from 10,800 gpm to 11,200 gpm should not have any adverse impacts on instream or riparian ecological communities. Using a discharge pipe on the bottom of the river readily, disperses blowdown once in the river. Therefore, SSES has determined that this impact is SMALL and does not warrant further mitigation.

4.2 ENTRAINMENT OF FISH AND SHELLFISH IN EARLY LIFE STAGES

NRC

"If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations…or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from…entrainment." 10 CFR 51.53(c)(3)(ii)(B)

"...The impacts of entrainment are small in early life stages at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid..." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 25

The issue of entrainment of fish and shellfish in early life stages does not apply to SSES because the station does not utilize once-through cooling or cooling pond heat dissipation systems.

4.3 IMPINGEMENT OF FISH AND SHELLFISH

NRC

"If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act 316(b) determinations…or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from…impingement…." 10 CFR 51.53(c)(3)(ii)(B)

"…The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems…." 10 CFR 51, Subpart A, Appendix B, Table B 1, Issue 26

The issue of impingement of fish and shellfish does not apply to SSES because the station does not utilize once-through cooling or cooling pond heat dissipation systems.

4.4 HEAT SHOCK

NRC

"If the applicant's plant utilizes once-through cooling or cooling pond heat dissipation systems, the applicant shall provide a copy of current Clean Water Act… 316(a) variance in accordance with 40 CFR Part 125, or equivalent State permits and supporting documentation. If the applicant cannot provide these documents, it shall assess the impact of the proposed action on fish and shellfish resources resulting from heat shock …." 10 CFR 51.53(c)(3)(ii)(B)

"…Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 27

The issue of heat shock does not apply to SSES because the station does not utilize once-through cooling or cooling pond heat dissipation systems.

4.5 GROUNDWATER USE CONFLICTS (PLANTS USING > 100 GPM OF GROUNDWATER)

NRC

"If the applicant's plant…pumps more than 100 gallons (total onsite) of ground water per minute, an assessment of the impact of the proposed action on groundwater use must be provided." 10 CFR 51.53(c)(3)(ii)(C)

"…Plants that use more than 100 gpm may cause ground-water use conflicts with nearby ground-water users…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 33

NRC made this groundwater use conflict a Category 2 issue because overuse of an aquifer could exceed the natural recharge. Locally, a withdrawal rate of more than 100 gallons per minute (gpm) could create a cone of depression that could extend offsite. This could inhibit the withdrawal capacity of nearby offsite users.

As described in Section 3.1.2.2 (Groundwater Resources), the average groundwater use for Wells TW-1 (even though tied into SSES well water system it does not presently provide water) and TW-2 at SSES from July 1999 to June 2003 was 65.4 gpm. In addition, offsite buildings could use another 5.5 gpm. Therefore, the issue of groundwater use conflicts (plants using more than 100 gpm groundwater) does not apply.

4.6 GROUNDWATER USE CONFLICTS (PLANTS USING COOLING TOWERS WITHDRAWING MAKEUP WATER FROM A SMALL RIVER)

NRC

"If the applicant's plant utilizes cooling towers or cooling ponds and withdraws make-up water from a river whose annual flow rate is less than 3.15×10^{12} ft^3 / year...[t]he applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow." 10 CFR 51.53(3)(ii)(A)

"…Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come on line before the time of license renewal…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 34

NRC made this groundwater use conflict a Category 2 issue because surface water withdrawals from small rivers could adversely impact aquatic life, downstream users of the small river, and groundwater-aquifer recharge. This is a particular concern during low-flow conditions and could create a cumulative impact due to upstream consumptive use. Cooling Towers and cooling ponds lose flow by evaporation, which is necessary to cool the heated water before it is discharged to the environment.

The issue of groundwater use conflicts applies because SSES withdraws makeup water from a small river, the Susquehanna River, which has an annual flow of 4.6×10^{11} cubic feet per year (14,586 cfs) at the SSES intake location (Ecology III 2003). As discussed in Section 3.1.2, SSES has a natural-draft Cooling Tower heat dissipation system. Circulated cooling water lost to Cooling Tower evaporation is replaced by make-up water pumped from the Susquehanna River.

During low flow (drought) conditions surface water is released from the U.S. Army Corps of Engineers Cowanesque Reservoir in coordination with the SRBC to replace station consumptive use water. As stated in Section 3.1.2, PPL is in compliance with SRBC low flow augmentation regulations.

Given the Susquehanna River flow and the fact that the site area is not located in a recharge area for any aquifer (see Section 2.3), SSES concludes that impacts of withdrawing water from the river on the alluvial aquifer would be SMALL and that mitigation measures would not be warranted. In addition, should increases in groundwater usage occur, procedures are in place via the SRBC regulations to

compensate for this usage and PPL Susquehanna would comply with those requirements.

4.7 GROUNDWATER USE CONFLICTS (PLANTS USING RANNEY WELLS)

NRC

"If the applicant's plant uses Ranney wells…an assessment of the impact of the proposed action on groundwater use must be provided." 10 CFR 51.53(c)(3)(ii)(C)

"…Ranney wells can result in potential ground-water depression beyond the site boundary. Impacts of large ground-water withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 35

NRC made this groundwater use conflict a Category 2 issue because large quantities of groundwater withdrawn from Ranney wells could degrade groundwater quality at river sites by induced infiltration of poor-quality river water into an aquifer.

The issue of groundwater use conflicts does not apply to SSES because the plant does not use Ranney wells. As Section 3.1.2 describes, SSES uses a closed cycle cooling system with Cooling Towers that removes make-up water from the Susquehanna River and discharges blowdown to the Susquehanna River.

4.8 DEGRADATION OF GROUNDWATER QUALITY

NRC

"If the applicant's plant is located at an inland site and utilizes cooling ponds, an assessment of the impact of the proposed action on groundwater quality must be provided." 10 CFR 51.53(c)(3)(ii)(D)

"…Sites with closed-cycle cooling ponds may degrade ground-water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses…." 10 CFR 51, Subpart A, Appendix B, Table B 1, Issue 39

NRC made degradation of groundwater quality a Category 2 issue because evaporation from closed-cycle cooling ponds concentrates dissolved solids in the water and settles suspended solids. In turn, seepage into the water table aquifer could degrade groundwater quality.

The issue of groundwater degradation does not apply to SSES because the plant does not use cooling ponds. As Section 3.1.2 describes, SSES uses a closed cycle cooling system with Cooling Towers that withdraws make-up water from the Susquehanna River and discharges blowdown to the Susquehanna River.

4.9 IMPACTS OF REFURBISHMENT ON TERRESTRIAL RESOURCES

NRC

The environmental report must contain an assessment of "…the impacts of refurbishment and other license renewal-related construction activities on important plant and animal habitats…." 10 CFR 51.53(c)(3)(ii)(E)

"…Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 40

"…If no important resources would be affected, the impacts would be considered minor and of small significance. If important resources could be affected by refurbishment activities, the impacts would be potentially significant…." NRC 1996a

NRC made impacts to terrestrial resources from refurbishment a Category 2 issue, because the significance of ecological impacts cannot be determined without considering site- and project-specific details (NRC 1996a). Aspects of the site and project to be ascertained are: (1) the identification of important ecological resources, (2) the nature of refurbishment activities, and (3) the extent of impacts to plant and animal habitats.

The issue of impacts of refurbishment on terrestrial resources is not applicable to SSES because, as discussed in Section 3.2, PPL Susquehanna has no plans for refurbishment or other license-renewal-related construction activities at SSES.

4.10 THREATENED OR ENDANGERED SPECIES

NRC

"Additionally, the applicant shall assess the impact of the proposed action on threatened or endangered species in accordance with the Endangered Species Act." 10 CFR 51.53(c)(3)(ii)(E)

"Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 49

NRC made impacts to threatened and endangered species a Category 2 issue because the status of many species is being reviewed, and site-specific assessment is required to determine whether any identified species could be affected by refurbishment activities or continued plant operations through the renewal period. In addition, compliance with the Endangered Species Act requires consultation with the appropriate federal agency (NRC 1996a, Sections 3.9 and 4.1).

Section 2.2 of this Environmental Report describes the aquatic communities of the Susquehanna River. Section 2.4 describes important terrestrial habitats at SSES and along the associated transmission corridors. Section 2.5 discusses threatened or endangered species that may occur in the vicinity of SSES or its associated transmission corridors.

Except as discussed in Section 2.5, PPL Susquehanna is not aware of any threatened or endangered species that could occur at SSES or along the associated transmission corridors. Current operation of SSES and vegetation management practices along the transmission line rights-of-way do not adversely affect any listed species or its habitat (see Section 2.5). Furthermore, plant operations and transmission line maintenance practices are not expected to change significantly during the license renewal term. Therefore, no adverse impacts to threatened or endangered terrestrial species from current or future operations are anticipated.

PPL Susquehanna wrote the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Game Commission, the Pennsylvania Fish and Boat Commission, and the U.S. Fish and Wildlife Service requesting information on any listed

species or critical habitats that might occur on the SSES site or along the associated transmission corridors, with particular emphasis on species that might be adversely affected by continued operation over the license renewal period. Agency responses are provided in Attachment B and indicate that license renewal is unlikely to affect any listed species.

As discussed in Section 3.2, PPL Susquehanna has no plans to conduct refurbishment activities at SSES during the license renewal term. Therefore, there would be no refurbishment-related impacts to special-status species and no further analysis of refurbishment-related impacts is applicable. Furthermore, because PPL Susquehanna has no plans to alter current operations, and resource agencies contacted by PPL Susquehanna evidenced no serious concerns about license renewal impacts, PPL Susquehanna concludes that impacts to threatened or endangered species from license renewal would be SMALL and do not warrant mitigation. License renewal of SSES is not expected to result in taking of any threatened or endangered species. Renewal of licenses is not likely to jeopardize the continued existence for any threatened or endangered species or result in the destruction or adverse modifications of any critical habitat.

4.11 AIR QUALITY DURING REFURBISHMENT (NON-ATTAINMENT AREAS)

NRC

"…If the applicant's plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment workforce must be provided in accordance with the Clean Air Act as amended…." 10 CFR 51.53(c)(3)(ii)(F)

"…Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 50

NRC made impacts to air quality during refurbishment a Category 2 issue because vehicle exhaust emissions could be cause for some concern, and a general conclusion about the significance of the potential impact could not be drawn without considering the compliance status of each site and the number of workers expected to be employed during an outage (NRC 1996a). Information needed would include: (1) the attainment status of the plant-site area, and (2) the number of additional vehicles as a result of refurbishment activities.

Air quality during refurbishment is not applicable to SSES because, as discussed in Section 3.2, PPL Susquehanna has no plans for refurbishment at SSES.

4.12 MICROBIOLOGICAL ORGANISMS

NRC

"If the applicant's plant uses a cooling pond, lake, or canal or discharges into a river having an annual average flowrate of less than 3.15×10^{12} ft^3/year (9×10^{10} m^3/year), an assessment of the impact of the proposed action on public health from thermophilic organisms in the affected water must be provided." 10 CFR 51.53(c)(3)(ii)(G)

"These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically." 10 CFR 51,Subpart A, Appendix B, Table B-1, Issue 57

Due to the lack of sufficient data from facilities using cooling ponds, lakes, or canals or discharging to small rivers, NRC designated impacts on public health from thermophilic organisms a Category 2 issue. Information to be determined is: (1) whether the plant discharges to a small river, and (2) whether discharge characteristics (particularly temperature) are favorable to the survival of thermophilic organisms.

This issue is applicable to SSES because the plant discharges to the Susquehanna River, which has an average flow rate of 4.25×10^{11} to 4.83×10^{11} cubic feet per year at U.S. Geological Survey gaging stations up- and downstream of the station (USGS 2004). It is also relevant because the Susquehanna River in the vicinity of SSES is used by the public for recreation, including boating and fishing.

Organisms of concern include the enteric pathogens *Salmonella* and *Shigella*, the *Pseudomonas aeruginosa* bacterium, thermophilic Actinomycetes ("fungi"), the many species of *Legionella* bacteria, and pathogenic strains of the free-living *Naegleria* amoeba.

Bacteria pathogenic to humans have evolved to survive in the digestive tracts of mammals and accordingly have optimum temperatures of around 99°F (Joklik and Smith 1972, pg. 65). Many of these pathogenic microorganisms (e.g., *Pseudomonas, Salmonella*, and *Shigella*) are ubiquitous in nature, occurring in the digestive tracts of wild mammals and birds (and thus in natural waters), but are usually only a problem when the host is immunologically compromised. Thermophilic bacteria generally occur at temperatures from 77°F to 176°F, with maximum growth at 122°F to 140°F (Joklik and Smith 1972).

SSES uses two natural draft Cooling Towers to transfer waste heat from the Circulating Water System which cools the main condensers to the atmosphere (see Section 3.1.2 for detailed description of condenser cooling system). Thermal modeling conducted for the FES for operation of SSES indicated that outside of a small (less than one acre) mixing zone, the station's discharge would have a modest (0.5 to 2.0˚F) effect on downstream river temperature in summer (NRC 1981, Table 4.1). The SSES NPDES permit does not require monitoring of blowdown or discharge temperatures, but temperatures measured at the Bell Bend monitoring station immediately downstream of the station's discharge to the Susquehanna River are typically indistinguishable from those measured upstream of the plant's intake. The highest temperatures at the station upstream of the plants intake (site SSES) were 21˚C (69.8˚F) in 2000 (August 24), 26˚C (78.8˚F) in 2001 (August 16), 25˚C (77˚F) in 2002 (June 26), 3.5˚C (74.3˚F) in 2003 (August 27), and 22.5˚C (72.5˚F) in 2004 (June 24) (Ecology III 2001, 2002, 2003, 2004, 2005). The highest temperature measured over the same period at the Bell Bend monitoring station, which is downstream of SSES, was 26˚C (78.8˚F).

Water at these temperatures could, in theory, allow limited survival of thermophilic microorganisms, but are well below the optimal temperature range for growth and reproduction of thermophilic microorganisms.

Another factor controlling the survival and growth of thermophilic microorganisms in the Susquehanna River is the disinfection of SSES sewage treatment plant effluent. This reduces the likelihood that a seed source or inoculant will be introduced into the Susquehanna River via the SSES discharge. Wastewater, whether from domestic sewage or industrial sources, is frequently a source of pathogens in natural waters.

Fecal coliform bacteria are regarded as indicators of other pathogenic microorganisms, and are the organisms normally monitored by state health agencies. The present NPDES permit for SSES requires monitoring of fecal coliforms in sewage treatment plant effluent. Samples are collected once per month for fecal coliform analysis and other parameters. The SSES NPDES permit calls for "effective disinfection" to control disease-producing organisms during the swimming season (May 1 through September 30) and imposes a limit of 200 fecal coliform cells (geometric average value) per 100 ml sample. The NPDES permit also stipulates that no more than 10 percent of samples tested may contain 1,000 cells.

Given the thermal characteristics of the Susquehanna River at the SSES thermal discharge and disinfection of sewage treatment plant effluent, PPL Susquehanna does not expect station operations to stimulate growth or reproduction of thermophilic microorganisms.

PP&L collected samples of water (from condenser cooling systems), sludge (from condensers and Cooling Tower basins), and air (from inside Cooling Towers) from six power generating stations and a steam heating plant in 1980 and tested them for free-living amoebas and Legionella bacteria (Fields 1982). A sample from the condenser at a (fossil-fueled) plant contained significant concentrations of *Naegleria fowleri*, and several generating stations (not SSES) had small concentrations of *Naegleria* that may or may not have been pathogenic forms. *Legionella pneumophila* was found in all condenser cooling systems sampled except SSES Unit 1. Concentrations of Legionella were similar to those found in nature. As a result of these surveys, PP&L distributed information to its employees regarding possible health effects of thermophilic pathogens in cooling water systems and instituted a number of requirements and procedures related to safe practices and safety equipment in areas that could harbor pathogens.

PPL Susquehanna has written the Bureau of Water Supply Management of the Pennsylvania Department of Environmental Protection (DEP), requesting information on any studies that may have been conducted on thermophilic microorganisms in the Susquehanna River and any concerns Pennsylvania DEP may have relative to these organisms. Copies of the correspondence are included in Attachment C of this environmental report. PPL Susquehanna is not aware of reported cases of illness caused by *Naegleria* or *Legionella* at, in the vicinity, or downstream of the plant. Therefore, PPL Susquehanna concludes that the impact of thermophilic organisms is SMALL and does not warrant mitigation, particularly since there is no known swimming in the area.

4.13 ELECTRIC SHOCK FROM TRANSMISSION-LINE-INDUCED CURRENTS

NRC

The environmental report must contain an assessment of the impact of the proposed action on the potential shock hazard from transmission lines "...[i]f the applicant's transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the National Electric Safety Code for preventing electric shock from induced currents…" 10 CFR 51.53(c)(3)(ii)(H)

"…Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site…." 10 CFR 51, Subpart A, Table B 1, Issue 59

NRC made impacts of electric shock from transmission lines a Category 2 issue because, without a review of each plant's transmission line conformance with the National Electrical Safety Code (NESC) criteria (IEEE 1997), NRC could not determine the significance of the electric shock potential.

In the case of SSES, PPL Susquehanna reported a generic induced current analysis for the 500 kilovolt lines in Amendments 4 and 5 of the original licensing environmental report (PP&L undated; PP&L 1976). The results of these analyses were used by NRC in the Final Environmental Statement for operation (NRC 1981). In its environmental report amendments, PP&L committed to designing and constructing the 500-kilovolt lines to meet the induced current requirements of the NESC. Indeed, the subsequent construction drawings reference the FES regarding line clearance specifications. However, these analyses were performed for a generic 500-kilovolt line, and the truck size assumed was much smaller than might be expected on highways today. Additionally, there was no induced current analysis of the short 230-kilovolt connections near the plant. Therefore, this section provides an analysis of the PPL Electric Utilities' transmission lines' conformance with the NESC standard. The analysis is based on computer modeling of induced current under the line.

Objects located near transmission lines can become electrically charged due to their immersion in the lines' electric field. This charge results in a current that flows through

the object to the ground. The current is called "induced" because there is no direct connection between the line and the object. The induced current can also flow to the ground through the body of a person who touches the object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called "capacitively charged." A person standing on the ground and touching a vehicle or a fence receives an electrical shock due to the sudden discharge of the capacitive charge through the person's body to the ground. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors, including the following:

- the strength of the electric field which, in turn, depends on the voltage of the transmission line as well as its height and geometry
- the size of the object on the ground
- the extent to which the object is grounded.

In 1977, the NESC adopted a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98-kilovolt alternating current to ground.[1] The clearance must limit the induced current[2] due to electrostatic effects to 5 milliamperes if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. By way of comparison, the setting of ground fault circuit interrupters used in residential wiring (special breakers for outside circuits or those with outlets around water pipes) is 4 to 6 milliamperes.

As described in Section 3.1.3, there are two 500-kilovolt lines, one 230-kilovolt line designed to 500-kilovolt standards, and three short 230-kilovolt connections specifically constructed to distribute power from SSES to the electric grid. PPL Susquehanna's analysis of these transmission lines began by identifying all road crossing and selecting the lowest clearance locations for analysis. These limiting cases represent locations along the line where the potential for current-induced shock would be greatest. Once the limiting cases were identified, PPL Susquehanna calculated the electric field strength for the transmission line at that location, then calculated the induced current. Had the limiting cases' induced current exceeded the NESC limit, additional analyses would have been performed to identify all locations with potential to exceed the limit.

PPL Susquehanna calculated electric field strength and induced current using a computer code called ACDCLINE, produced by the Electric Power Research Institute. The results of this computer program have been field-verified through actual electric

[1] Part 2, Rules 232C1c and 232D3c.
[2] The NESC and the GEIS use the phrase "steady-state current," whereas 10 CFR 51.53(c)(3)(ii)(H) uses the phrase "induced current." The phrases mean the same here.

field measurements by several utilities. The input parameters included design features of the limiting-case scenario and the NESC requirement that line sag be determined at 120°F conductor temperature. For analysis purposes, the maximum vehicle size under the lines is considered to be a tractor-trailer of 8 feet wide, 12 feet average height, and 65 feet long.

The analysis determined that there are no locations under the transmission line that have the capacity to induce more than 5 milliamperes in a vehicle parked beneath the line (TtNUS 2004). The analytical results for each line's limiting case are presented in Table 4.13-1.

PPL Electric Utilities and other owners and operators of the transmission lines conduct surveillance and maintenance to assure that design ground clearances will not change. These procedures include routine inspection by aircraft on a regular basis. The aerial patrols of all corridors include checks for encroachments, broken conductors, broken or leaning structures, and signs of burnt trees, any of which would be evidence of clearance problems. Ground inspections include examination for clearance at questionable locations, integrity of structures, and surveillance for dead or diseased trees that might fall on the transmission line. Problems noted during any inspection are brought to the attention of the appropriate organizations for corrective action.

PPL Susquehanna's assessment under 10 CFR 51 concludes that electric shock is of SMALL significance for the SSES transmission lines because the magnitude of the induced currents do not exceed the NESC standard. Mitigation measures are not warranted because there is adequate clearance between energized conductors and the ground. PPL Susquehanna's conclusions on this issue would remain valid into the future, provided there are no changes in line use, voltage, and maintenance practices and no changes in land use under the line.

Table 4.13-1. Results of Induced Current Analysis.

Transmission Line	Voltage (kV)	Limiting Case Induced Current (milliamperes)
Susquehanna-Wescosville-Alburtis	500	3.7
Sunbury- Susquehanna #2	500	3.1
Stanton- Susquehanna #2	230[1]	3.8
Short connections near plant	230	3.8

1. This transmission line was designed to operate at 500 kilovolts, but it has always operated at 230 kilovolts. The analysis was performed for 500-kilovolt operation.

4.14 HOUSING IMPACTS

NRC

The environmental report must contain "...[a]n assessment of the impact of the proposed action on housing availability…" 10 CFR 51.53(c)(3)(ii)(I)

"…Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or areas with growth control measures that limit housing development…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 63

"...[S]mall impacts result when no discernible change in housing availability occurs, changes in rental rates and housing values are similar to those occurring statewide, and no housing construction or conversion occurs…." (NRC 1996a, Section 4.7.1.1, pp. 4-101 to 4-102)

NRC made housing impacts a Category 2 issue, because impact magnitude depends on local conditions that the NRC could not predict for all plants at the time of GEIS publication (NRC 1996a). Local conditions that need to be ascertained are: (1) population categorization as small, medium, or high, and (2) applicability of growth control measures.

Refurbishment activities and continued operations could result in housing impacts as a result of increased staffing. As described in Section 3.2, PPL Susquehanna has identified no refurbishment-related activities required for extended operations. PPL Susquehanna concludes that there would be no refurbishment-related impacts to area housing and no analysis is therefore required. The following discussion focuses on impacts of continued operations on local housing availability, and the assumption that SSES would add up to 60 additional license-term employees. As described in Section 3.4, this assumption is for purposes of analysis only.

As described in Section 2.6, SSES is located in a high population area. As noted in Section 2.8, the area of interest is not subject to growth control measures that limit housing development. In 10 CFR 51, Subpart A, Appendix B, Table B-1, NRC concluded that impacts to housing are expected to be of small significance at plants located in "high" population areas where growth control measures are not in effect. Therefore, PPL Susquehanna expects housing impacts to be small.

This conclusion is supported by the following site-specific housing analysis. The maximum impact to area housing is calculated using the following assumptions: (1) all direct and indirect jobs would be filled by in-migrating residents; (2) the residential distribution of new residents would be similar to current worker distribution; and (3) each new job created (direct and indirect) represents one housing unit. As described in Section 3.4, PPL Susquehanna estimate of 60 license renewal employees could generate the demand for 177 housing units (60 direct and 117 indirect jobs). In an area which has a population within a 50-mile radius of 1,684,794 and an average of 2.42 persons per household (USCB 2000), suggesting the existence of approximately 696,196 housing units, it is reasonable to conclude that this demand would not create a discernible change in housing availability, rental rates or housing values, or spur housing construction or conversion. PPL Susquehanna concludes that impacts to housing availability resulting from station-related population growth would be SMALL and would not warrant mitigation.

4.15 PUBLIC UTILITIES: PUBLIC WATER SUPPLY AVAILABILITY

NRC

The environmental report must contain "…an assessment of the impact of population increases attributable to the proposed project on the public water supply." 10 CFR 51.53(c)(3)(ii)(I)

"…An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 65

"Impacts on public utility services are considered small if little or no change occurs in the ability to respond to the level of demand and thus there is no need to add capital facilities. Impacts are considered moderate if overtaxing of facilities during peak demand periods occurs. Impacts are considered large if existing service levels (such as quality of water and sewage treatment) are substantially degraded and additional capacity is needed to meet ongoing demands for services." (NRC 1996a, Section 3.7.4.5, pg. 3-19)

NRC made public utility impacts a Category 2 issue because an increased problem with water availability, resulting from pre-existing water shortages, could occur in conjunction with plant demand and plant-related population growth (NRC 1996a). Local information needed includes: (1) a description of water shortages experienced in the area, and (2) an assessment of the public water supply system's available capacity.

NRC's analysis of impacts to the public water supply system considered both plant demand and plant-related population growth demands on local water resources. As Section 3.4 indicates, PPL Susquehanna analyzes a 60-person increase in SSES employment attributable to license renewal. Section 2.6 describes the SSES regional demography. Section 2.9.1 describes the public water supply systems in the area, their permitted capacities, and current demands. As discussed in Section 3.2, no refurbishment is planned for SSES and refurbishment impacts are therefore not expected. Accordingly, the following discussion focuses on impacts of continued operations on local public utilities, and the assumption that SSES would add up to 60 additional license-term employees.

SSES does not use water from a municipal system and plant groundwater usage during the renewed license period of operations would be considered small (Section 4.5).

Further, no increase in plant demand is projected. Therefore, PPL Susquehanna does not expect SSES operations to have an effect on local water supplies.

The impact to the local water supply systems from plant-related population growth can be determined by calculating the amount of water that would be required by these individuals. The average American uses about 90 gallons per day for personal use (EPA 2003). As described in Section 3.4, SSES's estimate of 60 license renewal employees could generate a total of 177 new jobs, which could result in a population increase of 428 in the area (177 jobs multiplied by 2.42, which is the average number of persons per household in the area [USCB 2000]). Using this consumption rate, the plant-related population increase could require an additional 38,520 gallons per day (428 people multiplied by 90 gallons per day) in an area where the excess public water supply capacity is approximately 2.9 million gallons per day from the Columbia County suppliers alone and 2.2 million gallons per day for Luzerne County suppliers. Of the 10 major water suppliers in Luzerne and Columbia Counties, there is none for which demand exceeds supply. If it is assumed that this increase in population is distributed across Luzerne and Columbia Counties, consistent with current employee trends, the increase in water demand would not create shortages in capacity of the water supply systems in these communities. (See Section 2.9.1 for a discussion of these systems). PPL Susquehanna concludes that impacts resulting from plant-related population growth to public water supplies would be SMALL, requiring no additional capacity and not warranting mitigation.

4.16 EDUCATION IMPACTS FROM REFURBISHMENT

NRC

The environmental report must contain "…an assessment of the impact of the proposed action on public schools (impacts from refurbishment activities only) within the vicinity of the plant…." 10 CFR 51.53(c)(3)(ii)(I)

"…Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 66

"…[S]mall impacts are associated with project-related enrollment increases of 3 percent or less. Impacts are considered small if there is no change in the school systems' abilities to provide educational services and if no additional teaching staff or classroom space is needed. Moderate impacts are associated with 4 to 8 percent increases in enrollment, and if a school system must increase its teaching staff or classroom space even slightly to preserve its pre-project level of service…. Large impacts are associated with enrollment increases greater than 8 percent…." NRC 1996a, Section 3.7.4.1

NRC made refurbishment-related impacts to education a Category 2 issue because site- and project-specific factors determine the significance of impacts (NRC 1996a). Local factors to be ascertained include: (1) project-related enrollment increases and (2) status of the student/teacher ratio.

The issue of impacts to the local education system due to refurbishment is not applicable to SSES because, as Section 3.2 discusses, PPL Susquehanna has identified no refurbishment needs at SSES.

4.17 OFFSITE LAND USE

4.17.1 Offsite Land Use - Refurbishment

NRC

The environmental report must contain "…an assessment of the impact of the proposed action on... land-use... (impacts from refurbishment activities only) within the vicinity of the plant…" 10 CFR 51.53(c)(3)(ii)(I)

"…Impacts may be of moderate significance at plants in low population areas…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 68

"…[I]f plant-related population growth is less than 5 percent of the study area's total population, off-site land-use changes would be small, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons per square mile, and at least one urban area with a population of 100,000 or more within 50 miles…." (NRC 1996a, Section 3.7.5)

This issue is not applicable to SSES because, as Section 3.2 discusses, PPL Susquehanna has no plans for refurbishment at SSES.

4.17.2 Offsite Land Use – License Renewal Term

NRC

The environmental report must contain "…an assessment of the impact of the proposed action on …land-use…within the vicinity of the plant…" 10 CFR 51.53(c)(3)(ii)(I)

"Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 69

"…[I]f plant-related population growth is less than five percent of the study area's total population, off-site land-use changes would be small…" (NRC 1996a, Section 3.7.5)

"If the plant's tax payments are projected to be small, relative to the community's total revenue, new tax-driven land-use changes during the plant's license renewal term would be small, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development." (NRC 1996a, Section 4.7.4.1)

NRC made impacts to offsite land use during the license renewal term a Category 2 issue because land-use changes may be perceived as beneficial by some community members and adverse by others. Therefore, NRC could not assess the potential significance of site-specific offsite land-use impacts (NRC 1996a, Section 4.7.4.1). Site-specific factors to be considered in an assessment of new tax-driven land-use impacts include: (1) the size of plant-related population growth compared to the area's total population, (2) the size of the plant's tax payments relative to the community's total revenue, (3) the nature of the community's existing land-use pattern, and (4) the extent to which the community already has public services in place to support and guide development.

The GEIS presents an analysis of offsite land use for the renewal term that is characterized by two components: population-driven and tax-driven impacts (NRC 1996a).

Population-Related Impacts

Based on the GEIS case-study analysis, NRC concluded that all new population-driven land-use changes during the license renewal term at all nuclear plants would be small.

Population growth caused by license renewal would represent a much smaller percentage of the local area's total population than the percentage presented by operations-related growth (NRC 1996a).

Tax-Revenue-Related Impacts

NRC has determined that the significance of tax payments as a source of local government revenue would be large if the payments are greater than 20 percent of revenue, moderate if the payments are between 10 and 20 percent of revenue, and small if the payments are less than 10 percent of revenue (NRC 1996a).

NRC defined the magnitude of land-use changes as follows (NRC 1996a):

SMALL - very little new development and minimal changes to an area's land-use pattern.

MODERATE - considerable new development and some changes to land-use pattern.

LARGE - large-scale new development and major changes in land-use pattern.

NRC further determined that, if a plant's tax payments are projected to be small relative to the community's total revenue, new tax-driven land-use changes would be small, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development.

Table 2.7-1 provides a comparison of total tax payments made by SSES to Luzerne County and the Berwick Area School District, Luzerne County's annual property tax revenues, and the Berwick Area School District's annual revenues. For the five-year period from 2000 through 2004, SSES's tax payments to Luzerne County represented between 1.8 and 2.4 percent of the County's total annual property tax revenues. Using NRC's criteria, SSES's tax payments are of small significance to Luzerne County. For the five-year period from 2000 through 2004, SSES's tax payments to the Berwick Area School District represented approximately 5.5 to 6.9 percent of the School District's total revenues. Using NRC's criteria, SSES's tax payments are of small significance to the Berwick Area School District. For the period 2001 through 2004, SSES's tax payments to Salem Township represented 50.3 to 53.9 percent of the township's total revenues. However, the population and land use in Salem Township has not changed significantly during this period, indicating that the tax revenues are not leading to land use impacts. Discontinuing the current level of tax revenues on the other hand would likely have a significant adverse economic impact on the jurisdiction. Using NRC's criteria, SSES's tax payments are of large significance to the township.

Neither Luzerne nor Columbia Counties have growth control measures and planners suggest that, if needed, remediating constrained land would offer additional space for potential growth.

As described in Section 3.2, PPL Susquehanna does not anticipate refurbishment or license renewal-related construction during the license renewal period. Therefore, PPL Susquehanna does not anticipate any increase in the assessed value of SSES due to refurbishment-related improvements, or any related tax-increase-driven changes to offsite land-use and development patterns.

PPL Susquehanna concludes that the land-use impact would be SMALL and therefore, mitigation is not warranted.

4.18 TRANSPORTATION

NRC

The environmental report must "...assess the impact of highway traffic generated by the proposed project on the level of service of local highways during periods of license renewal refurbishment activities and during the term of the renewed license." 10 CFR 51.53(c)(3)(ii)(J)

"…Transportation impacts…are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 70

Small impacts would be associated with U.S. Transportation Research Board Level of Service A, having the following condition: "…Free flow of the traffic stream; users are unaffected by the presence of others." and Level of Service B, having the following condition: "…Stable flow in which the freedom to select speed is unaffected but the freedom to maneuver is slightly diminished…." (NRC 1996a, Section 3.7.4.2)

NRC made impacts to transportation a Category 2 issue, because impact significance is determined primarily by road conditions existing at the time of license renewal, which NRC could not forecast for all facilities (NRC 1996a). Local road conditions to be ascertained are: (1) level of service conditions, and (2) incremental increases in traffic associated with refurbishment activities and license renewal staff.

As described in Section 3.2, no major refurbishment is planned and no refurbishment impacts to local transportation are therefore anticipated. Accordingly, the following discussion focuses on impacts of continued operations on transportation, and the assumption that SSES would add up to 60 additional license-term employees.

PPL Susquehanna workforce includes approximately 1,200 permanent and 260 contract employees. On a 24-month cycle (Units 1 and 2 refueling on alternate years), as many as 1,400 additional workers join the permanent workforce during the refueling outages with concomitant increases in traffic on the local roads. PPL Susquehanna projection of 60 additional employees associated with license renewal for SSES represents a 5 percent increase in the current number of permanent employees and an even smaller percentage of employee's present onsite during refueling outages. Given these employment projections and the average number of vehicles per day currently using the

roads surrounding SSES, PPL Susquehanna concludes that impacts to transportation would be SMALL and mitigation would not be warranted.

4.19 HISTORIC AND ARCHAEOLOGICAL RESOURCES

NRC

The environmental report must contain an assessment of "…whether any historic or archaeological properties will be affected by the proposed project." 10 CFR 51.53(c)(3)(ii)(K)

"Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 71

"Sites are considered to have small impacts to historic and archaeological resources if (1) the State Historic Preservation Officer (SHPO) identifies no significant resources on or near the site; or (2) the SHPO identifies (or has previously identified) significant historic resources but determines they would not be affected by plant refurbishment, transmission lines, and license-renewal term operations and there are no complaints from the affected public about altered historic character; and (3) if the conditions associated with moderate impacts do not occur." (NRC 1996a, Section 3.7.7)

NRC made impacts to historic and archaeological resources a Category 2 issue, because determinations of impacts to historic and archaeological resources are site-specific in nature and the National Historic Preservation Act mandates that impacts must be determined through consultation with the State Historic Preservation Officer (NRC 1996a).

In the construction FES, the AEC concluded that the construction of the SSES would have no effect on any national historical landmarks and reported that Mr. Ira F. Smith, Archeologist at the William Penn Museum, and Mr. William J. Wewer, Executive Director of the Pennsylvania Historical and Museum Commission and State Liaison Officer for Historical Preservation, stated that the SSES project would not adversely impact any known archaeological or historical resources of value (AEC 1973).

In the FES for operation of the SSES, the NRC concluded that direct impacts of the Station's operation on cultural resource sites would be expected to be minimal if known prehistoric sites were protected by a well-designed mitigation/avoidance program, and if

care was exercised to recognize and protect cultural resources discovered during operational activities involving disruption of topsoil or vegetation (NRC 1981). PPL Susquehanna Environmental Inspection Plan (CH-ER-314) requires annual inspections of identified archaeological sites to ensure they remain undisturbed.

As discussed in Section 3.2, PPL Susquehanna has no refurbishment plans and no refurbishment-related impacts are anticipated. PPL Susquehanna is not aware of any additional historic or archaeological resources that have been affected, to date, by SSES operations, including the operation and maintenance of transmission lines. Because PPL Susquehanna has no plans to construct additional facilities at SSES during the license renewal term and because PPL Susquehanna maintains land disturbing standard operating procedures, PPL Susquehanna concludes that operation of these generation and transmission facilities over the license renewal term would not impact cultural resources; hence, mitigation would not be warranted. This conclusion is consistent with results of the correspondence between PPL Susquehanna and the Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation Office (See Attachment D).

4.20 SEVERE ACCIDENT MITIGATION ALTERNATIVES (SAMA)

NRC

The environmental report must contain a consideration of alternatives to mitigate severe accidents "…if the staff has not previously considered severe accident mitigation alternatives for the applicant's plant in an environmental impact statement or related supplement or in an environment assessment..." 10 CFR 51.53(c)(3)(ii)(L)

"…The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives…." 10 CFR 51, Subpart A, Appendix B, Table B-1, Issue 76

Section 4.20 summarizes PPL Susquehanna's analysis of alternative ways to mitigate the impacts of severe accidents. Attachment E provides a detailed description of the severe accident mitigation alternatives (SAMA) analysis.

The term "accident" refers to any unintentional event (i.e., outside the normal or expected plant operation envelope) that results in the release or a potential for release of radioactive material to the environment. NRC categorizes accidents as "design basis" or "severe." Design basis accidents are those for which the risk is great enough that NRC requires plant design and construction to prevent unacceptable accident consequences. Severe accidents are those that NRC considers too unlikely to warrant design controls.

NRC concluded in its license renewal rulemaking that the unmitigated environmental impacts from severe accidents met its Category 1 criteria. However, NRC made consideration of mitigation alternatives a Category 2 issue because not all plants had completed ongoing regulatory programs related to mitigation (e.g., individual plant examinations and accident management). Site-specific information to be presented in the license renewal environmental report includes: (1) potential SAMAs; (2) benefits, costs, and net value of implementing potential SAMAs; and (3) sensitivity of analysis to changes in key underlying assumptions.

Susquehanna Steam Electric Station (SSES) maintains a probabilistic risk assessment (PRA) model to use in evaluating the most significant risks of core damage and the

resulting radiological release from the containment structures. For the SAMA analysis, SSES used the PRA model output as input to an NRC-approved methodology that calculates economic costs and dose to the public from hypothesized releases from the containment structure into the environment. Then, using NRC regulatory analysis techniques, SSES calculated the monetary value of the unmitigated severe accident risk. The result represents the monetary value of the base risk of dose to the public and worker, offsite and onsite economic costs, and replacement power. This value became a cost/benefit-screening tool for potential SAMAs; a SAMA whose cost of implementation exceeded the base risk value could be rejected as being not cost-beneficial. The following list summarizes the steps of this process:

- SSES PRA Model – Use the SSES Internal Events PRA model as the basis for the analysis (Section E.2). Incorporate External Events contributions based on available quantitative information as described in Section E.5.1.8.
- Level 3 PRA Analysis – Use SSES Level 1 and 2 Internal Events PRA output and site-specific meteorology, demographic, land use, and emergency response data as input in performing a Level 3 PRA using the MELCOR Accident Consequences Code System Version 2 (MACCS2) (Section E.3). Incorporate External Events contributions as described in Section E.5.1.8.
- Baseline Risk Monetization – Use NRC regulatory analysis techniques, calculate the monetary value of the unmitigated SSES severe accident risk. This becomes the maximum averted cost-risk that is possible (Section E.4).
- Phase I SAMA Analysis – Identify potential SAMA candidates based on the SSES PRA, IPE, IPEEE, and documentation from the industry and the NRC. Screen out Phase I SAMA candidates that are not applicable to the SSES design or are of low benefit in boiling water reactors, candidates that have already been implemented at SSES or whose benefits have been achieved at SSES using other means, and candidates whose estimated implementation cost exceeds the maximum averted cost-risk (Section E.5).
- Phase II SAMA Analysis – Calculate the risk reduction attributable to each remaining SAMA candidate and compare it to a more detailed cost analysis to identify any net cost benefit. PRA insights are also used to screen SAMA candidates in this phase (Section E.6).
- Uncertainty Analysis – Evaluate how changes in the SAMA analysis assumptions might affect the cost/benefit evaluation (Section E.7).

Using this process, SSES incorporated industry, NRC, and plant-specific information to create a list of 14 SAMAs for consideration. SSES analyzed this list and screened out SAMAs that would not apply to the SSES design, that SSES had already implemented, or that would achieve results that SSES had already achieved at the site by other

means. SSES used the cost estimates for the remaining SAMAs and compared them with the maximum averted cost-risk value to screen out SAMAs that would not be cost-beneficial. Eleven candidate SAMAs remained for further consideration.

SSES calculated the risk reduction that would be attributable to each candidate SAMA (assuming SAMA implementation) and re-quantified the cost-risk value. The difference between the base cost-risk value and the SAMA-reduced cost-risk value became the averted cost-risk, or the value of implementing the SAMA. SSES used the cost estimates for implementing each SAMA and repeated the cost/benefit comparison using the SAMA specific averted cost-risk. Two SAMAs were initially found to be cost beneficial for SSES:

- SAMA 2a: Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-D, B-C)
- SAMA 6: Procure Spare 480V AC Portable Station Generator

The 4kV AC emergency bus cross-tie between the “A” and “D” or “B” and “C” buses (SAMA 2a) is a cost beneficial enhancement at Susquehanna. While SSES already has the “E” EDG to compensate for primary EDG failures, the largest contributor to site risk is still the LOOP initiating event. For a moderate cost of implementation, a means of further reducing LOOP risk could be added to the site.

SAMA 6 is also identified as a cost beneficial change; however, common cause failure of the additional generator is not currently included in the analysis. If common cause failures are included and if SAMA 2a is implemented, the benefit of this SAMA would be reduced. Because of these mitigating factors, this SAMA is not recommended for implementation.

SSES performed three additional analyses to evaluate how the SAMA analysis would change if certain key parameters were changed. The results of the uncertainty analysis indicate that use of the 95th percentile PRA results would suggest that three additional SAMAs are cost beneficial for SSES:

- SAMA 2b: Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-B-C-D)
- SAMA 3: Proceduralize Staggered RPV Depressurization When Fire Protection System Injection is the Only Available Makeup Source
- SAMA 5: Auto Align 480V AC Portable Station Generator

The expanded 4kV AC cross-tie (SAMA 2b) would allow any given EDG the capability to power any particular 4kV AC emergency bus. While the cost of implementation is greater than the monetary equivalent of the associated risk reduction based on the best

estimate results, the sensitivity case shows that SAMA 2b is a borderline case and that it could be considered as a means of reducing plant risk. However, if lower cost SAMA 2a is implemented, most of the cross-tie benefit would be obtained and the further changes required to implement SAMA 2b would not be cost beneficial. This judgement is based on the difference in averted cost risk-shown for the two SAMAs in Section E.7.2. SAMA 2b yields an additional benefit of only $20,000 for an additional cost input of $728,000. This SAMA is not recommended for consideration.

SAMA 3 provides a means of ensuring that injection with the Fire Main can prevent core damage when it is the only available injection source. As this SAMA only requires procedure changes and supporting analysis to support the use of an existing injection system, this low cost SAMA should be considered for implementation.

SAMA 5 only becomes cost effective by about 7.5 percent of its cost of implementation when the 95th percentile PRA results are used. While this SAMA could be considered cost beneficial, SAMAs 2a and 3 yield larger cost benefit margins and should be considered for implementation before SAMA 5.

In conclusion, the benefits of revising the operational strategies in place at SSES and/or implementing hardware modifications can be evaluated without the insight from a risk-based analysis. Use of the PRA in conjunction with cost benefit analysis methodologies has, however, provided an enhanced understanding of the effects of the proposed changes relative to the cost of implementation and projected impact on a much larger future population. The results of this study indicate that of the identified potential improvements that can be made at SSES, a few are cost beneficial based on the methodology applied however, none of the SAMAs are related to plant aging. Therefore, they are not required modifications for the License Renewal Period.

4.21 REFERENCES

Note to reader: Some web pages cited in this document are no longer available, or are no longer available through the original URL addresses. Hard copies of cited web pages are available in PPL Susquehanna files. Some sites, for example the census data, cannot be accessed through their given URLs. The only way to access these pages is to follow queries on previous web pages. The complete URLs used by PPL Susquehanna have been given for these pages, even though they may not be directly accessible. Also, all references are specific to respective chapter.

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5.0 ASSESSMENT OF NEW AND SIGNIFICANT INFORMATION

NRC

"The environmental report must contain any new and significant information regarding the environmental impacts of license renewal of which the applicant is aware." 10 CFR 51.53(c)(3)(iv)

5.1 DESCRIPTION OF PROCESS

The NRC licenses the operation of domestic nuclear power plants and provides for license renewal, requiring a license renewal application that includes an environmental report (10 CFR 54.23). NRC regulations, 10 CFR 51, prescribe the environmental report content and identify the specific analyses the applicant must perform. In an effort to perform the environmental review efficiently and effectively, the NRC has resolved most of the environmental issues generically, but requires an applicant's analysis of all the remaining issues.

While NRC regulations do not require an applicant's environmental report to contain analyses of the impacts of those environmental issues that have been generically resolved (10 CFR 51.53(c)(3)(i)), the regulations do require that an applicant identify any new and significant information of which the applicant is aware (10 CFR 51.53(c)(3)(iv)). The purpose of this requirement is to alert the NRC staff to such information so that the staff can determine whether to seek the Commission's approval to waive or suspend application of the Rule with respect to the affected generic analysis. The NRC has explicitly indicated, however, that an applicant is not required to perform a site-specific validation of GEIS conclusions (NUREG-1529, *Public Comments on the Proposed 10 CFR Part 51 Rule for Renewal of Nuclear Power Plant Operating Licenses and Supporting Documents: Review of Concerns and NRC Staff Response* (May 1996), page C9-13, Concern Number NEP.015).

PPL Susquehanna assumes new and significant information would be the following:

- Information that identifies a significant environmental issue not covered in the GEIS and codified in the regulations, or
- Information that was not covered in the GEIS analyses and which leads to an impact finding different from that codified in the regulation.

The NRC does not define the term "significant." For the purpose of its review, PPL Susquehanna used guidance available in Council on Environmental Quality (CEQ)

regulations. CEQ guidance provides that federal agencies should prepare environmental impact statements for actions that would significantly affect the environment (40 CFR 1502.3), to focus on significant environmental issues (40 CFR 1502.1), and to eliminate from detailed study issues that are not significant (40 CFR 1501.7(a)(3)). The CEQ guidance includes a definition of “significantly” that requires consideration of the context of the action, and the intensity or severity of the impact(s) (40 CFR 1508.27). PPL Susquehanna assumes that moderate or large impacts, as defined by the NRC, would be significant. Section 4.0 presents the NRC definitions of “moderate” and “large” impacts.

PPL Susquehanna has implemented a process to identify new and significant information as part of its preparation of this environmental report for SSES. PPL Susquehanna is aware of no new and significant information regarding the environmental impacts of SSES license renewal.

The SSES Environmental Protection Plan (EPP) and tiered departmental procedures govern review of environmental issues. Changes in plant design, operation, or tests and experiments with potential for environmental impact are reviewed in accordance with established procedures and responsibilities to ensure that such activities do not involve an unreviewed environmental question or require changes to the EPP. The environmental impacts of license renewal were evaluated prior to submittal of the license application. Established procedures and responsibilities ensure that any new and significant information related to renewal of the SSES licenses will be identified, reviewed, and addressed.

6.0 SUMMARY OF LICENSE RENEWAL IMPACTS AND MITIGATING ACTIONS

6.1 LICENSE RENEWAL IMPACTS

PPL Susquehanna has reviewed the environmental impacts of renewing the SSES operating licenses and has concluded that impacts would be small and would not require mitigation. This environmental report documents the basis for PPL Susquehanna's conclusion. Chapter 4 incorporates by reference NRC findings for the 55 Category 1 issues that apply to SSES, all of which have impacts that are small (Table A-1). The rest of Chapter 4 analyzes Category 2 issues, all of which are either not applicable or have impacts that are small. Table 6.1-1 identifies the impacts that SSES license renewal would have on resources associated with Category 2 issues.

Table 6.1-1. Environmental Impacts Related to License Renewal at SSES.

No.	Category 2 Issue	Environmental Impact
Surface Water Quality, Hydrology, and Use (for all plants)		
13	Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	**Small**. SSES consumptive average water use is approximately 0.47 percent of average river flow. PPL Susquehanna complies with the Susquehanna River Basin Commission's Standards for Surface Water Withdrawals in 18 CFR 803.23.
Aquatic Ecology (for plants with once-through or cooling pond heat dissipation systems)		
25	Entrainment of fish and shellfish in early life stages	**None**. This issue does not apply because SSES does not use a once-through or cooling pond heat dissipation system.
26	Impingement of fish and shellfish	**None**. This issue does not apply because SSES does not use a once-through or cooling pond heat dissipation system.
27	Heat shock	**None**. This issue does not apply because SSES does not use a once-through or cooling pond heat dissipation system.
Groundwater Use and Quality		
33	Groundwater use conflicts (potable and service water, and dewatering; plants that use > 100 gpm)	**None**. This issue does not apply because SSES uses less than 100 gallons of groundwater per minute.
34	Groundwater use conflicts (plants using cooling towers or cooling ponds and withdrawing makeup water from a small river)	**Small**. SSES is not located in any aquifer recharge area.
35	Groundwater use conflicts (Ranney wells)	**None**. This issue does not apply because SSES does not use Ranney wells.
39	Groundwater quality degradation (cooling ponds at inland sites)	**None**. This issue does not apply because SSES does not use cooling ponds.
Terrestrial Resources		
40	Refurbishment impacts	**None**. No impacts are expected because SSES has no plans to undertake refurbishment.
Threatened or Endangered Species		
49	Threatened or endangered species	**Small**. Bald eagles are common on the Susquehanna River during some seasons of the year. Other protected bird species are occasionally observed at SSES, but none nest on the site. The transmission lines cross counties that have known populations of protected species but PPL Susquehanna has not identified any observances of these species in the corridors.

Table 6.1-1. Environmental Impacts Related to License Renewal at SSES (Continued).

No.	Category 2 Issue	Environmental Impact
Air Quality		
50	Air quality during refurbishment (non-attainment and maintenance areas)	**None**. No impacts are expected because SSES has no plans to undertake refurbishment.
Human Health		
57	Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	**Small**. The low temperatures in the Susquehanna River, and the disinfection at the sewage treatment facility do not support the propagation of pathological microbes.
59	Electromagnetic fields, acute effects (electric shock)	**Small**. The largest modeled induced current under the SSES lines is substantially less than the 5-milliampere limit. Therefore, the SSES transmission lines conform to the National Electrical Safety Code provisions for preventing electric shock from induced current.
Socioeconomics		
63	Housing impacts	**Small**. The conceptual addition of 177 direct/indirect jobs would not noticeably affect a housing market of approximately 700,000 housing units.
65	Public services: public utilities	**Small**. Water suppliers in Luzerne and Columbia Counties have excess capacity. The conceptual addition of 177 direct/ indirect jobs would not adversely affect the available water supply.
66	Public services: education (refurbishment)	**None**. No impacts are expected because SSES has no plans to undertake refurbishment.
68	Offsite land use (refurbishment)	**None**. No impacts are expected because SSES has no plans to undertake refurbishment.
69	Offsite land use (license renewal term)	**Small**. No plant-induced changes to offsite land use are expected from license renewal because SSES taxes are less than 10 percent of total tax revenues to the school district and Luzerne County. There are no growth control measures that would limit growth. SSES pays 54 percent of the total taxes to Salem township; however land use in the township remains unchanged, indicating that the taxes do not affect land use.
70	Public services: transportation	**Small**. The addition of 60 employees would not noticeably increase traffic or adversely affect level of service in the vicinity of SSES.
71	Historic and archaeological resources	**Small**. Continued operation of SSES would not require construction at the site. Therefore, license renewal would have little or no effect on historic or archaeological resources.
Postulated Accidents		
76	Severe accidents	**Small** The benefit/cost analysis identified no severe accident mitigation alternatives that would avert public risk.

6.2 MITIGATION

NRC

"The report must contain a consideration of alternatives for reducing adverse impacts…for all Category 2 license renewal issues…" 10 CFR 51.53(c)(3)(iii)

"The environmental report shall include an analysis that considers and balances…alternatives available for reducing or avoiding adverse environmental effects…" 10 CFR 51.45(c) as incorporated by 10 CFR 51.53(c)(2) and 10 CFR 51.45(c)

Impacts of license renewal are small and would not require mitigation. Current operations include monitoring activities that would continue during the license renewal term. PPL Susquehanna performs routine monitoring to ensure the safety of workers, the public, and the environment. These activities include the radiological environmental monitoring program, air quality emissions monitoring, and effluent chemistry monitoring. These monitoring programs ensure that the plant's permitted emissions and discharges are within regulatory limits and any unusual or off-normal emissions/discharges would be quickly detected, mitigating potential impacts.

6.3 UNAVOIDABLE ADVERSE IMPACTS

NRC

The environmental report shall discuss any "...adverse environmental effects which cannot be avoided should the proposal be implemented..." 10 CFR 51.45(b)(2) as adopted by 10 CFR 51.53(c)(2).

This environmental report adopts by reference NRC findings for applicable Category 1 issues, including discussions of any unavoidable adverse impacts (Table A-1). PPL Susquehanna examined 21 Category 2 issues and identified the following unavoidable adverse impacts of license renewal:

- The Cooling Towers and their vapor plumes are visible from offsite. This visual impact will continue during the license renewal term.
- Procedures for the disposal of sanitary, chemical, and radioactive wastes are intended to reduce adverse impacts from these sources to acceptably low levels. A small impact will occur as long as the plant is in operation. Solid radioactive wastes are a product of plant operations and long-term disposal of these materials must be considered.
- Operation of SSES results in a very small increase in radioactivity in the air and water. However, fluctuations in natural background radiation are expected to exceed the small incremental increase in dose to the local population. Operation of SSES also creates a very low probability of accidental radiation exposure to inhabitants of the area.
- Operations of SSES results in consumptive use of Susquehanna River water. By law, PPL Susquehanna is required to have plans for low-flow augmentation during drought conditions.
- Limited numbers of adult and juvenile fish are impinged on the traveling screens at the cooling water River Intake Structure.
- Very small numbers of larval fish are entrained at the cooling water River Intake Structure.

6.4 IRREVERSIBLE AND IRRETRIEVABLE RESOURCE COMMITMENTS

NRC

The environmental report shall discuss any "...irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented…" 10 CFR 51.45(b)(5) as adopted by 10 CFR 51.53(c)(2)

Continued operation of SSES for the license renewal term will result in irreversible and irretrievable resource commitments, including the following:

- Nuclear fuel, which is used in the reactor and is converted to radioactive waste;
- Land required to dispose of spent nuclear fuel offsite, low-level radioactive wastes generated as a result of plant operations; and sanitary wastes generated from normal industrial operations;
- The onsite dry spent fuel storage area will need to be expanded if offsite disposal is not available;
- Elemental materials that will become radioactive; and
- Materials used for the normal industrial operations of the plant that cannot be recovered or recycled or that are consumed or reduced to unrecoverable forms.

6.5 SHORT-TERM USE VERSUS LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

NRC

The environmental report shall discuss the "...relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity..." 10 CFR 51.45(b)(4) as adopted by 10 CFR 51.53(c)(2)

The current balance between short-term use and long-term productivity at the SSES site was established with the decision to convert approximately 450 acres of farmland and woodland to industrial use. The FESs related to construction (AEC 1973) and operation (NRC 1981) evaluated the impacts of constructing and operating SSES. Natural resources that would be subjected to short-term use include land and water. The plant site and the area surrounding it are largely undeveloped. Approximately 450 acres of the 2,355-acre site are devoted to the production of electrical energy. This includes the area occupied by SSES facilities (buildings, parking lots, roadways) and landscaped areas around the facilities. Transmission line construction required about 4,900 acres of land that resulted in the alteration of natural wildlife habitats.

Although SSES consumes water from the Susquehanna River, the impacts are minor and would cease once the reactors cease operation. The productivity of the aquatic community in the Susquehanna River in the vicinity of SSES is not affected by the water use.

After decommissioning, most environmental disturbances would cease and restoration of the natural habitat could occur. Thus, the "trade-off" between the production of electricity and changes in the local environment is reversible to some extent.

Experience with other experimental, developmental, and commercial nuclear plants has demonstrated the feasibility of decommissioning and dismantling such plants sufficiently to restore a site to its former use. The degree of dismantlement will take into account the intended new use of the site and a balance among health and safety considerations, salvage values, and environmental impact. However, decisions on the ultimate disposition of these lands have not yet been made. Continued operation for an additional 20 years would not increase the short-term productivity impacts described here.

6.6 REFERENCES

AEC (Atomic Energy Commission). 1973. Final Environmental Statement Related to the Construction of Susquehanna Steam Electric Station Units 1 and 2, Pennsylvania Power and Light Company. Docket Nos. 50-387 and 50-388. June.

NRC (U.S. Nuclear Regulatory Commission). 1981. Final Environmental Statement related to the operation of Susquehanna Steam Electric Station Units 1 and 2, Pennsylvania Power and Light Company. Dockets Nos. 50-387 and 50-388. Office of Nuclear Reactor Regulation. Washington, D.C. June.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

NRC

The environmental report shall discuss "Alternatives to the proposed action.…" 10 CFR 51.45(b)(3), as adopted by reference at 10 CFR 51.53(c)(2).

"...The report is not required to include discussion of need for power or economic costs and benefits of ... alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation...." 10 CFR 51.53(c)(2).

"While many methods are available for generating electricity, and a huge number of combinations or mixes can be assimilated to meet a defined generating requirement, such expansive consideration would be too unwieldy to perform given the purposes of this analysis. Therefore, NRC has determined that a reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable…" (NRC 1996a).

"…The consideration of alternative energy sources in individual license renewal reviews will consider those alternatives that are reasonable for the region, including power purchases from outside the applicant's service area...." (NRC 1996b).

Chapter 7 evaluates alternatives to SSES license renewal. The chapter identifies actions that PPL Susquehanna might take, and associated environmental impacts, if the U.S. Nuclear Regulatory Commission (NRC) does not renew the plant's operating licenses. The chapter also addresses actions that PPL Susquehanna has considered, but would not take, and identifies bases for determining that such actions would be unreasonable.

PPL Susquehanna divided its alternatives discussion into two categories, "no-action" and "alternatives that meet system generating needs." In considering the level of detail and analysis that it should provide for each category, PPL Susquehanna relied on the NRC decision-making standard for license renewal:

> "…the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision makers would be unreasonable." [10 CFR 51.95(c)(4)].

PPL Susquehanna has determined that the environmental report would support NRC decision making as long as the document provides sufficient information to clearly indicate whether an alternative would have a smaller, comparable, or greater environmental impact than the proposed action. Providing additional detail or analysis serves no function if it only brings to light additional adverse impacts of alternatives to license renewal. This approach is consistent with regulations of the Council on Environmental Quality, which provide that the consideration of alternatives (including the proposed action) should enable reviewers to evaluate their comparative merits (40 CFR 1500-1508). PPL Susquehanna judges that Chapter 7 provides sufficient detail about alternatives to establish the basis for necessary comparisons to the Chapter 4 discussion of impacts from the proposed action.

In characterizing environmental impacts from alternatives, PPL Susquehanna has used the same definitions of "small," "moderate," and "large" that are presented in the introduction to Chapter 4.

7.1 NO-ACTION ALTERNATIVE

PPL Susquehanna uses "no-action alternative" to refer to a scenario in which NRC does not renew the SSES operating licenses. Components of this alternative include replacing the generating capacity of SSES and decommissioning the facility, as described below.

SSES provides approximately 18 terawatt-hours of electricity and approximately 2,500 megawatts of base-load electrical capacity to residents and other consumers in the mid-Atlantic region (PPL 2004). PPL Susquehanna judges that any alternative would be unreasonable if it did not include replacing the capacity of SSES. Replacement could be accomplished by (1) building new generating base-load capacity, (2) purchasing power from the wholesale market, or (3) reducing power requirements through demand reduction. Section 7.2.1 describes each of these possibilities in detail, and Section 7.2.2 describes environmental impacts from feasible alternatives.

The Generic Environmental Impact Statement (GEIS) (NRC 1996a, pg. 7-1) defines decommissioning as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. NRC-evaluated decommissioning options include immediate decontamination and dismantlement, and safe storage of the stabilized and defueled facility for a period of time, followed by additional decontamination and dismantlement. Regardless of the option chosen, decommissioning must be completed within a 60-year period. Under the no-action alternative, PPL Susquehanna would continue operating SSES until the existing licenses expire, then initiate decommissioning activities in accordance with NRC requirements. The GEIS describes decommissioning activities based on an evaluation of a larger reactor (the "reference" boiling-water reactor is the 1,155-megawatt electric [MWe] Energy Northwest's Columbia Plant). This description is applicable to decommissioning activities that PPL Susquehanna would conduct at SSES.

As the GEIS notes, NRC has evaluated environmental impacts from decommissioning. NRC-evaluated impacts include impacts of occupational and public radiation dose; impacts of waste management; impacts to air and water quality; and ecological, economic, and socioeconomic impacts. NRC indicated in the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities; Supplement 1* (NRC 2002a, Section 4.3.8) that the environmental effects of greatest concern (i.e., radiation dose and releases to the environment) are substantially less than the same effects resulting from reactor operations. PPL Susquehanna adopts by reference the NRC conclusions regarding environmental impacts of decommissioning.

PPL Susquehanna notes that decommissioning activities and their impacts are not discriminators between the proposed action and the no-action alternative. PPL Susquehanna will have to decommission SSES regardless of the NRC decision on license renewal; license renewal would only postpone decommissioning for another 20 years. NRC has established in the GEIS that the timing of decommissioning operations does not substantially influence the environmental impacts of decommissioning. PPL Susquehanna adopts by reference the NRC findings (10 CFR 51, Appendix B, Table B-1, Decommissioning) to the effect that delaying decommissioning until after the renewal term would have small environmental impacts. The discriminators between the proposed action and the no-action alternative lie within the choice of generation replacement options to be part of the no-action alternative. Section 7.2.2 analyzes the impacts from these options.

PPL Susquehanna concludes that the decommissioning impacts under the no-action alternative would not be substantially different from those occurring following license renewal, as identified in the GEIS (NRC 1996a) and in the decommissioning generic environmental impact statement (NRC 2002a). These impacts would be temporary and would occur at the same time as the impacts from meeting system generating needs.

7.2 ALTERNATIVES THAT MEET SYSTEM GENERATING NEEDS

SSES will have a net capacity of 2,510 MWe (approximate) when the NRC approves the Extended Power Uprate for which PPL Susquehanna has applied. In 2003 SSES generated approximately 18 terawatt-hours of electricity (PPL 2004). This power, equivalent to the energy used by approximately 1.8 million residents, would be unavailable to customers in the event the SSES operating licenses are not renewed. If the SSES operating licenses were not renewed, PPL companies would need to build new generating capacity, purchase power, or reduce power requirements through demand reduction to ensure it meets the electric power requirements of its customers.

The power consumed in Pennsylvania is not limited to electricity generated within the Commonwealth. Pennsylvania relies on electricity drawn from the PJM Interconnection, a regional network that pools power generated in Pennsylvania, New Jersey, Maryland, and all or parts of Delaware, Ohio, Virginia, West Virginia and the District of Columbia. One consequence of the network is that electric power consumers in Pennsylvania are not specifically dependent on electricity generated within the Commonwealth. The current mix of power generation options within the PJM region is one indicator of what PPL Susquehanna considers to be feasible alternatives. In 2003, electric generators connected to the PJM network had a total generating capacity of 76,664 MWe (PJM 2004a). This capacity includes units fueled by coal (36.2 percent), dual-fired (i.e., gas and oil; 18.9 percent), nuclear (17.1 percent), oil (14.3 percent), gas (6.8 percent), hydroelectric (5.4 percent), and renewable (1.3 percent). In 2003, the electric industry in the PJM region provided 348.7 terawatt-hours of electricity (PJM 2004b). Utilization of generating capacity in the PJM region was dominated by coal (53.5 percent), followed by nuclear (32.9 percent), gas (8.4 percent), hydroelectric (2.1 percent), oil (2.0 percent) and renewable (1.1 percent) (PJM 2004c). Figures 7.2-1 and 7.2-2 illustrate the electric industry generating capacity and utilization, respectively, for the PJM region.

Comparison of generating capacity with actual utilization of this capacity indicates that coal and nuclear are used by PJM substantially more relative to their PJM capacity than either oil-fired or gas-fired generation. This condition reflects the relatively low fuel cost and baseload suitability for nuclear power and coal-fired plants, and relatively higher use of gas- and oil-fired units to meet peak loads. Comparison of capability and utilization for petroleum and gas-fired facilities indicates a strong preference of gas firing over oil firing, indicative of higher cost and greater air emissions associated with oil firing. Energy production from hydroelectric sources is similarly preferred from a

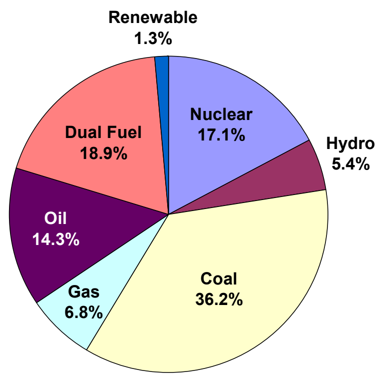

Figure 7.2-1. PJM Regional Generating Capacity by Fuel Type, 2003

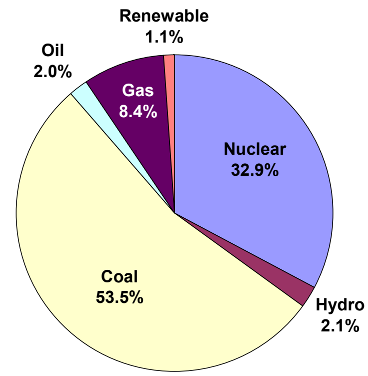

Figure 7.2-2. PJM Regional Generation by Fuel Type, 2003

cost standpoint, but capacity is limited and utilization can vary substantially depending on water availability.

7.2.1 Alternatives Considered

<u>Technology Choices</u>

For the purposes of this environmental report, PPL Susquehanna conducted evaluations of alternative generating technologies to identify candidate technologies that would be capable of replacing the net base-load capacity (2,510 MWe) of the nuclear units at SSES.

Based on these evaluations, it was determined that feasible new plant systems to replace the capacity of the SSES nuclear units are limited to pulverized-coal and gas-fired combined-cycle units for base-load operation. This conclusion is borne out by the generation utilization information presented above that identifies coal as the most heavily utilized non-nuclear generating technology in the region. PPL Susquehanna would use gas as the primary fuel in its combined-cycle turbines because of the economic and environmental advantages of gas over oil. Manufacturers now have large standard sizes of combined-cycle gas turbines that are economically attractive and suitable for high-capacity base-load operation. For the purposes of the SSES license renewal environmental report, PPL Susquehanna has limited its analysis of new generating capacity alternatives to the technologies it considers feasible: pulverized

coal- and gas-fired units. PPL Susquehanna chose to evaluate combined-cycle turbines in lieu of simple-cycle turbines because the combined-cycle option is more economical. The benefits of lower operating costs for the combined-cycle option outweigh its higher capital costs.

Mixture

NRC indicated in the GEIS that, while many methods are available for generating electricity and a huge number of combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy, given the purposes of the alternatives analysis. Therefore, NRC determined that a reasonable set of alternatives should be limited to the analysis of single discrete electrical generation sources and only those electric generation technologies that are technically reasonable and commercially viable (NRC 1996a, pg. 8-1). Consistent with the NRC determination, PPL Susquehanna has not evaluated mixes of generating sources. The impacts from coal- and gas-fired generation presented in this chapter would bound the impacts from any generation mixture of the two technologies.

Effects of Restructuring

Nationally, the electric power industry has been undergoing a transition from a regulated industry to a competitive market environment. Efforts to deregulate the electric utility industry began with passage of the National Energy Policy Act of 1992. Provisions of this act required electric utilities to allow open access to their transmission lines and encouraged development of a competitive wholesale market for electricity. The Act did not mandate competition in the retail market, leaving that decision to the states (NEI 2000). Over the past few years, states within the PJM region have transitioned to competitive wholesale and retail markets.

In 1996, Pennsylvania enacted the “Electricity Generation Customer Choice and Competition Act” (Act). Provisions of the Act opened Pennsylvania’s retail electric power market to competition. The Pennsylvania Public Utility Commission (PPUC) provides strategic direction and policy guidance for oversight of the electric power industry in the Commonwealth, including the restructuring initiative (Pennsylvania General Assembly 1996).

In 2004, Pennsylvania adopted the Alternative Energy Portfolio Standards Act (AEPS), which requires all suppliers selling retail electricity in Pennsylvania (retail electric suppliers) to include alternative energy sources in the mix of energy that they sell. Eligible resources may be located anywhere within the PJM region (Pennsylvania General Assembly 2004).

The AEPS established two tiers of alternative energy sources and set minimum requirements for each tier. By 2007 at least 1.5 percent of the electricity sold by a retail electric supplier must come from Tier I sources. Tier I sources include wind, solar photovoltaic energy, low-impact hydropower, geothermal sources, biologically-derived methane gas, fuel cells, biomass, and coal mine methane. The Tier I percentage increases by 0.5 percent each year, and by the year 2020, at least 8 percent of the retail electric energy sold in Pennsylvania must be generated from Tier I sources. The AEPS also requires that a very small percentage of Tier I generation be from solar photovoltaic technologies.

In addition, a certain percentage of electricity sold by retail electric suppliers must be generated from Tier II alternative energy sources. Tier II sources include energy derived from waste coal, distributed generation systems, demand side management (DSM), large-scale hydropower, municipal solid waste generation, utilizing the byproducts of pulping or wood-manufacturing processes, and integrated combined coal gasification technology. The AEPS requires 4.2 percent of energy sold each year through 2009 to be generated using Tier II resources. The percentage increases incrementally until the year 2020 when at least 10 percent of the retail electric energy sold in Pennsylvania must be supplied from Tier II sources.

As mentioned above, the AEPS includes provisions for DSM measures to reduce electricity demand within the Commonwealth. Eligible measures include energy efficiency measures undertaken by residential, commercial, institutional, or governmental customers; load management and demand response approaches that shift electric load from periods of higher to lower demand; and the reuse of energy from exhaust gases or other manufacturing by-products or useful thermal energy for electricity production by industrial and manufacturing customers. These measures also enable electricity customers to benefit from the energy credit market created by the portfolio standard. Retail customers who reduce their electricity demand through energy efficiency and load management, or who generate electricity by reusing energy, will earn alternative energy credits that they can sell to utility companies (Pennsylvania General Assembly 2004).

<u>Alternatives</u>

The following sections present fossil-fuel-fired generation (Section 7.2.1.1) and purchased power (Section 7.2.1.2) as reasonable alternatives to license renewal. Section 7.2.1.3 discusses reduced demand and presents the basis for concluding that it is not a reasonable alternative to license renewal. Section 7.2.1.4 discusses other

alternatives that PPL Susquehanna has determined are not reasonable and PPL Susquehanna bases for these determinations.

7.2.1.1 Construct and Operate Fossil-Fuel-Fired Generation

PPL Susquehanna analyzed locating hypothetical new coal- and gas-fired units at the existing SSES site and at an undetermined green field site. PPL Susquehanna concluded that SSES is the preferred site for new construction because this approach would minimize environmental impacts by building on previously disturbed land and by making the most use possible of existing facilities, such as transmission lines, roads and parking areas, office buildings, and components of the cooling system. Locating hypothetical units at the existing site has, therefore, been applied to the coal- and gas-fired units.

For comparability, PPL Susquehanna selected gas- and coal-fired units of equal electric power capacity. One unit with a net capacity of 2,510 MWe could be assumed to replace the 2,510-MWe SSES net capacity. However, PPL Susquehanna's experience indicates that, although custom size units can be built, using standardized sizes is more economical. For example, standard-sized units include a gas-fired combined-cycle plant of 600 MWe net capacity. Four of these standard-sized units would have 2,400 MWe net capacity. For comparability, PPL Susquehanna set the net power of the coal-fired units equal to the gas-fired plants (2,400 MWe). Although this provides less capacity than the existing unit, it ensures against overestimating environmental impacts from the alternatives. The shortfall in capacity could be replaced by other methods (see Mixture in Section 7.2.1).

It must be emphasized, however, that these are hypothetical scenarios. PPL Susquehanna does not have plans for such construction at SSES.

<u>Gas-Fired Generation</u>

For purposes of this analysis, PPL Susquehanna assumed development of a modern natural gas-fired combined-cycle plant with design characteristics similar to those being developed elsewhere in the PJM region, and with a generating capacity similar to SSES. The Fairless Energy Works, a two unit plant in Bucks County, Pennsylvania that has a net generating capacity of 1,200 MWe, meets these general criteria (Power Engineering 2003). Four units similar to the units at the Fairless Energy Works would meet the criteria for replacing SSES capacity. Therefore, PPL Susquehanna used characteristics of this plant and other relevant resources in defining the SSES gas-fired alternative. PPL Susquehanna assumes that the representative plant would be located at the SSES site, which offers potential advantages of existing infrastructure

(e.g., cooling water system, transmission, roads, and technical and administrative support facilities). Table 7.2-1 presents the basic gas-fired alternative characteristics.

Coal-Fired Generation

NRC has routinely evaluated coal-fired generation alternatives for nuclear plant license renewal. In the Supplemental GEIS for McGuire Nuclear Station (NRC 2002b), NRC analyzed 2,400 MWe of coal-fired generation capacity. PPL Susquehanna has reviewed the NRC analysis, considers it to be sound, and notes that it analyzed the same generating capacity, 2,400 MWe, discussed in this analysis. In defining the SSES coal-fired alternative, PPL Susquehanna has used site- and Pennsylvania-specific input and has applied the NRC analysis, where appropriate.

Table 7.2-2 presents the basic coal-fired alternative emission control characteristics. PPL Susquehanna based its emission control technology and percent control assumptions on alternatives that the U.S. Environmental Protection Agency has identified as being available for minimizing emissions (EPA 1998a). PPL Susquehanna assumes that the representative plant would be located at the SSES site, which offers potential advantages of existing infrastructure (e.g., cooling water system, transmission, roads, and technical and administrative support facilities). For the purposes of analysis, PPL Susquehanna has assumed that coal and lime (calcium oxide) would be delivered via an existing rail spur to SSES.

Table 7.2-1. Gas-Fired Alternative

Characteristic	Basis
Unit size = 600 MWe ISO rating net:[a]	Manufacturer's standard size gas-fired combined-cycle plant that is ≤ SSES net capacity - 2,510 MWe
Unit size = 624 MWe ISO rating gross[a] Combined cycle consisting of two 172 MWe combustion turbines and one 256 MWe heat recovery steam generator (HRSG) [b]	Calculated based on 4 percent onsite power
Number of units = 4	Assumed
Fuel type = natural gas	Assumed
Fuel heating value = 1,027 Btu/ft^3	2002 value for gas used in Pennsylvania (EIA 2004a)
Fuel SO_x content = 0.0034 lb/MMBtu	EPA 2000, Table 3.1-2a
NO_X control = selective catalytic reduction (SCR) with steam/water injection	Best available for minimizing NO_X emissions (EPA 2000)
Fuel NOx content = 0.0109 lb/MMBtu	Typical for large SCR-controlled gas fired units with water injection (EPA 2000)
Fuel CO content = 0.00226 lb/MMBtu	Typical for large SCR-controlled gas fired units (EPA 2000)
Fuel PM_{10} content = 0.0019 lb/MMBtu	EPA 2000, Table 3.1-2a
Heat rate = 6,040 Btu/kWh	(Chase and Kehoe 2000)
Capacity factor = 0.85	Assumed based on performance of modern plants

a. The difference between "net" and "gross" is electricity consumed onsite.
b. The HRSG does not contribute to air emissions.

Btu = British thermal unit
ft^3 = cubic foot
ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity, and 14.696 pounds of atmospheric pressure per square inch
kWh = kilowatt hour
MM = million
MWe = megawatt electrical
NO_X = nitrogen oxides
PM_{10} = particulates having diameter of 10 microns or less
≤ = less than or equal to

Table 7.2-2. Coal-Fired Alternative

Characteristic	Basis
Unit size = 600 MWe ISO rating net[a]	Calculated to be ≤ SSES net capacity – 2,510 MWe
Unit size = 636 MWe ISO rating gross[a]	Calculated based on 6 percent onsite power
Number of units = 4	Assumed
Boiler type = tangentially fired, dry-bottom	Minimizes nitrogen oxides emissions (EPA 1998a)
Fuel type = bituminous, pulverized coal	Typical for coal used in Pennsylvania
Fuel heating value = 11,782 Btu/lb	2002 value for coal used in Pennsylvania (EIA 2004a)
Fuel ash content by weight = 8.96 percent	2001 value for coal used in Pennsylvania (EIA 2004b)
Fuel sulfur content by weight = 1.90 percent	2002 value for coal used in Pennsylvania (EIA 2004a)
Uncontrolled NO_x emission = 10 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, NSPS (EPA 1998a)
Uncontrolled CO emission = 0.5 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, NSPS (EPA 1998a)
Heat rate = 10,200 Btu/kWh	Typical for coal-fired, single-cycle steam turbines (EIA 2002)
Capacity factor = 0.85	Typical for large coal-fired units
NO_x control = low NO_x burners, overfire air and selective catalytic reduction (95 percent reduction)	Best available and widely demonstrated for minimizing NO_x emissions (EPA 1998a)
Particulate control = fabric filters (baghouse-99.9 percent removal efficiency)	Best available for minimizing particulate emissions (EPA 1998a)
SO_x control = Wet scrubber - lime (95 percent removal efficiency)	Best available for minimizing SO_x emissions (EPA 1998a)

a. The difference between "net" and "gross" is electricity consumed onsite.

Btu = British thermal unit
ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity, and 14.696 pounds of atmospheric pressure per square inch
kWh = kilowatt hour
NSPS = New Source Performance Standard
lb = pound
MWe = megawatt electrical
NO_x = nitrogen oxides
SO_x = oxides of sulfur
≤ = less than or equal to

7.2.1.2 Purchase Power

PPL Susquehanna has evaluated conventional and prospective power supply options that could be reasonably implemented before the existing SSES licenses expire. As noted in Section 7.2.1, electric industry restructuring initiatives in the Commonwealth of Pennsylvania and other states in the PJM region are designed to promote competition in energy supply markets by facilitating participation by non-utility suppliers. PJM has implemented market rules to appropriately anticipate and meet electricity demands in the resulting wholesale electricity market. As an additional facet of this restructuring effort, retail customers in the region now may choose among any company with electric generation to supply their power, resulting in uncertainty with regard to future PPL Susquehanna load obligations. In view of these conditions, PPL Susquehanna assumes for purposes of this analysis that adequate supplies of electricity would be available, and that purchased power would be a reasonable alternative to meet the Station's load requirements in the event the existing operating licenses for SSES are not renewed.

The source of this purchased power may reasonably include new generating facilities developed elsewhere in the Commonwealth, or neighboring states in the PJM region. The technologies that would be used to generate this purchased power are similarly speculative. PPL Susquehanna assumes that the generating technology used to produce purchased power would be one of those that NRC analyzed in the GEIS. For this reason, PPL Susquehanna is adopting by reference the GEIS description of the alternative generating technologies as representative of the purchase power alternative. Of these technologies, facilities fueled by coal and combined-cycle facilities fueled by natural gas are the most cost effective for providing base-load capacity.

PPL Susquehanna anticipates that additional transmission infrastructure would be needed in the event purchased power must replace SSES capacity. From a local perspective, loss of the SSES could result in a load pocket that would require construction of new transmission lines to ensure local system stability. From a regional perspective, PJM's interconnected transmission system is highly reliable, and the market-driven process for generation addition in the region is expected to have a positive impact on overall system reliability.

7.2.1.3 Demand Side Management

As discussed in Section 7.2.1, Pennsylvania has adopted Alternative Energy Portfolio Standards (AEPS) that include provisions for market–based DSM measures to reduce electricity demand within the Commonwealth.

Prior to adopting the AEPS, Pennsylvania had developed through individual settlements with the Commonwealth's major distribution companies, a comprehensive program to promote and advance DSM in the retail electric market. The Pennsylvania Sustainable Energy Board worked in partnership with regional sustainable energy boards, other commonwealth agencies, electric utilities, business organizations and environmental organizations to develop and implement "tools" to save energy. Pennsylvania's DSM offerings under this program ranged from load curtailment incentives during periods of peak demand to rebates and financial incentives for commercial, industrial, and residential customers for installation of energy-efficient appliances and equipment to educational programs and demonstration projects (PSEB 2004).

Since 1997, Pennsylvania's DSM programs have saved Pennsylvania residents and businesses over 56 terawatt-hours in avoided electricity use, and additional demand reductions are projected to result from these efforts (Pinero 2001). However, it is expected that projected energy efficiencies would be anticipated by the market. As a practical matter, it would be impossible to increase those energy savings by an additional 2,510 MWe to replace SSES generating capability. For these reasons, PPL Susquehanna does not consider energy conservation to represent a reasonable alternative to renewal of the SSES operating licenses.

7.2.1.4 Other Alternatives

This section identifies alternatives that PPL Susquehanna has determined are not reasonable and the PPL Susquehanna bases for these determinations. PPL Susquehanna accounted for the fact that SSES is a base-load generator and that any feasible alternative to SSES would also need to be able to generate base-load power. For the purposes of analysis PPL Susquehanna assumed that the states of Pennsylvania, New Jersey and Maryland comprise PJM region. In performing this evaluation, PPL Susquehanna relied heavily upon NRC's GEIS (NRC 1996a).

Wind

Wind power, by itself, is not suitable for large base-load generation. As discussed in Section 8.3.1 of the GEIS, wind has a high degree of intermittence, and average annual capacity factors for wind plants are relatively low (less than 30 percent). Wind power, in conjunction with energy storage mechanisms, might serve as a means of providing base-load power. However, current energy storage technologies are too expensive for wind power to serve as a large base-load generator.

Based on American Wind Energy Association estimates (AWEA 2002), the PJM region has the technical potential (the upper limit of renewable electricity production and

capacity that could be brought online, without regard to cost, market acceptability, or market constraints) for roughly 6,658 MWe of installed wind power capacity. The full exploitation of wind energy is constrained by a variety of factors including land availability and land-use patterns, surface topography, infrastructure constraints, environmental constraints, wind turbine capacity factor, wind turbine availability, and grid availability. When these constraints on wind energy development are considered the achievable wind energy potential is expected to fall in the range of 10-30 percent of technical potential estimates or 665-1,995 MWe. By the end of 2004 a total of 129 MWe of wind energy had been developed in PJM region. Projected new capacity in various stages of review within the PJM region includes an additional 226 MWe of wind energy (DOE 2004a).

Wind farms, the most economical wind option, generally consist of 10-50 turbines in the 1-3 MWe range. Estimates based on existing installations indicate that a utility-scale wind farm would occupy about 50 acres per MWe of installed capacity (McGowan & Connors 2000). Therefore, replacement of SSES generating capacity (2,510 MWe net) with wind power, even assuming ideal wind conditions, would require dedication of about 196 square miles. Based on the amount of land needed to replace SSES, the wind alternative would require a large green field site, which would result in a large environmental impact. Additionally, wind plants have aesthetic impacts, generate noise, and harm birds.

The scale of this technology is too small to directly replace a power plant of the size of SSES, capacity factors are low (30 to 40 percent), and the land requirement (196 square miles) is large. Therefore, PPL Susquehanna has concluded that wind power is not a reasonable alternative to SSES license renewal.

Solar

By its nature, solar power is intermittent. In conjunction with energy storage mechanisms, solar power might serve as a means of providing base-load power. However, current energy storage technologies are too expensive to permit solar power to serve as a large base-load generator. Even without storage capacity, solar power technologies (photovoltaic and thermal) cannot currently compete with conventional fossil-fueled technologies in grid-connected applications, due to high costs per kilowatt of capacity (NRC 1996a).

Solar power is not a technically feasible alternative for baseload capacity in the PJM region. The PJM region receives 2.8 to 3.9 kilowatt hours of solar radiation per square meter per day, compared with 5 to 7.2 kilowatt hours per square meter per day in areas

of the West, such as California, which are most promising for solar technologies (NRC 1996a).

Estimates based on existing installations indicate that utility-scale plants would occupy about 7.4 acres per MWe for photovoltaic and 4.9 acres per MWe for solar thermal systems (DOE 2004b). Utility-scale solar plants have only been used in regions, such as the western U.S., that receive high concentrations (5 to 7.2 kilowatt hours per square meter per day) of solar radiation. PPL Susquehanna believes that a utility-scale solar plant located in the PJM region, which receives 2.8 to 3.9 kilowatt hours of solar radiation per square meter per day, would occupy about 16.4 acres per MWe for photovoltaic and 10.9 acres per MWe for solar thermal systems. Therefore, replacement of SSES generating capacity with solar power would require dedication of about 64 square miles for photovoltaic and 43 square miles for solar thermal systems. Neither type of solar electric system would fit at the SSES site, and both would have large environmental impacts at a green field site.

PPL Susquehanna has concluded that, due to the high cost, limited availability of sufficient incident solar radiation, and amount of land needed (approximately 43 to 64 square miles), solar power is not a reasonable alternative to SSES license renewal.

Hydropower

A portion (about 4,150 MWe) of utility generating capacity in the PJM region is hydroelectric (PJM 2004a). As the GEIS points out in Section 8.3.4, hydropower's percentage of United States generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern over flooding, destruction of natural habitat, and alteration of natural river courses. A small number of hydropower projects, the largest of which is 10 MWe, are being considered in the PJM region (FERC 2005). These small hydropower projects could not replace the 2510 MWe generated at SSES. According to the U.S. Hydropower Resource Assessment (INEEL 1998), there are no remaining sites in the PJM region that would be environmentally suitable for a large hydroelectric facility.

The GEIS estimates land use of 1,600 square miles per 1,000 MWe for hydroelectric power. Based on this estimate, replacement of SSES generating capacity would require flooding approximately 4,020 square miles, resulting in a large impact on land use. Further, operation of a hydroelectric facility would alter aquatic habitats above and below the dam, which would impact existing aquatic communities.

PPL Susquehanna has concluded that, due to the lack of suitable sites in the PJM region for a large hydroelectric facility and the amount of land needed (approximately

4,020 square miles), hydropower is not a reasonable alternative to SSES license renewal.

Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC 1996a), geothermal plants might be located in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. However, because there are no high-temperature geothermal sites in PJM region, PPL Susquehanna concludes that geothermal is not a reasonable alternative to SSES license renewal.

Wood Energy

As discussed in the GEIS (NRC 1996a), the use of wood waste to generate electricity is largely limited to those states with significant wood resources. The pulp, paper, and paperboard industries in states with adequate wood resources generate electric power by consuming wood and wood waste for energy, benefiting from the use of waste materials that could otherwise represent a disposal problem. According to the U.S. Department of Energy, Pennsylvania is the only state in the PJM region that is considered to have adequate wood resources (Walsh et al. 2000). However, the largest wood waste power plants are 40 to 50 MWe in size.

Further, as discussed in Section 8.3.6 of the GEIS (NRC 1996a), construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood-waste plants require large areas for fuel storage, processing, and waste (i.e., ash) disposal. Additionally, operation of wood-fired plants has environmental impacts, including impacts on the aquatic environment and air. Wood has a low heat content that makes it unattractive for base-load applications. It is also difficult to handle and has high transportation costs.

While some wood resources are available in the PJM region, PPL Susquehanna has concluded that, due to the lack of an environmental advantage, low heat content, handling difficulties, and high transportation costs, wood energy is not a reasonable alternative to SSES license renewal.

Municipal Solid Waste

As discussed in Section 8.3.7 of the GEIS (NRC 1996a), the initial capital costs for municipal solid waste plants are greater than for comparable steam turbine technology at wood-waste facilities. This is due to the need for specialized waste separation and handling equipment.

The decision to burn municipal solid waste to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of unfavorable economics.

Estimates in the GEIS suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as that for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal). Some of these impacts would be moderate, but still larger than the environmental effects of SSES license renewal.

PPL Susquehanna has concluded that, due to the high costs and lack of environmental advantages, burning municipal solid waste to generate electricity is not a reasonable alternative to SSES license renewal.

<u>Other Biomass-Derived Fuels</u>

In addition to wood and municipal solid waste fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), and gasifying energy crops (including wood waste). As discussed in the GEIS, none of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a base-load plant such as SSES.

Further, estimates in the GEIS suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as that for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air). These systems also have large impacts on land use, due to the acreage needed to grow the energy crops.

PPL Susquehanna has concluded that, due to the high costs and lack of environmental advantage, burning other biomass-derived fuels is not a reasonable alternative to SSES license renewal.

<u>Petroleum</u>

The PJM region has several petroleum (oil)-fired power plants; however, they produce less than 2 percent of the total power generated in the region (PJM 2004c). From 1993 to 2002, utilities in the PJM region reduced the amount of power produced by oil-fired generating plants by about 46 percent (EIA 2004a). Oil-fired operation is more expensive than nuclear or coal-fired operation, and future increases in petroleum prices

are expected to make oil-fired generation increasingly more expensive than coal-fired generation.

Also, construction and operation of an oil-fired plant would have environmental impacts. For example, Section 8.3.11 of the GEIS (NRC 1996a) estimates that construction of a 1,000-MWe oil-fired plant would require about 120 acres. Additionally, operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant.

PPL Susquehanna has concluded that, due to the high costs and lack of obvious environmental advantage, oil-fired generation is not a reasonable alternative to SSES license renewal.

Fuel Cells

Fuel cell power plants are in the initial stages of commercialization. While more than 650 large stationary fuel cell systems have been built and operated worldwide, the global stationary fuel cell electricity generating capacity in 2003 was only 125 MWe. In addition, the largest stationary fuel cell power plant is only 11 MWe (Fuel Cell Today 2003). Recent estimates suggest that a company would have to produce about 100 MWe of fuel cell stacks annually to achieve a price of $1,000 to $1,500 per kilowatt (Kenergy 2000). However, the production capability of the largest stationery fuel cell manufacturer is 50 MWe per year (CSFCC 2002). PPL Susquehanna judges that this technology has not matured sufficiently to support production for a facility the size of SSES. PPL Susquehanna has concluded that, due to cost and production limitations, fuel cell technology is not a reasonable alternative to SSES license renewal.

Advanced Nuclear Reactor

Increased interest in the development of advanced nuclear power plants has been expressed recently by members of both industry and government. However, PPL Susquehanna has no plans to construct a new nuclear power plant, and considers it unlikely that a replacement for SSES could be planned, licensed, constructed, and on line by the time the existing operating licenses expire.

Delayed Retirement

As the NRC noted in the GEIS (NRC 1996a, Section 8.3.13), extending the lives of existing non-nuclear generating plants beyond the time they were originally scheduled to be retired represents another potential alternative to license renewal. PPL Generation will retire two 140 MWe coal-fired units at the Martins Creek plant in September 2007. PPL will also retire two small diesel generators rated 2 and 3 MWe respectively in September 2007. The delayed retirement of the above generation

sources could not replace the 2510 MWe generated at SSES. The PJM region has a younger generation fleet than the nation as a whole and relatively little generation has been retired in the region since the onset of competitive markets. This trend is likely to continue, and PPL Susquehanna is not aware of opportunities for delayed retirement that may be available to other energy suppliers in the region. For these reasons, the delayed retirement of non-nuclear generating units is not considered a reasonable alternative to SSES license renewal.

7.2.2 Environmental Impacts of Alternatives

This section evaluates the environmental impacts of alternatives that PPL Susquehanna has determined to be reasonable alternatives to SSES license renewal: gas-fired generation, coal-fired generation, and purchased power.

7.2.2.1 Gas-Fired Generation

NRC evaluated environmental impacts from gas-fired generation alternatives in the GEIS, focusing on combined-cycle plants. Section 7.2.1.1 presents PPL Susquehanna's reasons for defining the gas-fired generation alternative as a combined-cycle plant on the SSES site. Land-use impacts from gas-fired units on SSES would be less than those from the existing plant. Reduced land requirements, due to a smaller facility footprint, would reduce impacts to ecological, aesthetic, and cultural resources. A smaller workforce could have adverse socioeconomic impacts. Human health effects associated with air emissions would be of concern. Aquatic biota losses due to cooling water withdrawals would be offset by the concurrent shutdown of the nuclear generators.

In the Supplemental GEIS for McGuire Nuclear Station (NRC 2002b) NRC evaluated the environmental impacts of constructing and operating five 482 MWe combined-cycle gas-fired units as an alternative to a nuclear power plant license renewal. This analysis is for a generating capacity similar to the SSES gas-fired alternatives analysis, because PPL Susquehanna would install 2,400 MWe of net power. PPL Susquehanna has adopted the NRC analysis with necessary Pennsylvania- and PPL Susquehanna-specific modifications noted.

<u>Air Quality</u>

Natural gas is a relatively clean-burning fossil fuel that primarily emits nitrogen oxides (NO_x), a regulated pollutant, during combustion. A natural gas-fired plant would also emit small quantities of sulfur oxides (SO_x), particulate matter, and carbon monoxide, all of which are regulated pollutants. Control technology for gas-fired turbines focuses on

NO_x emissions. PPL Susquehanna estimates the gas-fired alternative emissions to be as follows:

SO_x = 191 tons per year

NO_x = 612 tons per year

Carbon monoxide = 127 tons per year

Filterable Particulates = 107 tons per year (all particulates are PM_{10})

Table 7.2-3 shows how PPL Susquehanna calculated these emissions.

In 2002, Pennsylvania was ranked 2nd nationally in sulfur dioxide (SO_2) emissions and 6th nationally in NO_x emissions from electric power plants (EIA 2004a). The ranking was based on quantity emitted. For example, the electric power plants in only 1 state emitted more SO_2 than those located in Pennsylvania. The acid rain requirements of the Clean Air Act Amendments capped the nation's SO_2 emissions from power plants. Each company with fossil-fuel-fired units was allocated SO_2 allowances. To be in compliance with the Act, the companies must hold enough allowances to cover their annual SO_2 emissions. PPL Susquehanna would need to obtain SO_2 credits to operate a fossil-fuel-burning plant at the SSES site. In 1998, the EPA promulgated the NO_x SIP (State Implementation Plan) Call regulation that required 22 states, including Pennsylvania, to reduce their NO_x emissions by over 30 percent to address regional transport of ground-level ozone across state lines (EPA 1998b). To operate a fossil-fuel-fired plant at the SSES site, PPL Susquehanna would need to obtain enough NO_x credits to cover annual emissions either from the set-aside pool or by buying NO_x credits from other sources. Additionally, because all Pennsylvania is treated as a nonattainment area for ozone a fossil-fuel plant would need to obtain NO_x emission reduction credits in the amount of 1.15 tons of NO_x for every ton of NO_x emitted.

NO_x effects on ozone levels, SO_2 allowances, and NO_x credits could all be issues of concern for gas-fired combustion. While gas-fired turbine emissions are less than coal-fired boiler emissions, the emissions are still substantial. PPL Susquehanna concludes that emissions from the gas-fired alternative at SSES would noticeably alter local air quality, but would not cause or contribute to violations of National Air Quality Standards. Air quality impacts would therefore be moderate.

Waste Management

The solid waste generated from this type of facility would be minimal. The only noteworthy waste would be from spent SCR catalyst used for NO_x control. The SCR process for a 2400 MWe plant would generate approximately 1500 ft^3 of spent catalyst

Table 7.2-3. Air Emissions from Gas-Fired Alternative

Parameter	Calculation	Result
Annual gas consumption	$4\ \text{units} \times \frac{624\ \text{MW}}{\text{unit}} \times \frac{6{,}040\ \text{Btu}}{\text{kW} \times \text{hr}} \times \frac{1{,}000\ \text{kW}}{\text{MW}} \times 0.85 \times \frac{\text{ft}^3}{1{,}027\ \text{Btu}} \times \frac{24\ \text{hr}}{\text{day}} \times \frac{365\ \text{day}}{\text{yr}}$	109,303,509,873 ft^3 of gas per year
Annual Btu input	$\frac{109{,}303{,}509{,}873\ \text{ft}^3}{\text{yr}} \times \frac{1{,}027\ \text{Btu}}{\text{ft}^3} \times \frac{\text{MMBtu}}{10^6\ \text{Btu}}$	112,254,705 MMBtu per year
SO_x[a]	$\frac{0.0034\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{112{,}254{,}705\ \text{MMBtu}}{\text{yr}}$	191 tons SO_x per year
NO_x[b]	$\frac{0.0109\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{112{,}254{,}705\ \text{MMBtu}}{\text{yr}}$	612 tons NO_x per year
CO[b]	$\frac{0.00226\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{112{,}254{,}705\ \text{MMBtu}}{\text{yr}}$	127 tons CO per year
TSP[a]	$\frac{0.0019\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{112{,}254{,}705\ \text{MMBtu}}{\text{yr}}$	107 tons TSP per year
PM_{10}[a]	$\frac{107\ \text{tons TSP}}{\text{yr}}$	107 tons PM_{10} per year

a. EPA 2000, Table 3.1-1.
b. EPA 2000, Table 3.1-2.
CO = carbon monoxide
NO_x = oxides of nitrogen
PM_{10} = particulates having diameter of 10 microns or less
SO_x = oxides of sulfur
TSP = total suspended particulates

per year (NRC 2002b). PPL Susquehanna concludes that gas-fired generation waste management impacts would be small.

Other Impacts

The ability to construct the gas-fired alternative on the existing SSES site would reduce construction-related impacts. A new gas pipeline would be required for the four gas turbine generators in this alternative. To the extent practicable, PPL Susquehanna would route the pipeline along existing, previously disturbed, right-of-way to minimize impacts. Approximately 2 miles of new pipeline construction would be required to connect SSES to an existing 24-inch pipeline just north of the plant. A 16-inch diameter pipeline would necessitate a 50-foot-wide corridor, resulting in the disturbance of as much as 12 acres. This new construction may also necessitate an upgrade of the State-wide pipeline network. PPL Susquehanna estimates that 160 acres would be needed for a plant site; this much previously disturbed acreage is available at SSES, reducing loss of terrestrial habitat. Aesthetic impacts, erosion and sedimentation, fugitive dust, and construction debris impacts would be noticeable but small. PPL Susquehanna estimates a peak construction workforce of 1,043 so socioeconomic impacts of construction would be small. However, PPL Susquehanna estimates a workforce of 88 for gas operations. The reduction in work force would result in adverse socioeconomic impacts. PPL Susquehanna judges these impacts would be moderate and would be mitigated by the site's proximity to several large metropolitan areas.

Impacts to aquatic resources and water quality would be similar to, but smaller than the impacts of SSES, due to the plant's use of the existing cooling water system that withdraws from and discharges to the Susquehanna River, and would be offset by the concurrent shutdown of SSES. The additional stacks and boilers would increase the visual impact of the existing site. Impacts to cultural resources would be unlikely, due to the previously disturbed nature of the site.

PPL Susquehanna judges that other construction and operation impacts would be small. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these other impacts, mitigation would not be warranted beyond that previously mentioned.

7.2.2.2 Coal-Fired Generation

NRC evaluated environmental impacts from coal-fired generation alternatives in the GEIS (NRC 1996a). NRC concluded that construction impacts could be substantial, due in part to the large land area required (which can result in natural habitat loss) and the large workforce needed. NRC pointed out that siting a new coal-fired plant where

an existing nuclear plant is located would reduce many construction impacts. NRC identified major adverse impacts from operations as human health concerns associated with air emissions, waste generation, and losses of aquatic biota due to cooling water withdrawals and discharges.

The coal-fired alternative that PPL Susquehanna has defined in Section 7.2.1.1 would be located at SSES.

Air Quality

A coal-fired plant would emit SO_2, NO_x, particulate matter, and carbon monoxide, all of which are regulated pollutants. As Section 7.2.1.1 indicates, PPL Susquehanna has assumed a plant design that would minimize air emissions through a combination of boiler technology and post-combustion pollutant removal. PPL Susquehanna estimates the coal-fired alternative emissions to be as follows:

SO_2 = 14,800 tons per year

NO_x = 2,050 tons per year

Carbon monoxide = 2,050 tons per year

Particulates:

Total suspended particulates = 367 tons per year

PM_{10} (particulates having a diameter of less than 10 microns) = 84 tons per year

Table 7.2-4 shows how PPL Susquehanna calculated these emissions.

The Section 7.2.2.1 discussion of regional air quality is applicable to the coal-fired generation alternative. In addition, NRC noted in the GEIS that adverse human health effects from coal combustion have led to important federal legislation in recent years and that public health risks, such as cancer and emphysema, have been associated with coal combustion. NRC also mentioned global warming and acid rain as potential impacts. PPL Susquehanna concludes that federal legislation and large-scale concerns, such as global warming and acid rain, are indications of concerns about destabilizing important attributes of air resources. However, SO_2 emission allowances, NO_x credits, low NO_x burners, overfire air, fabric filters or electrostatic precipitators, and scrubbers are regulatorily-imposed mitigation measures. As such, PPL Susquehanna concludes that the coal-fired alternative would have moderate impacts on air quality; the impacts would be noticeable and greater than those of the gas-fired alternative, but would not destabilize air quality in the area.

Table 7.2-4. Air Emissions from Coal-Fired Alternative

Parameter	Calculation	Result
Annual coal consumption	$4\ \text{unit} \times \frac{636\ \text{MW}}{\text{unit}} \times \frac{10{,}200\ \text{Btu}}{\text{kW} \times \text{hr}} \times \frac{1{,}000\ \text{kW}}{\text{MW}} \times \frac{\text{lb}}{11{,}782\ \text{Btu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times 0.85 \times \frac{24\ \text{hr}}{\text{day}} \times \frac{365\ \text{day}}{\text{yr}}$	8,199,574 tons of coal per year
SO_x[a,c]	$\frac{38 \times 1.9\ \text{lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{100 - 95}{100} \times \frac{8{,}199{,}574\ \text{tons}}{\text{yr}}$	14,800 tons SO_x per year
NO_x[b,c]	$\frac{10\ \text{lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{100 - 95}{100} \times \frac{8{,}199{,}574\ \text{tons}}{\text{yr}}$	2,050 tons NO_x per year
CO[c]	$\frac{0.5\ \text{lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{8{,}199{,}574\ \text{tons}}{\text{yr}}$	2,050 tons CO per year
TSP[d]	$\frac{10 \times 8.96\ \text{lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{100 - 99.9}{100} \times \frac{8{,}199{,}574\ \text{tons}}{\text{yr}}$	367 tons TSP per year
PM_{10}[d]	$\frac{2.3 \times 8.96\ \text{lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{100 - 99.9}{100} \times \frac{8{,}199{,}574\ \text{tons}}{\text{yr}}$	84 tons PM_{10} per year

a. EPA 1998a, Table 1.1-1.
b. EPA 1998a, Table 1.1-2.
c. EPA 1998a, Table 1.1-3.
d. EPA 1998a, Table 1.1-4.

CO = carbon monoxide
NO_x = oxides of nitrogen
PM_{10} = particulates having diameter less than 10 microns
SO_x = oxides of sulfur
TSP = total suspended particulates

Waste Management

PPL Susquehanna concurs with the GEIS assessment that the coal-fired alternative would generate substantial solid waste. The coal-fired plant would annually consume approximately 8,200,000 tons of coal having an ash content of 8.96 percent (Tables 7.2-4 and 7.2-2, respectively). After combustion, 90 percent of this ash, approximately 661,000 tons per year, would be marketed for beneficial reuse. The remaining ash, approximately 73,000 tons per year, would be collected and disposed of onsite. In addition, approximately 808,000 tons of scrubber sludge would be disposed of onsite each year (based on annual lime usage of nearly 273,000 tons). PPL Susquehanna estimates that ash and scrubber waste disposal over a 40-year plant life would require approximately 386 acres (a square area with sides of approximately 4,103 feet). Table 7.2-5 shows how PPL Susquehanna calculated ash and scrubber waste volumes. While only half this waste volume and acreage would be attributable to the 20-year license renewal period alternative, the total numbers are pertinent as a cumulative impact.

PPL Susquehanna judges that, with proper siting coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. There would be space within the SSES property for this disposal. After closure of the waste site and revegetation, the land would be available for other uses. For these reasons, PPL Susquehanna judges that waste disposal for the coal-fired alternative would have moderate impacts; the impacts of increased waste disposal would be noticeable, but would not destabilize any important resource, and further mitigation would be unwarranted.

Other Impacts

PPL Susquehanna estimates that construction of the powerblock and coal storage area would affect 686 acres of land and associated terrestrial habitat. Because most of this construction would be on previously cleared land, impacts at the SSES site would be small to moderate but would be somewhat less than the impacts of using a green field site. Upgrades to an existing rail spur, approximately 1 mile in length, would be required for coal and lime deliveries under this alternative. Visual impacts would be consistent with the industrial nature of the site. As with any large construction project, some erosion and sedimentation and fugitive dust emissions could be anticipated, but would be minimized by using best management practices. Debris from clearing and grubbing could be disposed of onsite. PPL Susquehanna estimates a peak construction work force of 1,600. Socioeconomic impacts from the construction workforce would be

Table 7.2-5. Solid Waste from Coal-Fired Alternative

Parameter	Calculation	Result
Annual SO_x generated[a]	$\frac{8{,}199{,}574 \text{ ton coal}}{\text{yr}} \times \frac{1.9 \text{ ton S}}{100 \text{ ton coal}} \times \frac{64.1 \text{ ton } SO_2}{32.1 \text{ ton S}}$	311,428 tons of SO_x per year
Annual SO_x removed	$\frac{311{,}428 \text{ ton } SO_x}{\text{yr}} \times \frac{95}{100}$	295,857 tons of SO_x per year
Annual ash generated	$\frac{8{,}199{,}574 \text{ ton coal}}{\text{yr}} \times \frac{8.96 \text{ ton ash}}{100 \text{ ton coal}} \times \frac{99.9}{100}$	733,947 tons of ash per year
Annual ash recycled	$\frac{733{,}947 \text{ ton ash}}{\text{yr}} \times \frac{90}{100}$	660,552 tons of ash recycled per year
Annual lime consumption[b]	$\frac{311{,}428 \text{ ton } SO_2}{\text{yr}} \times \frac{56.1 \text{ ton CaO}}{64.1 \text{ ton } SO_2}$	272,561 tons of CaO per year
Calcium sulfate[c]	$\frac{295{,}857 \text{ ton } SO_2}{\text{yr}} \times \frac{172 \text{ ton } CaSO_4 \bullet 2H_2O}{64.1 \text{ ton } SO_2}$	793,875 tons of $CaSO_4 \bullet 2H_2O$ per year
Annual scrubber waste[d]	$\frac{272{,}561 \text{ ton CaO}}{\text{yr}} \times \frac{100-95}{100} + 793{,}875 \text{ ton } CaSO_4 \bullet 2H_2O$	807,503 tons of scrubber waste per year
Total volume of scrubber waste[e]	$\frac{807{,}503 \text{ ton}}{\text{yr}} \times 40 \text{ yr} \times \frac{2{,}000 \text{ lb}}{\text{ton}} \times \frac{ft^3}{144.8 \text{ lb}}$	446,232,920 ft^3 of scrubber waste
Total volume of ash[f]	$\frac{733{,}947 \text{ ton}}{\text{yr}} \times 40 \text{ yr} \times \frac{2{,}000 \text{ lb}}{\text{ton}} \times \frac{ft^3}{100 \text{ lb}}$	587,157,728 ft^3 of ash
Total volume of solid waste	$446{,}232{,}920 \ ft^3 + 587{,}157{,}728 \ ft^3 \times \frac{100-90}{100}$	504,948,693 ft^3 of solid waste
Waste pile area (acres)	$\frac{504{,}948{,}693 \ ft^3}{30 \text{ ft}} \times \frac{\text{acre}}{43{,}560 \ ft^2}$	386 acres of solid waste
Waste pile area (ft x ft square)	$\sqrt{(504{,}948{,}693 \ ft^3/30 \text{ ft})}$	4,103 feet by feet square of solid waste

Based on annual coal consumption of 8,199,574 tons per year (Table 7.2-4).
a. Calculations assume 100 percent combustion of coal.
b. Lime consumption is based on total SO_2 generated.
c. Calcium sulfate generation is based on total SO_2 removed.
d. Total scrubber waste includes scrubbing media carryover.
e. Density of $CaSO_4 \bullet 2H_2O$ is 144.8 lb/ft^3.
f. Density of coal bottom ash is 100 lb/ft^3 (FHA 2000).

S = sulfur
SO_x = oxides of sulfur
CaO = calcium oxide (lime)
CaSO4•2H2O = calcium sulfate dihydrate

minimal, because worker relocation would not be expected, due to the site's proximity to several large metropolitan areas. PPL Susquehanna estimates an operational workforce of 197 for the coal-fired alternative. The reduction in workforce would result in adverse socioeconomic impacts. PPL Susquehanna judges these impacts would be small, due to SSES's proximity to large metropolitan areas.

Impacts to aquatic resources and water quality would be similar to impacts of SSES, due to the plant's use of the existing cooling water system that withdraws from and discharges to the Susquehanna River, and would be offset by the concurrent shutdown of SSES. The additional stacks, boilers, and rail deliveries would increase the visual impact of the existing site. Impacts to cultural resources would be unlikely, due to the previously disturbed nature of the site.

PPL Susquehanna judges that other construction and operation impacts would be small. In most cases, the impacts would be detectable, but they would not destabilize any important attribute of the resource involved. Due to the minor nature of these other impacts, mitigation would not be warranted beyond that previously mentioned.

7.2.2.3 Purchased Power

As discussed in Section 7.2.1.2, PPL Susquehanna assumes that the generating technology used under the purchased power alternative would be one of those that NRC analyzed in the GEIS. PPL Susquehanna is also adopting by reference the NRC analysis of the environmental impacts from those technologies. Under the purchased power alternative, therefore, environmental impacts would still occur, but they would likely originate from a power plant located elsewhere in the PJM region. PPL Susquehanna judges that imports from outside the PJM region would not be required.

The purchased power alternative would include constructing up to 50 miles of high-voltage (i.e., 345- or 500-kilovolt) transmission lines to get power from the remote locations in the PJM region to the PPL Electric Utilities' service area. PPL Susquehanna judges most of the transmission lines could be routed along existing rights-of-way. PPL Susquehanna assumes that the environmental impacts of transmission line construction would be moderate. As indicated in the introduction to Section 7.2.1.1, the environmental impacts of construction and operation of new coal- or gas-fired generating capacity for purchased power at a previously undisturbed green field site would exceed those of a coal- or gas-fired alternative located on the SSES site.

7.3 REFERENCES

Note to reader: Some web pages cited in this document are no longer available, or are no longer available through the original URL addresses. Hard copies of cited web pages are available in PPL Susquehanna files. Some sites, for example the census data, cannot be accessed through their given URLs. The only way to access these pages is to follow queries on previous web pages. The complete URLs used by PPL Susquehanna have been given for these pages, even though they may not be directly accessible. Also, all references are specific to respective chapter.

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8.0 COMPARISON OF ENVIRONMENTAL IMPACT OF LICENSE RENEWAL WITH THE ALTERNATIVES

NRC

"To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form..." 10 CFR 51.45(b)(3) as adopted by 51.53(c)(2)

Chapter 4 analyzes environmental impacts of SSES license renewal and Chapter 7 analyzes impacts from renewal alternatives. Table 8.0-1 summarizes environmental impacts of the proposed action (license renewal) and the alternatives, for comparison purposes. The environmental impacts compared in Table 8.0-1 are those that are either Category 2 issues for the proposed action or are issues that the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) (NRC 1996) identified as major considerations in an alternatives analysis. For example, although the U. S. Nuclear Regulatory Commission (NRC) concluded that air quality impacts from the proposed action would be small (Category 1), the GEIS identified major human health concerns associated with air emissions from alternatives (Section 7.2.2). Therefore, Table 8.0-1 compares air impacts from the proposed action to the alternatives. Table 8.0-2 is a more detailed comparison of the alternatives.

Table 8.0-1. Impacts Comparison Summary.

Impact	Proposed Action (License Renewal)	No-Action Alternatives			
		Base (Decommissioning)	With Coal-Fired Generation	With Gas-Fired Generation	With Purchased Power
Land Use	SMALL	SMALL	MODERATE	SMALL to MODERATE	MODERATE
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Air Quality	SMALL	SMALL	MODERATE	MODERATE	SMALL to MODERATE
Ecological Resources	SMALL	SMALL	MODERATE	SMALL	SMALL to MODERATE
Threatened or Endangered Species	SMALL	SMALL	SMALL	SMALL	SMALL
Human Health	SMALL	SMALL	MODERATE	SMALL	SMALL to MODERATE
Socioeconomics	SMALL	SMALL	SMALL	MODERATE	SMALL to MODERATE
Waste Management	SMALL	SMALL	MODERATE	SMALL	SMALL to MODERATE
Aesthetics	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE
Cultural Resources	SMALL	SMALL	SMALL	SMALL	SMALL

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource. 10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3.

Table 8.0-2. Impacts Comparison Detail.

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	**With Gas-Fired Generation**	**With Purchased Power**
Alternative Descriptions				
SSES license renewal for 20 years, followed by decommissioning	Decommissioning following expiration of current SSES license. Adopting by reference, as bounding SSES decommissioning, GEIS description (NRC 1996, Section 7.1)	New construction at the SSES site.	New construction at the SSES site.	Would involve construction of new generation capacity in the PJM region. Adopting by reference GEIS description of alternate technologies (Section 7.2.1.2)
		Upgrade 1 mile of existing rail spur.	Construct 2 miles of gas pipeline in a 50-foot-wide corridor, disturbing up to 12 acres. May require upgrades to existing 24-inch pipelines.	
		Use existing switchyard and transmission lines	Use existing switchyard and transmission lines	Construct up to 50 miles of transmission lines
		Four 600-MW (net) tangentially-fired, dry bottom units; capacity factor 0.85	Four 600-MW (net) combined-cycle units (two 172-MW combustion turbines, one 256-MW heat recovery steam generators); capacity factor 0.85	

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	**With Gas-Fired Generation**	**With Purchased Power**
		Existing SSES intake/ discharge canal system	Existing SSES intake/ discharge canal system	
		Pulverized bituminous coal, 11,782 Btu/lb; 10,200 Btu/kWh; 8.96% ash; 1.90% sulfur; 10 lb/ton nitrogen oxides; 8,199,574 tons coal/yr	Natural gas, 1,027 Btu/ft^3; 6,040 Btu/kWh; 0.0034 lb sulfur/MMBtu; 0.0109 lb NOx/MMBtu; 109,303,509,873 ft^3 gas/yr	
		Low NOx burners, overfire air and selective catalytic reduction (95% NOx reduction efficiency).	Selective catalytic reduction with steam/water injection	
		Wet scrubber – lime/limestone desulfurization system (95% SOx removal efficiency); 272,561 tons lime/yr Fabric filters or electrostatic precipitators (99.9% particulate removal efficiency)		

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	**With Gas-Fired Generation**	**With Purchased Power**
1,200 permanent and 160 long-term contract workers		197 workers (Section 7.2.2.2)	88 workers (Section 7.2.2.1)	
Land Use Impacts				
SMALL – Adopting by reference Category 1 issue findings (Attachment A, Table A-1, Issues 52, 53)	SMALL – Not an impact evaluated by GEIS (NRC 1996)	MODERATE – 686 acres required for the powerblock and associated facilities; 195 acres for ash disposal (Section 7.2.2.2).	SMALL to MODERATE – 160 acres for facility at SSES location; 12 acres for pipeline (Section 7.2.2.1). New gas pipeline would be built to connect with existing gas pipeline corridor.	MODERATE – most transmission facilities could be constructed along existing transmission corridors (Section 7.2.2.3). Adopting by reference GEIS description of land use impacts from alternate technologies (NRC 1996)
Water Quality Impacts				
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 3, 6, 7-11 and 32). Two Category 2 groundwater issues apply (Section 4.1, Issue 13; and Section 4.6, Issue 34). Three Category 2 groundwater issues don't apply (Section 4.5, Issue 33; Section 4.7, Issue 35; and Section 4.8, Issue 39).	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 89).	SMALL – Construction impacts minimized by use of best management practices. Operational impacts minimized by use of the existing cooling towers that withdraw make-up water from the Susquehanna River. (Section 7.2.2.2)	SMALL – Reduced cooling water demands, inherent in combined-cycle design (Section 7.2.2.1)	SMALL to MODERATE – Adopting by reference GEIS description of water quality impacts from alternate technologies (NRC 1996)

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	With Gas-Fired Generation	With Purchased Power
Air Quality Impacts				
SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 51). Category 2 issue not applicable (Section 4.11, Issue 50).	SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issue 88)	MODERATE – 14,800 tons SOx/yr 2,050 tons NOx/yr 2,050 tons CO/yr 367 tons TSP/yr 84 tons PM-10/yr (Section 7.2.2.2)	MODERATE – 191 tons SOx/yr 612 tons NOx/yr 127 tons CO/yr 107 tons PM-10/yr[a] (Section 7.2.2.1)	SMALL to MODERATE – Adopting by reference GEIS description of air quality impacts from alternate technologies (NRC 1996)
Ecological Resource Impacts				
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 15-24,28-30, 41-43, and 45-48). Four Category 2 issues not applicable (Section 4.2, Issue 25; Section 4.3, Issue 26; Section 4.4, Issue 27; and Section 4.9, Issue 40).	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 90)	MODERATE – 386 acres of former woodland could be required for ash/sludge disposal over 20-year license renewal term. (Section 7.2.2.2)	SMALL – Construction of 2 miles of pipeline could alter the terrestrial habitat. (Section 7.2.2.1)	SMALL to MODERATE – Adopting by reference GEIS description of ecological resource impacts from alternate technologies (NRC 1996)

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	With Gas-Fired Generation	With Purchased Power
Threatened or Endangered Species Impacts				
SMALL – No threatened or endangered species are known residents at the site or along the transmission corridors. (Section 4.10, Issue 49)	SMALL – Not an impact evaluated by GEIS (NRC 1996)	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats
Human Health Impacts				
SMALL – Adopting by reference Category 1 issues (Table A-1, Issues 56, 58, 61, 62). One Category 2 issue does apply (Section 4.12, Issue 57). Risk due to transmission-line induced currents minimal due to conformance with consensus code (Section 4.13, Issue 59)	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 86)	MODERATE – Adopting by reference GEIS conclusion that risks such as cancer and emphysema from emissions are likely (NRC 1996)	SMALL – Adopting by reference GEIS conclusion that some risk of cancer and emphysema exists from emissions (NRC 1996)	SMALL to MODERATE – Adopting by reference GEIS description of human health impacts from alternate technologies (NRC 1996)

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	**With Gas-Fired Generation**	**With Purchased Power**
Socioeconomic Impacts				
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 64, 67). Two Category 2 issues are not applicable (Section 4.16, Issue 66 and Section 4.17.1, Issue 68). Location in high population area with no growth controls minimizes potential for housing impacts. Section 4.14, Issue 63). Plant property tax payment represents 6 to 7 percent of county's total tax revenues (Section 4.17.2, Issue 69). Capacity of public water supply and transportation infrastructure minimizes potential for related impacts (Section 4.15, Issue 65 and Section 4.18, Issue 70)	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 91)	SMALL – Reduction in permanent work force at SSES could adversely affect surrounding counties, but would be mitigated by SSES's proximity to several metropolitan areas (Section 7.2.2.2).	SMALL to MODERATE – Reduction in permanent work force at SSES could adversely affect surrounding counties, but would be mitigated by SSES's proximity to several metropolitan areas (Section 7.2.2.1)	SMALL to MODERATE – Adopting by reference GEIS description of socioeconomic impacts from alternate technologies (NRC 1996)

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	**With Gas-Fired Generation**	**With Purchased Power**
Waste Management Impacts				
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 77-85)	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 87)	MODERATE – 73,000 tons of coal ash and 808,000 tons of scrubber sludge annually would require 193 acres over 20-year license renewal term. Industrial waste generated annually (Section 7.2.2.2)	SMALL – Approximately 1,500 ft^3 spent SCR catalyst per year (Section 7.2.2.1)	SMALL to MODERATE – Adopting by reference GEIS description of waste management impacts from alternate technologies (NRC 1996)
Aesthetic Impacts				
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 73, 74)	SMALL – Not an impact evaluated by GEIS (NRC 1996)	SMALL to MODERATE – The coal-fired power blocks and the exhaust stacks would be visible from a moderate offsite distance (Section 7.2.2.2)	SMALL– Steam turbines and stacks would create visual impacts comparable to those from existing SSES facilities (Section 7.2.2.1)	SMALL to MODERATE – Adopting by reference GEIS description of aesthetic impacts from alternate technologies (NRC 1996)

Table 8.0-2. Impacts Comparison Detail (Continued).

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives		
		With Coal-Fired Generation	With Gas-Fired Generation	With Purchased Power
Cultural Resource Impacts				
SMALL – SHPO consultation minimizes potential for impact (Section 4.19, Issue 71)	SMALL – Not an impact evaluated by GEIS (NRC 1996)	SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site (Section 7.2.2.2)	SMALL – 12 acres of pipeline construction in previously disturbed soil would be unlikely to affect cultural resources (Section 7.2.2.1)	SMALL – Adopting by reference GEIS description of cultural resource impacts from alternate technologies (NRC 1996)

SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource. (10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3).
a. All TSP for gas-fired alternative is PM-10.

Btu = British thermal unit
ft^3 = cubic foot
gal = gallon
GEIS = Generic Environmental Impact Statement (NRC 1996)
kWh = kilowatt hour
lb = pound
MM = million
MW = megawatt
NOx = nitrogen oxide
PJM = regional electric distribution network
PM-10 = particulates having diameter less than 10 microns
SHPO = State Historic Preservation Officer
SOx = sulfur dioxide
TSP = total suspended particulates
yr = year

8.1 REFERENCES

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. Volumes 1 and 2. NUREG-1437. Washington, DC. May.

9.0 STATUS OF COMPLIANCE

9.1 PROPOSED ACTION

NRC

"The environmental report shall list all federal permits, licenses, approvals and other entitlements which must be obtained in connection with the proposed action and shall describe the status of compliance with these requirements. The environmental report shall also include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, and thermal and other water pollution limitations or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection." 10 CFR 51.45(d), as adopted by 10 CFR 51.53(c)(2)

9.1.1 GENERAL

Table 9.1-1 lists environmental authorizations that PPL Susquehanna has obtained for current SSES operations. In this context, PPL Susquehanna uses "authorizations" to include any permits, licenses, approvals, or other entitlements. PPL Susquehanna expects to continue renewing these authorizations during the current license period and through the U.S. Nuclear Regulatory Commission (NRC) license renewal period. Because the NRC regulatory focus is prospective Table 9.1-1 does not include authorizations that PPL Susquehanna obtained for past activities that did not include continuing obligations.

Preparatory to applying for renewal of the SSES license to operate, PPL Susquehanna conducted an assessment to identify any new and significant environmental information (Chapter 5). The assessment included interviews with PPL Susquehanna subject experts, review of SSES environmental documentation, and communication with state and federal environmental protection agencies. Based on this assessment, PPL Susquehanna concludes that SSES is in compliance with applicable environmental standards and requirements.

Table 9.1-2 lists additional environmental authorizations and consultations related to NRC renewal of the SSES license to operate. As indicated, PPL Susquehanna anticipates needing relatively few such authorizations and consultations. Sections 9.1.2 through 9.1.5 discuss some of these items in more detail.

Table 9.1-1. Environmental Authorizations for Current SSES Operations.

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011, et seq.), 10 CFR 50.10	License to operate	NPF-14 NPF-22	Issued: 7/17/1982 Expires: 7/17/2022 Issued: 3/23/1984 Expires: 3/23/2024	Operation of SSES Unit 1 Operation of SSES Unit 2
U.S. Department of Transportation	49 USC 5108	Registration	0615065500290Q	Issued: 6/15/06 Expires: 6/30/09	Hazardous materials shipments
U.S. Environmental Protection Agency	40 CFR Part 68	Risk Management Program	EPA Facility ID # 1000 0004 9128	Issued: 6/15/04 Expires: 6/15/09	Hydrogen Tank Farm
U.S. Army Corps of Engineers	Section 10 of River and harbor Act of 1899 (33 U.S.C. 403)	Water Obstruction & Encroachment Permit Joint Permit	CENAB-OP-RPA 200300823-12	Issued: 2/15/2006 Expires:6/30/2006	Maintenance dredging in front of the River Intake Structure and Cleaning the Cooling Tower blowdown discharge diffuser pipe
Pennsylvania Department of Environmental Protection	Pennsylvania Public Laws 834, 204, 851, 1987, etc.	Water Obstruction & Encroachment Permit Joint Permit	PASPGP-2 E40-195	Issued:2/15/2006 Expires:6/30/2006	[Same as COE permit]

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
U.S. Army Corps of Engineers	Section 10 of River and Harbor Act of 1899 (33 U.S.C. 403)	Water Obstruction & Encroachment Permit Joint Permit	CENAB-OP-RR 87-1767-4	Issued: 8/31/88 Expired: 12/31/90	Boat Ramp Env. Lab; can perform routine maintenance
Pennsylvania Department of Environmental Protection	Pennsylvania Public Laws 834, 204, 851, 1987, etc.	Water Obstruction & Encroachment Permit Joint Permit	E40-192	Issued: 8/31/88 Expired: 12/31/90	Boat Ramp Env. Lab; can perform routine maintenance
U.S. Army Corps of Engineers	Section 10 of River and Harbor Act of 1899 (33 U.S.C. 403)	Water Obstruction & Encroachment Permit Joint Permit	PASPGP-2 E40-609 APS No. 457878	Issued: 12/19/02 Expired: 12/19/05	Work in wetlands
Pennsylvania Department of Environmental Protection	Title 25 Chapter 105, Dam Safety and Waterway Management	Water Obstruction & Encroachment Permit Joint Permit	PASPGP-2: E40-609 APS No. 457878	Issued: 12/19/02 Expired: 12/19/05	Work in wetlands

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
Pennsylvania Department of Environmental Protection	Clean Water Act (33 USC 1251 et seq.), PA Title 25 Chapter 92, National Pollutant Discharge Elimination System Permit	National Pollutant Discharge Elimination System Permit	PA-0047325	Issued: 9/1/2005 Expires:8/31/2010	Industrial wastewater discharges to Susquehanna River
Pennsylvania Department of Environmental Protection	Clean Air Act (42 USC 7401 et seq), PA Title 25 Chapter 127, Construction, Modification, Reactivation and Operation of Sources	Operating Permit	40-00027	Issued: 11/24/2003 Expires: 11/24/2008	All air emission sources at SSES

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
Pennsylvania Department of Environmental Protection	Clean Water Act (33 USC 1251 et seq.); Clean Air Act (42 USC 7401 et seq.); Resource Conservation and Recovery Act (42 USC 6901 et seq.); PA Title 245, Administration of the Storage Tank and Spill Prevention Program	Registration or certificate	40-10748-008A	Issued: 4/4/2006 Expires: 4/4/2007	Used diesel oil tank "A"
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-011A	Issued: 4/4/2006 Expires: 4/4/2007	Unit 1 condensate demineralizer sulfuric acid storage tank
Pennsylvania Department of Environmental Protection	same	Registration or Certificate	40-10748-012A	Issued: 4/4/2006 Expires: 4/4/2007	Unit 1 condensate demineralizer sodium hydroxide storage tank
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-020A	Issued: 4/4/2006 Expires: 4/4/2007	Raw water treatment alum storage tank

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-019A	Issued: 4/4/2006 Expires: 4/4/2007	Raw water treatment sodium hypochlorite storage tank
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-025A	Issued: 4/4/2006 Expires: 4/4/2007	Sodium bisulfite
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-023A	Issued: 4/4/2006 Expires: 4/4/2007	Sodium hypochlorite
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-024A	Issued: 4/4/2006 Expires: 4/4/2007	Sodium hypochlorite
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-016	Issued: 4/4/2006 Expires: 4/4/2007	Unit 1 batch lube oil tank
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-017	Issued: 4/4/2006 Expires: 4/4/2007	Unit 2 batch lube oil tank

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-018	Issued: 4/4/2006 Expires: 4/4/2007	Fuel farm gasoline tank
Pennsylvania Department of Environmental Protection	same	Registration or certificate	40-10748-019	Issued: 4/4/2006 Expires: 4/4/2007	Fuel farm diesel fuel tank
Pennsylvania Department of Environmental Protection	PA Title 25 Chapter 109, Safe Drinking Water	Public Water Supply Brief Description Form	ID 2400994 Site Well System (Wells TW1 & TW2)	Issued: 2/17/89 Expires: N/A	Well registration continues indefinitely unless there are upgrades
Pennsylvania Department of Environmental Protection	PA Title 25 Chapter 109, Safe Drinking Water	Public Water Supply Brief Description Form	ID 2400995 Riverlands Recreation Area	Issued: 12/4/85 Expires: N/A	Well registration continues indefinitely unless there are upgrades
Pennsylvania Department of Environmental Protection	PA Title 25 Chapter 109, Safe Drinking Water	Public Water Supply Brief Description Form	ID 2400999 Energy Information Center	Issued: 12/4/85 Expires: N/A	Well registration continues indefinitely unless there are upgrades
Pennsylvania Department of Environmental Protection	PA Title 25 Chapter 109, Safe Drinking Water	Public Water Supply Brief Description Form	ID 2400938 West Building (formerly Emergency Operations Facility)	Issued: 12/4/85 Expires: N/A	Well registration continues indefinitely unless there are upgrades

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
Pennsylvania Department of Environmental Protection	Section 3010 of Resource Conservation and Recovery Act	Acknowledgement of notification of Hazardous Waste Activity	PAD000765883	Issued: 8/9/2000 Expires: N/A	Hazardous waste
Pennsylvania Fish and Boat Commission	Chapter 29 of the Fish and Boat Code, Act 1980-175 amended	Scientific Collecting Permit	008 Type III (R) 007 Type III (R)	Issued: 3/28/2005 Expires: 12/31/2005	Collect fish, epilithic algae, zooplankton, macroinvertebrate, amphibians, reptiles
Susquehanna River Basin Commission	Regulation 18 CFR 803 for Consumptive use	Approval for Consumptive use water	Application 19950301	Issued: 3/9/1995 Expires: N/A	Low flow augmentation
South Carolina Department of Health and Environmental Control – Division of Waste Management	South Carolina Radioactive Waste Transportation and Disposal Act (Act No. 429)	South Carolina Radioactive Waste Transport Permit	0162-37-05	Issued: 11/18/05 Expires: 12/31/06	Transportation of radioactive waste into the State of South Carolina

Table 9.1-1. Environmental Authorizations for Current SSES Operations. (Continued)

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Federal and State Requirements					
State of Tennessee Department of Environment and Conservation Division of Radiological Health	Tennessee Department of Environment and Conservation Rule 1200-2-10.32	Tennessee Radioactive Waste License-for-Delivery	T-PA001-L05	Issued: 1/1/06 Expires: 12/31/06	Transportation of radioactive waste into the State of Tennessee
Commonwealth of Virginia Department of Emergency Management	Virginia Code, Title 44, Chapter 3.3, Section 44-143.30	Commonwealth of Virginia Radioactive Waste Transport Registration	PS-S-013107	Issued : 1/13/05 Expires: 1/31/07	Registration to transport hazardous radioactive materials in the State of Virginia

Table 9.1-2. Environmental Authorizations for SSES License Renewal[a]

Agency	Authority	Requirement	Remarks
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 USC 2011 et seq.)	License renewal	Environmental Report submitted in support of license renewal application
U.S. Fish and Wildlife Service (FWS)	Endangered Species Act Section 7 (16 USC 1536)	Consultation	Requires federal agency issuing a license to consult with the FWS (Attachment B)
Pennsylvania Department of Environmental Protection	Clean Water Act Section 401 (33 USC 1341)	Certification	State issuance of NPDES permit (Attachment F) constitutes 401 certification (Section 9.1.4)
Pennsylvania Historical and Museum Commission	National Historic Preservation Act Section 106 (16 USC 470f)	Consultation	Requires federal agency issuing a license to consider cultural impacts and consult with State Historic Preservation Officer (SHPO). SHPO must concur that license renewal will not affect any sites listed or eligible for listing (Attachment D)

a. No renewal-related requirements identified for local or other agencies.

9.1.2 THREATENED OR ENDANGERED SPECIES

Section 7 of the Endangered Species Act (16 USC 1531 et seq.) requires federal agencies to ensure that agency action is not likely to jeopardize any species that is listed, or proposed for listing as endangered, or threatened. Depending on the action involved, the Act requires consultation with the U.S. Fish and Wildlife Service (FWS) regarding effects on non-marine species, the National Marine Fisheries Service (NMFS) for marine species, or both. FWS and NMFS have issued joint procedural regulations at 50 CFR 402, Subpart B, that address consultation, and FWS maintains the joint list of threatened and endangered species at 50 CFR 17.

Although not required of an applicant by federal law or NRC regulation, PPL Susquehanna has chosen to invite comment from federal and state agencies regarding potential effects that SSES license renewal might have. Attachment B includes copies

of PPL Susquehanna correspondence with FWS, Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Game Commission, and the Pennsylvania Fish and Boat Commission. The FWS responded that license renewal will not adversely affect federally listed and proposed endangered and threatened species as long as tree-cutting activities follow specific guidelines to protect the endangered Indiana bat. The Pennsylvania Department of Conservation and Natural Resources provided a list of special status plants, terrestrial invertebrates, and natural communities in the vicinity of the transmission lines and indicated that no impact is likely from this project. The Pennsylvania Game Commission responded that license renewal will not adversely impact any special status species recognized by the Game Commission. The Pennsylvania Fish and Boat Commission responded that no adverse impacts are expected from license renewal.

9.1.3 HISTORIC PRESERVATION

Section 106 of the National Historic Preservation Act (16 USC 470 et seq.) requires federal agencies having the authority to license any undertaking to, prior to issuing the license, take into account the effect of the undertaking on historic properties and to afford the Advisory Council on Historic Preservation an opportunity to comment on the undertaking. Council regulations provide for the State Historic Preservation Officer (SHPO) to have a consulting role (35 CFR 800.2). Although not required of an applicant by federal law or NRC regulation, PPL Susquehanna has chosen to invite comment by the Pennsylvania SHPO. Attachment D contains a copy of PPL Susquehanna's letter to the Pennsylvania SHPO and the SHPO’s response agreeing that license renewal will have no adverse effect on significant cultural resources within the project area.

9.1.4 WATER QUALITY (401) CERTIFICATION

Federal Clean Water Act Section 401 can require an applicant for a federal license to conduct an activity that might result in a discharge into navigable waters to provide the licensing agency a certification from the state that the discharge will comply with applicable Clean Water Act requirements (33 USC 1341).

However, in the case of the SSES operation, the Pennsylvania Department of Environmental Resources determined that the 401 Certification was not required (PADER 1982). NRC has indicated in its Generic Environmental Impact Statement for License Renewal (NRC 1996, Section 4.2.1.1) that issuance of a National Pollutant Discharge Elimination System (NPDES) permit implies certification by the state. PPL

Susquehanna is applying to NRC for license renewal to continue SSES operations. Consistent with the GEIS, PPL Susquehanna is providing SSES's NPDES permit approval letter and cover sheet as evidence of state water quality (401) certification (Attachment F).

9.2 ALTERNATIVES

NRC

"The discussion of alternatives in the report shall include a discussion of whether the alternatives will comply with such applicable environmental quality standards and requirements." 10 CFR 51.45(d), as required by 10 CFR 51.53(c)(2)

The coal, gas, and purchased power alternatives discussed in Section 7.2.1 probably could be constructed and operated to comply with applicable environmental quality standards and requirements. PPL Susquehanna notes that increasingly stringent air quality protection requirements could make the construction of a large fossil-fueled power plant infeasible in many locations. PPL Susquehanna also notes that the U.S. Environmental Protection Agency has revised requirements for design and operation of cooling water intake structures at new and existing facilities (40 CFR 125 Subparts I and J). These requirements could necessitate construction of Cooling Towers for the coal- and gas-fired alternatives replacing once-through surface water cooling.

9.3 REFERENCES

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. Volume 1. NUREG-1437. Washington, DC. May.

PADER (Pennsylvania Department of Environmental Resources). 1982. Letter from Louis Bercheni (Bureau of Water Quality Management) to Robert Tedesco (Director of Licensing, Nuclear Regulatory Commission). PPL Water Quality Certification Under Section 401(a)(1) of the Clean Water Act. July 16.

ATTACHMENT A
NRC NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

PPL Susquehanna has prepared this environmental report in accordance with the requirements of U.S. Nuclear Regulatory Commission (NRC) regulation 10 CFR 51.53. NRC included in the regulation a list of National Environmental Policy Act (NEPA) issues for license renewal of nuclear power plants. Table A-1 lists these 92 issues and identifies the section in which PPL Susquehanna addressed each applicable issue in this environmental report. For organization and clarity, PPL Susquehanna has assigned a number to each issue and uses the issue numbers throughout the environmental report.

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a]

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Surface Water Quality, Hydrology, and Use (for all plants)			
1. Impacts of refurbishment on surface water quality	1	NA	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
2. Impacts of refurbishment on surface water use	1	NA	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
3. Altered current patterns at intake and discharge structures	1	4.0	4.2.1.2.1/4-5
4. Altered salinity gradients	1	NA	Issue applies to a plant feature, discharge to saltwater, that SSES does not have.
5. Altered thermal stratification of lakes	1	NA	Issue applies to a plant feature, discharge to a lake, that SSES does not have.
6. Temperature effects on sediment transport capacity	1	4.0	4.2.1.2.3/4-8
7. Scouring caused by discharged cooling water	1	4.0	4.2.1.2.3/4-6
8. Eutrophication	1	4.0	4.2.1.2.3/4-9
9. Discharge of chlorine or other biocides	1	4.0	4.2.1.2.4/4-10
10. Discharge of sanitary wastes and minor chemical spills	1	4.0	4.2.1.2.4/4-10
11. Discharge of other metals in waste water	1	4.0	4.2.1.2.4/4-10
12. Water use conflicts (plants with once-through cooling systems)	1	NA	Issue applies to a plant feature, once-through cooling, that SSES does not have.
13. Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	2	4.1	4.2.1.3/4-13

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Aquatic Ecology (for all plants)			
14. Refurbishment impacts to aquatic resources	1	NA	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
15. Accumulation of contaminants in sediments or biota	1	4.0	4.2.1.2.4/4-10
16. Entrainment of phytoplankton and zooplankton	1	4.0	4.2.2.1.1/4-15
17. Cold shock	1	4.0	4.2.2.1.5/4-18
18. Thermal plume barrier to migrating fish	1	4.0	4.2.2.1.6/4-19
19. Distribution of aquatic organisms	1	4.0	4.2.2.1.6/4-19
20. Premature emergence of aquatic insects	1	4.0	4.2.2.1.7/4-20
21. Gas supersaturation (gas bubble disease)	1	4.0	4.2.2.1.8/4-21
22. Low dissolved oxygen in the discharge	1	4.0	4.2.2.1.9/4-23
23. Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	1	4.0	4.2.2.1.10/4-24
24. Stimulation of nuisance organisms (e.g., shipworms)	1	4.0	4.2.2.1.11/4-25
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)			
25. Entrainment of fish and shellfish in early life stages for plants with once-through and cooling pond heat dissipation systems	2	NA, and discussed in Section 4.2	Issue applies to a plant feature, once-through cooling or a cooling pond, that SSES does not have.
26. Impingement of fish and shellfish for plants with once-through and cooling pond heat dissipation systems	2	NA, and discussed in Section 4.3	Issue applies to a plant feature, once-through cooling or a cooling pond, that SSES does not have.

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
27. Heat shock for plants with once-through and cooling pond heat dissipation systems	2	NA, and discussed in Section 4.4	Issue applies to a plant feature, once-through cooling or a cooling pond, that SSES does not have.
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)			
28. Entrainment of fish and shellfish in early life stages for plants with cooling-tower-based heat dissipation systems	1	4.0	4.3.3/4-33
29. Impingement of fish and shellfish for plants with cooling-tower-based heat dissipation systems	1	4.0	4.3.3/4-33
30. Heat shock for plants with cooling-tower-based heat dissipation systems	1	4.0	4.3.3/4-33
Ground-water Use and Quality			
31. Impacts of refurbishment on groundwater use and quality	1	NA	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
32. Groundwater use conflicts (potable and service water; plants that use < 100 gpm)	1	4.0	4.8.1.1/4-116
33. Groundwater use conflicts (potable, service water, and dewatering; plants that use > 100 gpm)	2	NA, and discussed in Section 4.5	Issue applies to an activity, using 100 gpm or more of groundwater, that SSES does not do.
34. Groundwater use conflicts (plants using cooling towers withdrawing make-up water from a small river)	2	4.6	4.8.1.3/4-117
35. Groundwater use conflicts (Ranney wells)	2	NA, and discussed in Section 4.7	Issue applies to a feature, Ranney wells, that SSES does not have.
36. Groundwater quality degradation (Ranney wells)	1	NA	Issue applies to a feature, Ranney wells, that SSES does not have.

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
37. Groundwater quality degradation (saltwater intrusion)	1	NA	Issue applies to a feature, location in a coastal area, that SSES does not have.
38. Groundwater quality degradation (cooling ponds in salt marshes)	1	NA	Issue applies to a feature, cooling ponds, that SSES does not have.
39. Groundwater quality degradation (cooling ponds at inland sites)	2	NA, and discussed in Section 4.8	Issue applies to a feature, cooling ponds at inland sites, that SSES does not have.
Terrestrial Resources			
40. Refurbishment impacts to terrestrial resources	2	NA, and discussed in Section 4.9	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
41. Cooling tower impacts on crops and ornamental vegetation	1	4.0	4.3.4/4-34
42. Cooling tower impacts on native plants	1	4.0	4.3.5.1./4-42
43. Bird collisions with cooling towers	1	4.0	4.3.5.2/4-45
44. Cooling pond impacts on terrestrial resources	1	NA	Issue applies to a feature, cooling ponds, that SSES does not have.
45. Power line right-of-way management (cutting and herbicide application)	1	4.0	4.5.6.1/4-71
46. Bird collisions with power lines	1	4.0	4.5.6.2/4-74
47. Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	1	4.0	4.5.6.3/4-77
48. Floodplains and wetlands on power line right-of-way	1	4.0	4.5.7/4-81
Threatened or Endangered Species (for all plants)			
49. Threatened or endangered species	2	4.10	4.1/4-1

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
Air Quality			
50. Air quality during refurbishment (non-attainment and maintenance areas)	2	NA, and discussed in Section 4.11	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
51. Air quality effects of transmission lines	1	4.0	4.5.2/4-62
Land Use			
52. Onsite land use	1	4.0	3.2/3-1
53. Power line right-of-way land use impacts	1	4.0	4.5.3/4-62
Human Health			
54. Radiation exposures to the public during refurbishment	1	NA	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
55. Occupational radiation exposures during refurbishment	1	NA	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
56. Microbiological organisms (occupational health)	1	4.0	4.3.6/4-48
57. Microbiological organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	2	4.12	4.3.6/4-48
58. Noise	1	4.0	4.3.7/4-49
59. Electromagnetic fields, acute effects (electric shock)	2	4.13	4.5.4.1/4-66
60. Electromagnetic fields, chronic effects	NA	4.0	NA – Not applicable. The categorization and impact finding definitions do not apply to this issue.
61. Radiation exposures to public (license renewal term)	1	4.0	4.6.2/4-87

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
62. Occupational radiation exposures (license renewal term)	1	4.0	4.6.3/4-95
Socioeconomics			
63. Housing impacts	2	4.14	3.7.2/3-10 (refurbishment) 4.7.1/4-101 (renewal term)
64. Public services: public safety, social services, and tourism and recreation	1	4.0	Refurbishment 3.7.4/3-14 (public services) 3.7.4.3/3-18 (safety) 3.7.4.4/3-19 (social) 3.7.4.6/3-20 (tour, rec) Renewal Term 4.7.3/4-104 (public services) 4.7.3.3/4-106 (safety) 4.7.3.4/4-107 (social) 4.7.3.6/4-107 (tour, rec)
65. Public services: public utilities	2	4.15	3.7.4.5/3-19 (refurbishment) 4.7.3.5/4-107 (renewal term)
66. Public services: education (refurbishment)	2	NA , and discussed in Section 4.16	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
67. Public services: education (license renewal term)	1	4.0	4.7.3.1/4-106
68. Offsite land use (refurbishment)	2	NA, and discussed in Section 4.17.1	Issue applies to an activity, refurbishment, that SSES has no plans to undertake.
69. Offsite land use (license renewal term)	2	4.17.2	4.7.4/4-107
70. Public services: transportation	2	4.18	3.7.4.2/3-17 (refurbishment) 4.7.3.2/4-106 (renewal term)
71. Historic and archaeological resources	2	4.19	3.7.7/3-23 (refurbishment) 4.7.7/4-114 (renewal term)
72. Aesthetic impacts (refurbishment)	1	NA	Issue applies to an activity, refurbishment, that SSES will not undertake.

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
73. Aesthetic impacts (license renewal term)	1	4.0	4.7.6/4-111
74. Aesthetic impacts of transmission lines (license renewal term)	1	4.0	4.5.8/4-83
Postulated Accidents			
75. Design basis accidents	1	4.0	5.3.2/5-11 (design basis) 5.5.1/5-114 (summary)
76. Severe accidents	2	4.20	5.3.3/5-12 (probablististic analysis) 5.3.3.2/5-19 (air dose) 5.3.3.3/5-49 (water) 5.3.3.4/5-65 (groundwater) 5.3.3.5/5-96 (economic) 5.4/5-106 (mitigation) 5.5.2/5-114 (summary)
Uranium Fuel Cycle and Waste Management			
77. Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	1	4.0	6.2/6-8
78. Offsite radiological impacts (collective effects)	1	4.0	Not in GEIS.
79. Offsite radiological impacts (spent fuel and high-level waste disposal)	1	4.0	Not in GEIS.
80. Nonradiological impacts of the uranium fuel cycle	1	4.0	6.2.2.6/6-20 (land use) 6.2.2.7/6-20 (water use) 6.2.2.8/6-21 (fossil fuel) 6.2.2.9/6-21 (chemical)
81. Low-level waste storage and disposal	1	4.0	6.4.2/6-36 (low-level definition) 6.4.3/6-37 (low-level volume) 6.4.4/6-48 (renewal effects)
82. Mixed waste storage and disposal	1	4.0	6.4.5/6-63
83. Onsite spent fuel	1	4.0	6.4.6/6-70

TABLE A-1. SSES ENVIRONMENTAL REPORT DISCUSSION OF LICENSE RENEWAL NEPA ISSUES[a] (CONTINUED)

Issue	Category	Section of this Environmental Report	GEIS Cross Reference[b] (Section/Page)
84. Nonradiological waste	1	4.0	6.5/6-86
85. Transportation	1	4.0	6.3/6-31, as revised by Addendum 1, August 1999.
Decommissioning			
86. Radiation doses (decommissioning)	1	4.0	7.3.1/7-15
87. Waste management (decommissioning)	1	4.0	7.3.2/7-19 (impacts) 7.4/7-25 (conclusions)
88. Air quality (decommissioning)	1	4.0	7.3.3/7-21 (air) 7.4/7-25 (conclusion)
89. Water quality (decommissioning)	1	4.0	7.3.4/7-21 (water) 7.4/7-25 (conclusion)
90. Ecological resources (decommissioning)	1	4.0	7.3.5/7-21 (ecological) 7.4/7-25 (conclusion)
91. Socioeconomic impacts (decommissioning)	1	4.0	7.3.7/7-24 (socioeconomic) 7.4/7-25 (conclusion)
Environmental Justice			
92. Environmental justice	NA	2.6.2	NA – Not applicable. The categorization and impact finding definitions do not apply to this issue.

a. Source: 10 CFR 51, Subpart A, Appendix A, Table B-1. (Issue numbers added to facilitate discussion.)
b. Source: Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437).
NEPA = National Environmental Policy Act.

ATTACHMENT B
SPECIAL-STATUS SPECIES CORRESPONDENCE

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ppl

March 24, 2005

Ms. Carole Copeyog (n) gtf 5/25/06
U.S. Fish and Wildlife Service
Pennsylvania Field Office
315 South Allen Street
Suite 322
State College, PA 16801

PPL SUSQUEHANNA, LLC
REQUEST FOR INFORMATION ON
THREATENED OR ENDANGERED SPECIES
LICREN ER 101013
PLR-050

Dear Mrs. Copeyog, (n) gtf 5/25/06

PPL Susquehanna, LLC (PPL Susquehanna) is preparing an application to the U. S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Susquehanna Steam Electric Station (SSES) Units 1 and 2. Current operating licenses for the two-unit plant expire in 2022 and 2024. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, the NRC requires license applicants to "assess the impact of the proposed action on threatened or endangered species in accordance the Endangered Species Act" (10 CFR 51.53). The NRC will also request an informal consultation with your office at a later date under Section 7 of the Endangered Species Act. By contacting you early in the application process, we hope to identify any issues that we need to address or any information that we should provide to your office to expedite the NRC consultation.

PPL Susquehanna has operated SSES and associated transmission lines since 1982. The facility is located on the west bank of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania, approximately 5 miles northeast of Berwick, Pennsylvania (see attached map).

The Final Environmental Statement (FES) for construction prepared in 1973 by the U.S. Atomic Energy Commission and the FES prepared for operation prepared in 1981 by the U.S. Nuclear Regulatory Commission identified three short 230-kilovolt ties in the vicinity of SSES, one longer 230 kilovolt line (Stanton #2), and two longer 500 kilovolt lines (Sunbury #2 and Siegfried) that were built to connect SSES to the electric grid. The three short connections were to provide startup power for SSES from pre-existing 230-kilovolt lines in the immediate vicinity of the plant and to connect the Unit 1 output to the pre-existing 230-kilovolt Susquehanna Switchyard across the Susquehanna River.

After publication of the FES for operation, PPL Susquehanna made several changes in the transmission system. As a result of these system changes, the transmission lines are somewhat different than those described in the FES. Six transmission lines connect the station to the regional grid, and are thus relevant to license renewal. They include:

- Short ties in the SSES vicinity (3) – These three lines (approximately 6.3 total miles) identified in the FES as necessary to connect SSES to the 230-kilovolt electrical system are primarily in areas controlled by SSES and not accessible to the public; however, U.S. Highway 11, Pennsylvania State Highway 239, and other paved roads in the immediate plant vicinity are crossed by the short ties.

- Stanton #2 – This single circuit 230-kilovolt line runs generally northeast from SSES for approximately 30 miles in a 100- to 400-footwide corridor.

- Wescosville – This 500-kilovolt line connects SSES with the Alburtis substation. It runs generally southeast for approximately 76 circuit miles in a corridor ranging from 100 to 350 feet wide.

- Sunbury #2 – This 500-kilovolt line shares a corridor with the pre-existing Sunbury #1 line and runs west-southwest. The corridor is about 325 feet wide and approximately 30 miles long.

In total, for the specific purpose of connecting SSES to the transmission system, PPL Susquehanna has approximately 150 miles of corridor that occupy approximately 3,341 acres. The corridors pass through land that is primarily agricultural or forest land. The areas are mostly remote, with low population densities. The longer lines cross numerous state and U.S. highways. Impact of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Pennsylvania counties crossed by the transmission lines include Luzerne (the location of SSES), Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, and Snyder. Based on our direct observations, a preliminary review of PPL Susquehanna records, a review of the U.S. Fish and Wildlife Service web site for federally-listed endangered or threatened species, we believe that the following four species could occur in the vicinity of Susquehanna Steam Electric Station or its associated transmission lines identified above: 1) Indiana bats (*Myotis sodalis*), which are federally-listed as endangered, hibernate in Luzerne County; 2) Bog turtles (*Clemmys muhlenbergii*), federally-listed as threatened, occur in Lehigh and Northampton Counties; 3) Bald eagles (*Haliaeetus leucocephalus*), federally-listed as threatened, nest in Northumberland County; and 4) Northeastern bulrush (*Scirpus ancistrochaetus*), federally-listed as endangered, are known from Carbon and Lehigh Counties.

PPL Susquehanna is committed to the conservation of significant natural habitats and protected species, and expects that operation of SSES, including maintenance of the identified transmission lines, through the license renewal period (an additional 20 years) would not adversely affect any listed species. PPL Susquehanna has no plans to alter current operations over the license renewal period. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas. No additional land disturbance is anticipated in support of license renewal.

Please do not hesitate to call Jerry Fields (610) 774-7889 if you have any questions or require any additional information. After your review, we would appreciate receiving your input by April 22, 2005, detailing any concerns you may have about any listed species or critical habitat in the area or confirming PPL Susquehanna's conclusion that operation of SSES over the license renewal term would have no effect on any threatened or endangered species. This will enable us to meet our application preparation schedule. PPL Susquehanna will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the SSES license renewal application.

Sincerely,

G. T. Jones

George T. Jones

Attachment – Figure 2.1-1, 50-Mile Vicinity Map

Response Requested: YES __X__ by April 22, 2005

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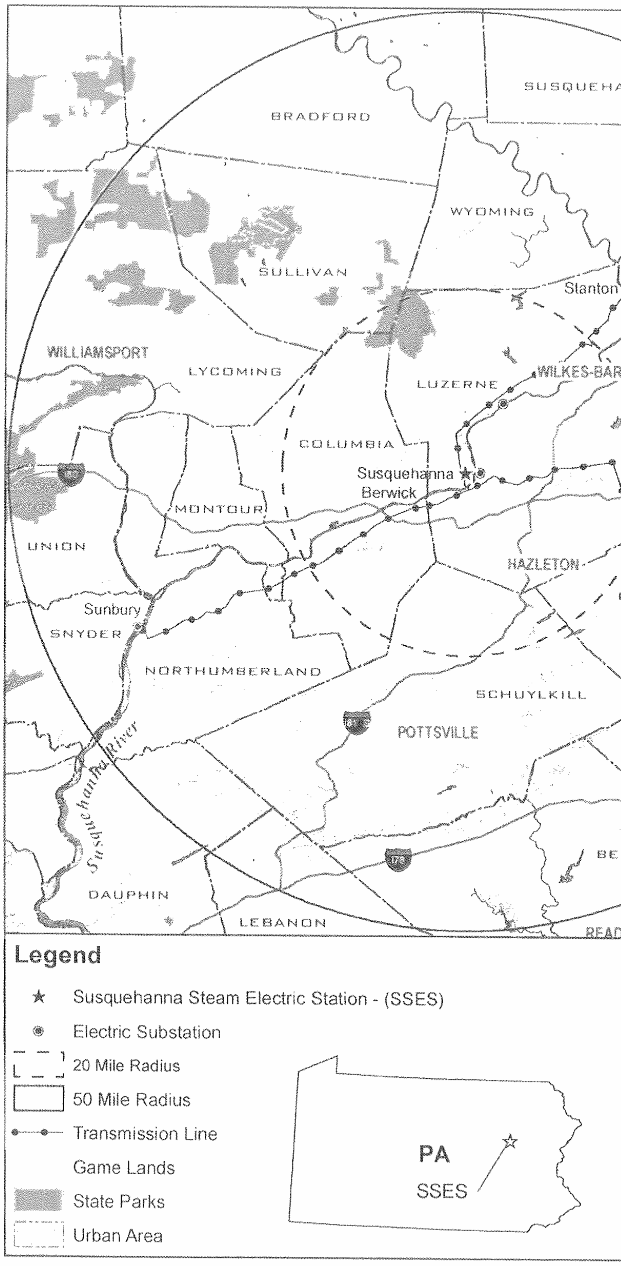
Susquehanna Steam Electric Station Units 1 & 2
License Renewal Application



SUSQUEHANNA STEAM ELECTRIC STATION
Figure 2.1-1
50-Mile-Vicinity Map

Location and Features Page 2.1-2 September 2006

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Field Office
315 South Allen Street, Suite 322
State College, Pennsylvania 16801-4850

May 23, 2005

George Jones
PPL Susquehanna
2 North Ninth Street
Allentown, PA 18101-1179

RE: USFWS Project #2005-1190

Dear Mr. Jones:

This responds to your letter of March 24, 2005, requesting information about federally listed and proposed endangered and threatened species within the area affected by the proposed U.S. Nuclear Regulatory Commission renewal of an operating license for Susquehanna Steam Electric Station Units 1 and 2, located in Luzerne County, Pennsylvania. The following comments are provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species.

The project is located within the range of the Indiana bat (*Myotis sodalis*), a species that is federally listed as endangered. Due to the proximity of the project site to a known Indiana bat hibernaculum (*i.e.,* within five miles), tree removal or forest clearing within the project area could result in the direct take of roosting Indiana bats, which could be injured or killed when trees are cut. Studies have found that forested areas located within five miles of hibernacula provide important foraging and roosting habitat for Indiana bats, especially during the fall and spring, when bats are building up their fat reserves prior to and after hibernation. In addition, female maternity colonies and individual male bats may be found in the vicinity of hibernacula throughout the summer months.

To avoid the direct take of Indiana bats, tree-cutting activities should be carried out from November 16 to March 31, during which time bats are hibernating. If any timber-cutting is necessary from April 1 to November 15, the following trees greater than or equal to five inches diameter breast height (d.b.h.) should not be cut or physically disturbed (*e.g.,* while harvesting any adjacent trees) in order to avoid killing or injuring roosting Indiana bats: 1) dead or dying trees and snags (including lightning struck trees) with exfoliating bark; 2) live trees (such as shagbark and shellbark hickory) which have exfoliating or defoliating bark in the trunk or branches; and 3) trees or snags that have characteristics typical of roost sites for Indiana bats (*i.e.,* have exfoliating or defoliating bark, or contain cracks, crevices, or holes that could be used by the species as a potential roost). Tree-clearing from November 16 to March 31 may proceed without these restrictions.

Based on a review of the project information, including the size of the project area and the anticipated effects on forested habitat, we have determined that the proposed project will not have a significant adverse effect on overall habitat quality for the Indiana bat. Therefore, if a seasonal restriction on tree-cutting is implemented to avoid the direct take of Indiana bats, construction of the proposed project is not likely to adversely affect this species. If you are unable to implement the above measures to avoid adverse effects, however, further consultation with this office will be necessary.

This response relates only to endangered and threatened species under our jurisdiction, based on an office review of the proposed project's location. No field inspection of the project area has been conducted by this office. Consequently, this letter is not to be construed as addressing other Service concerns under the Fish and Wildlife Coordination Act or other authorities.

To avoid potential delays in reviewing your project, please use the above-referenced USFWS project tracking number in any future correspondence regarding this project.

If you have any questions regarding this matter, please contact Jennifer Dombroskie of my staff at 814-234-4090.

Sincerely,

Cindy L. Tibbott

David Densmore
Supervisor

George T. Jones
Vice President
Special Projects

Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.7602 Fax 610.774.7797
gtjones@pplweb.com

March 24, 2005

Mr. James R. Leigey
Wildlife Impact Review Coordinator
Pennsylvania Game Commission
Bureau of Land Management
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

PPL SUSQUEHANNA, LLC
REQUEST FOR INFORMATION ON STATE-LISTED SPECIES AND IMPORTANT HABITATS (BIRDS AND MAMMALS)
LICREN ER 101013
PLR-051

Dear Mr. Leigey:

PPL Susquehanna, LLC (PPL Susquehanna) is preparing an application to the U. S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Susquehanna Steam Electric Station (SSES) Units 1 and 2. Current operating licenses for the two-unit plant expire in 2022 and 2024. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, the NRC requires license applicants to "assess the impact of the proposed action on threatened or endangered species in accordance the Endangered Species Act" (10 CFR 51.53). The NRC will also request an informal consultation with your office at a later date under Section 7 of the Endangered Species Act. By contacting you early in the application process, we hope to identify any issues that we need to address or any information that we should provide to your office to expedite the NRC consultation.

PPL Susquehanna has operated SSES and associated transmission lines since 1982. The facility is located on the west bank of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania, approximately 5 miles northeast of Berwick, Pennsylvania (see attached map).

The Final Environmental Statement (FES) for construction prepared in 1973 by the U.S. Atomic Energy Commission and the FES prepared for operation prepared in 1981 by the U.S. Nuclear Regulatory Commission identified three short 230-kilovolt ties in the vicinity of SSES, one longer 230 kilovolt line (Stanton #2), and two longer 500 kilovolt lines (Sunbury #2 and Siegfried) that were built to connect SSES to the electric grid. The three short connections were to provide startup power for SSES from pre-existing 230-kilovolt lines in the immediate vicinity of the plant and to connect the Unit 1 output to the pre-existing 230-kilovolt Susquehanna Switchyard across the Susquehanna River.

After publication of the FES for operation, PPL Susquehanna made several changes in the transmission system. As a result of these system changes, the transmission lines are somewhat different than those described in the FES. Six transmission lines connect the station to the regional grid, and are thus relevant to license renewal. They include:

- Short ties in the SSES vicinity (3) – These three lines (approximately 6.3 total miles) identified in the FES as necessary to connect SSES to the 230-kilovolt electrical system are primarily in areas controlled by SSES and not accessible to the public; however, U.S. Highway 11, Pennsylvania State Highway 239, and other paved roads in the immediate plant vicinity are crossed by the short ties.

- Stanton #2 – This single circuit 230-kilovolt line runs generally northeast from SSES for approximately 30 miles in a 100- to 400-footwide corridor.

- Wescosville – This 500-kilovolt line connects SSES with the Alburtis substation. It runs generally southeast for approximately 76 circuit miles in a corridor ranging from 100 to 350 feet wide.

- Sunbury #2 – This 500-kilovolt line shares a corridor with the pre-existing Sunbury #1 line and runs west-southwest. The corridor is about 325 feet wide and approximately 30 miles long.

In total, for the specific purpose of connecting SSES to the transmission system, PPL Susquehanna has approximately 150 miles of corridor that occupy approximately 3,341 acres. The corridors pass through land that is primarily agricultural or forest land. The areas are mostly remote, with low population densities. The longer lines cross numerous state and U.S. highways. Impact of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Pennsylvania counties crossed by the transmission lines include Luzerne (the location of SSES), Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, and Snyder. Based on our direct observations, a preliminary review of PPL Susquehanna records, a review of the Pennsylvania Natural Heritage Program, and a review of the U.S. Fish and Wildlife Service web site, we believe that the following species could occur in the vicinity of Susquehanna Steam Electric Station or its associated transmission lines identified above: 1) Indiana bats (*Myotis sodalis*), which are federally-listed as endangered, hibernate in Luzerne County; 2) Bald eagles (*Haliaeetus leucocephalus*), federally-listed as threatened, nest in Northumberland County; In addition to the Indiana bat, state-listed mammals recorded in counties crossed by the transmission lines are the Eastern woodrat (*Neotoma magister*), the small-footed myotis (*Myotis leibii*), and the Eastern fox squirrel (*Sciurus niger vulpinus*). The Eastern woodrat is known from Carbon and Snyder Counties, and the small-footed myotis has been recorded in Luzerne and Northumberland Counties.

The Susquehanna River and riparian wetlands near the river at SSES are also used by several special-status bird species, especially during autumn and spring migrations. Ospreys (*Pandion haliaetus*) and bald eagles (*Haliaeetus leucocephalus*) have become relatively common along the river near SSES during migrations and bald eagles winter along the Susquehanna River in Luzerne and Columbia Counties. Peregrine falcons (*Falco peregrinus*), short-eared owls (*Asio flammeus*), American bitterns (*Botaurus lentiginosus*), least bitterns (*Ixobrychus exilis*), and great egrets *(Ardea alba)* are occasionally observed at SSES. The sedge wren (*Cistothorus platensis*), upland sandpiper (*Bartramia longicauda*), and black tern (*Chlidonias niger*) have each been recorded once at SSES. None of the identified bird species is known to nest at SSES. Osprey nests have been recorded in Luzerne, Carbon, and Northampton counties, and the upland sandpiper is known to nest in Northumberland County.

PPL Susquehanna is committed to the conservation of significant natural habitats and protected species, and expects that operation of SSES, including maintenance of the identified transmission lines, through the license renewal period (an additional 20 years) would not adversely affect any listed species. PPL Susquehanna has no plans to alter current operations over the license renewal period. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas. No additional land disturbance is anticipated in support of license renewal.

Please do not hesitate to call Jerry Fields (610) 774-7889 if you have any questions or require any additional information. After your review, we would appreciate receiving your input by April 22, 2005, detailing any concerns you may have about any listed species or critical habitat in the area or confirming PPL Susquehanna's conclusion that operation of SSES over the license renewal term would have no effect on any threatened or endangered species. This will enable us to meet our application preparation schedule. PPL Susquehanna will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the SSES license renewal application.

Sincerely,

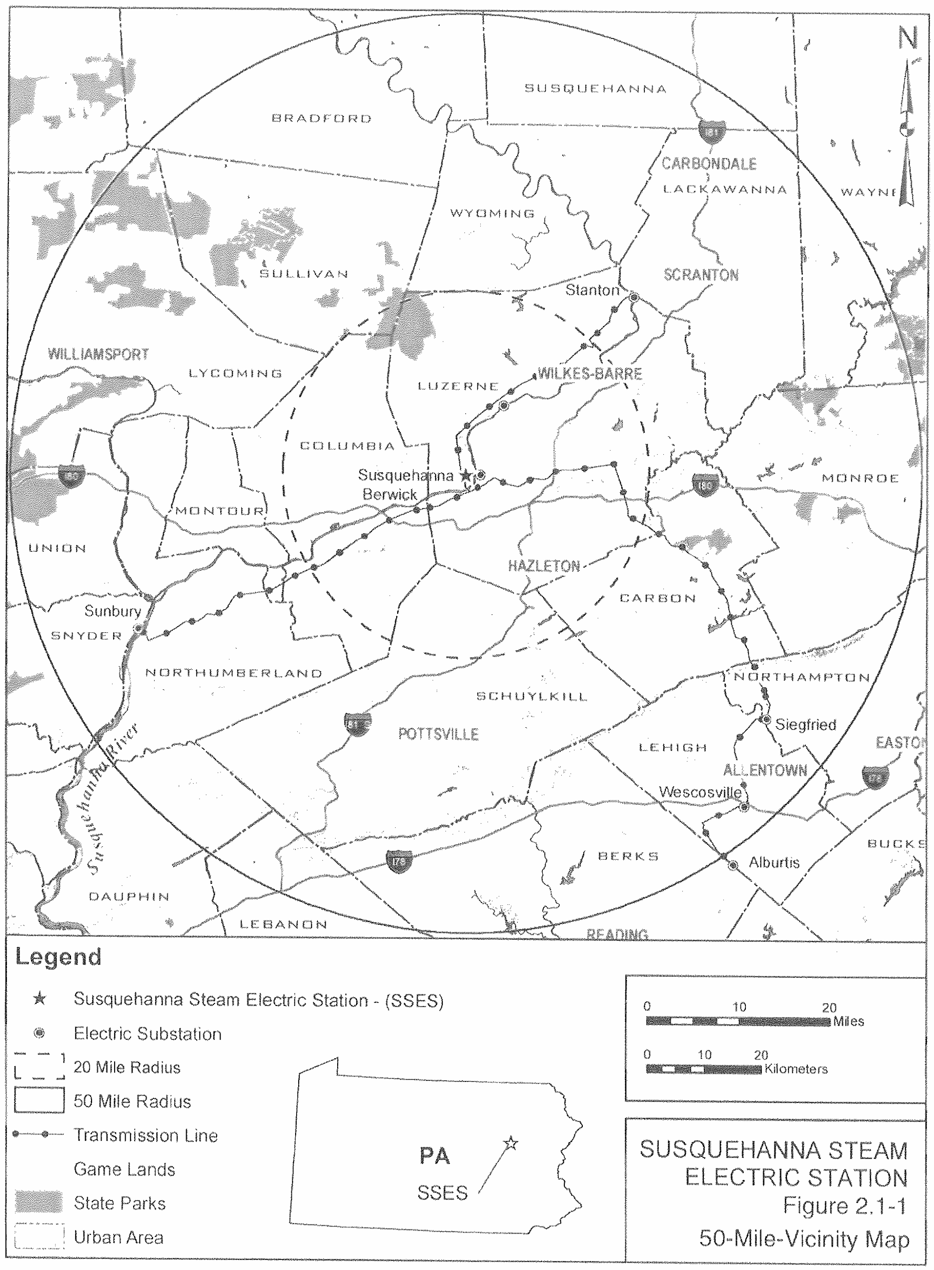
George T. Jones

Attachment – Figure 2.1-1, 50-Mile Vicinity Map

Response Requested: YES __X__ by April 22, 2005

g:\goadmin\licrenewal\plr\plr-051.doc

Susquehanna Steam Electric Station Units 1 & 2
License Renewal Application



SUSQUEHANNA STEAM ELECTRIC STATION
Figure 2.1-1
50-Mile-Vicinity Map

Location and Features Page 2.1-2 September 2006

May 20, 2005

TO: Mr. James R. Leigey, PA Game Commission
FAX 717-787-6957

FROM: Jerry Fields, PPL Susquehanna, LLC
610-774-7889, FAX 610-774-7782

RE: Any concerns from relicensing Susquehanna Steam
Electric Station, Salem Township, Luzerne County

Dear Mr. Leigey:

As you recommended during our last telephone conversation on May 12, 2005, I am attaching for your review copies of reduced topographic maps that include Susquehanna Steam Electric Station transmission line routes. As PPL stated in our March 24, 2005 letter, we are relicensing the station and our environmental assessment shows that there should be no effect on any threatened or endangered species over the 20-year renewal term. There will be no refurbishment of the station and there are no plans for additional transmission lines.

Also, attached for your use is a table listing routes of the three transmission lines leaving the Susquehanna Steam Electric Station to their final destination substations. The lines are Sunbury – Susquehanna #2, Susquehanna – Stanton, and Susquehanna - Wescosville. The Susquehanna – Wescosville line actually continues on to Alburtis.

If you have any additional questions or comments please give me a call.

Sincerely,

Jerry Fields

Jerome S. Fields

SUSQUEHANNA STEAM ELECTRIC STATION
TRANSMISSION LINE ROUTES

7.5 MINUTE TOPO	SUNBURY-SUSQUEHANNA # 2 ROUTE
Berwick	Starts on south side of Susq. SES and goes south with Susquehanna-Wescosville line and crosses river and splits. Next, this line travels west to just above ^{45}43 on left margin of map.
Mifflinville	Starts just above ^{45}43 on the right margin and goes southwest to ^{3}87 on the lower margin.
Shumans	Starts at ^{3}87 on top margin and goes southwest to just below ^{45}38 on left margin.
Catawissa	Starts just below ^{45}38 on right margin and travels west-southwest to about halfway between ^{45}31 and ^{45}32 on the left margin.
Danville	Starts halfway between ^{45}31 and ^{45}32 on the right margin and travels west to ^{45}28 on the left margin.
Riverside	Starts jus south of ^{45}32 on the right margin and goes south southwest between ^{3}61 and ^{3}62 on the bottom margin.
Treverton	Starts between ^{3}61 and ^{3}62 on the top margin and goes west to just above ^{45}22 on the left margin.
Sunbury	Starts just above ^{45}22 on the right margin and goes southwest then northwest into the power plant.

7.5 MINUTE TOPO	SUSQUEHANNA-STANTON ROUTE
Berwick	Starts on north side of station and goes north to just east of ^{4}02 on the top margin.
Shickshinny	Starts about halfway between ^{4}01 and ^{4}03 (there is no ^{4}02) on the bottom margin and goes north and then northeast to the word Nanticoke in the right margin between ^{45}59 and ^{45}61.
Nanticoke	Starts at the word Shickshinny in the left margin between ^{45}59 and ^{45}61 and goes northeast the top right hand corner of the map 76° 00'/41° 15'.
Wilkes-Barre West	Just touches top left corner at 76° 00'/41° 15'.
Kingston	Starts at bottom left corner at 76° 00'/41° 15' and continues northeast for about 5" and then goes east to St. Vincents and finally, to between ^{45}74 and ^{45}75 on the right margin between words "West Wyoming".
Pittston	Starts on left margin between ^{45}74 and ^{45}75 and continues north-northeast to between ^{4}31 and ^{4}32 on the top margin.
Ransom	Starts just east of ^{4}31 on the bottom margin and goes to a substation about 0.5 inches above ^{4}33 on the bottom margin.

SUSQUEHANNA STEAM ELECTRIC STATION
TRANSMISSION LINE ROUTES

7.5 MINUTE TOPO	SUSQUEHANNA-WESCOSVILLE ROUTE
Berwick	Starts on south side of Susq. SES and goes south with the Sunbury-Susquehanna #2 line and crosses river and splits. Next, this line travels east to just above $^{45}47$ on right margin of map.
Sybertsville	Starts just above $^{45}47$ on left margin of map and meanders east to just below $^{45}49$ on the right margin near Feys Grove.
Freeland	Starts below $^{45}49$ on the left margin goes northeast near a Rest Area then east to just above $^{45}51$ on the right margin.
White Haven	Starts just below $^{45}51$ on the left margin goes east then south and southeast to just above $^{45}30$ near the bottom right corner of the map.
Hickory Run	Starts in the bottom left hand corner of map below $^{45}40$ ($^{45}39$ not listed) and goes southeast to about halfway between $^{4}38$ and $^{4}39$ on the bottom margin.
Christmans	Starts between $^{4}38$ and $^{4}39$ on the top margin and goes southeast to just below $^{4}31$ on the right margin.
Pohopoco Mountain	Starts at $^{4}31$ on the left margin and goes south-southeast to just west of $^{4}50$ on the bottom margin.
Palmerton	Starts just west of $^{4}50$ on the top margin and crosses the map to the southeast corner just east of $^{4}56$ on the bottom margin.
Cementon	Starts just west of $^{4}50$ on the top margin then goes south, west and then almost in a semicircle goes south to just west of $^{4}52$ on the bottom margin.
Allentown West	Starts just west of $^{4}52$ on the top margin goes south and then west to just below $^{44}90$ on the left margin.
Topton	Starts just below $^{44}90$ on the right margin goes southwest then southeast and comes back to the right margin at $^{44}85$.
Allentown West (again)	Starts at $^{44}85$ on the left margin goes south to just west of $^{4}48$ on the bottom margin.
East Greenville	Starts at $^{4}48$ on the top margin goes southeast for about 5 inches to the substation.

2


SUNBURY - SUSQ #2
1 of 8
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BERWICK QUADRANGLE
PENNSYLVANIA
SUSQUEHANNA
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BERWICK
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ROAD CLASSIFICATION
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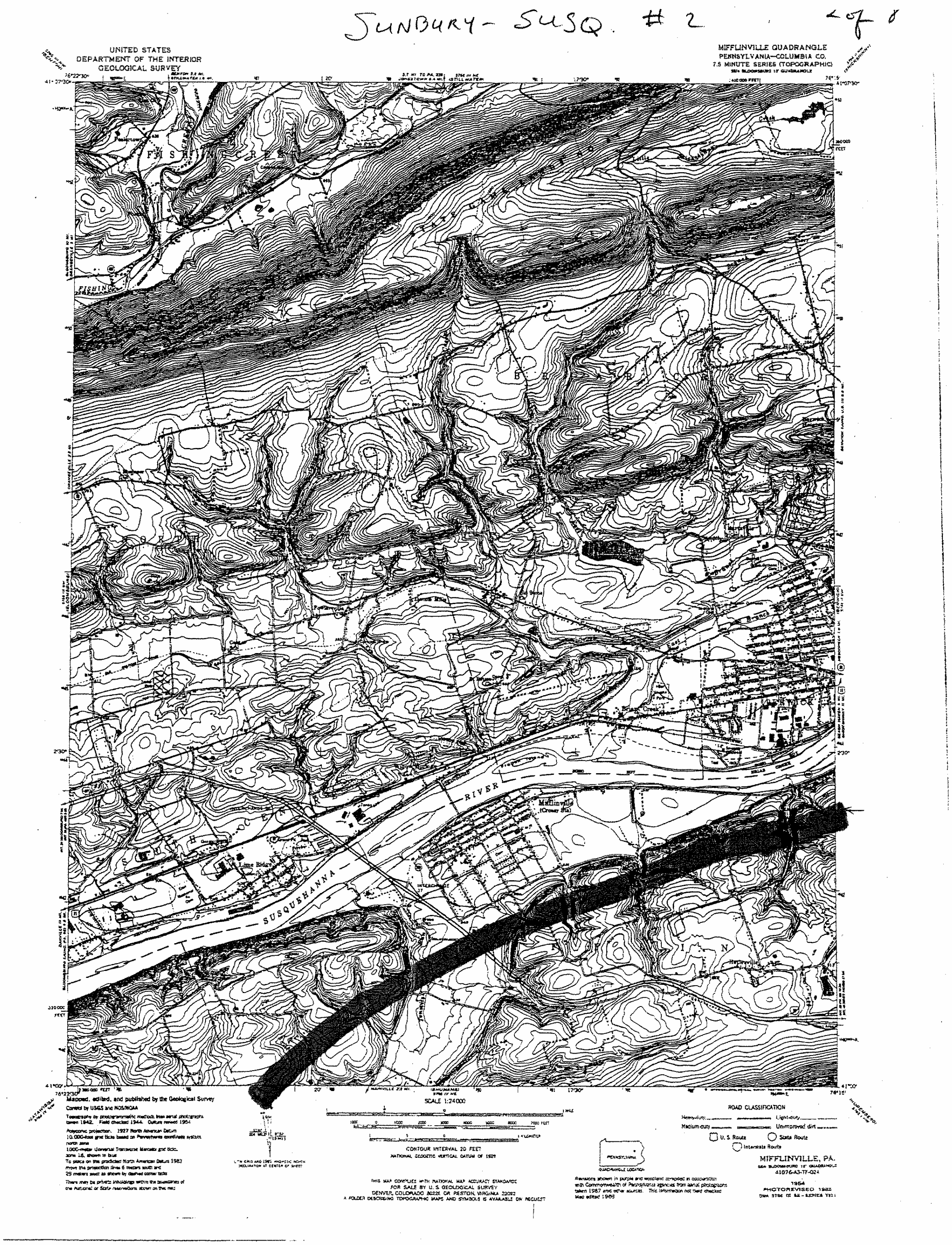
YDARS SERVICES, INC.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7.5 MINUTE SERIES (TOPOGRAPHIC)
RIVER
SUSQUEHANNA
Mapped, edited, and published by the Geological Survey
SCALE 1:24000
CONTOUR INTERVAL 20 FEET
ROAD CLASSIFICATION
MIFFLINVILLE, PA.


SUNBURY - SUSQ. #2
3 of 8
UNITED STATES
DEPARTMENT OF THE INTERIOR
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SHUMANS QUADRANGLE
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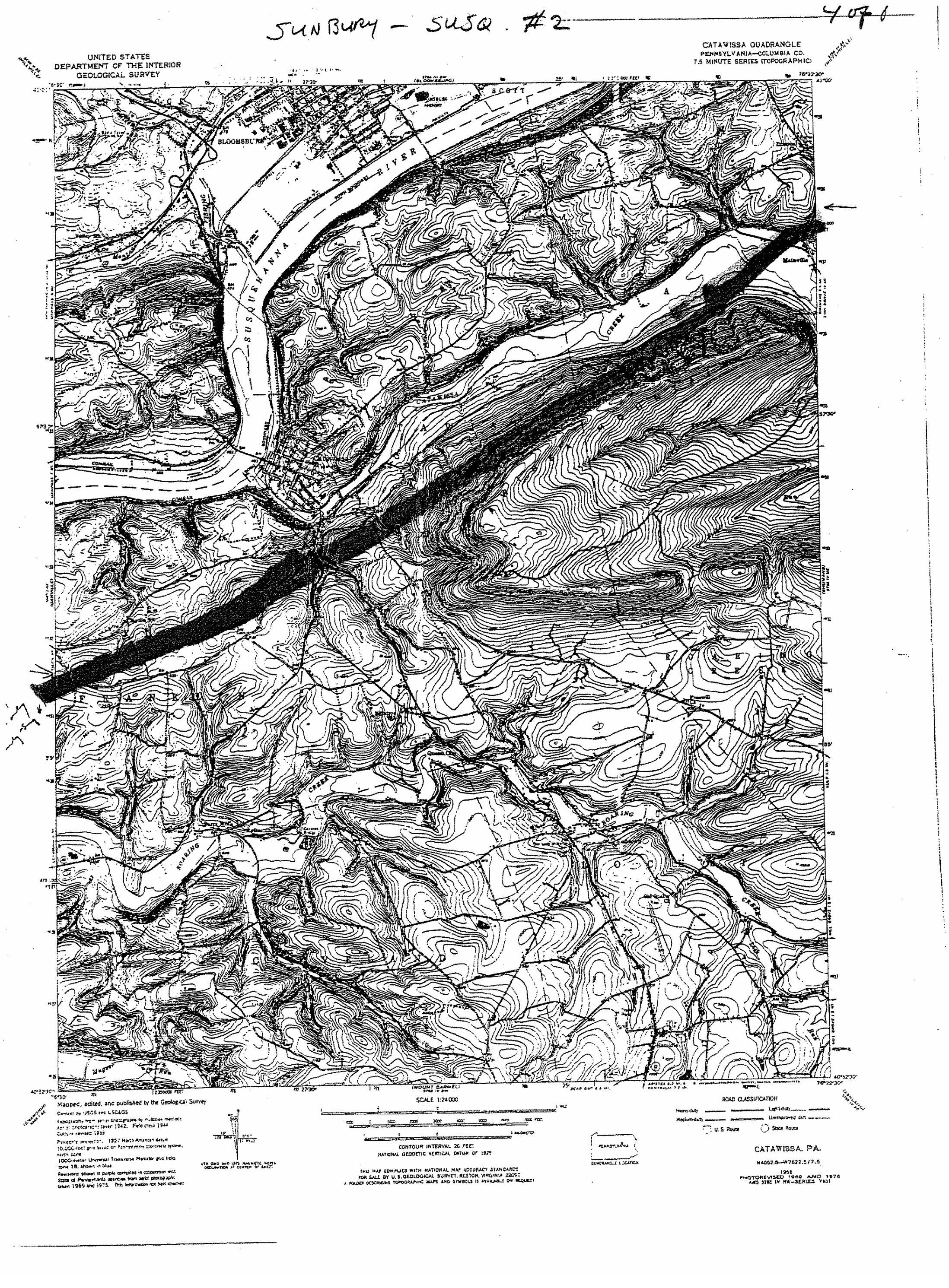
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SUSQUEHANNA
RIVER
CATAWISSA
CREEK
ROARING
SCALE 1:24000
CONTOUR INTERVAL 20 FEET
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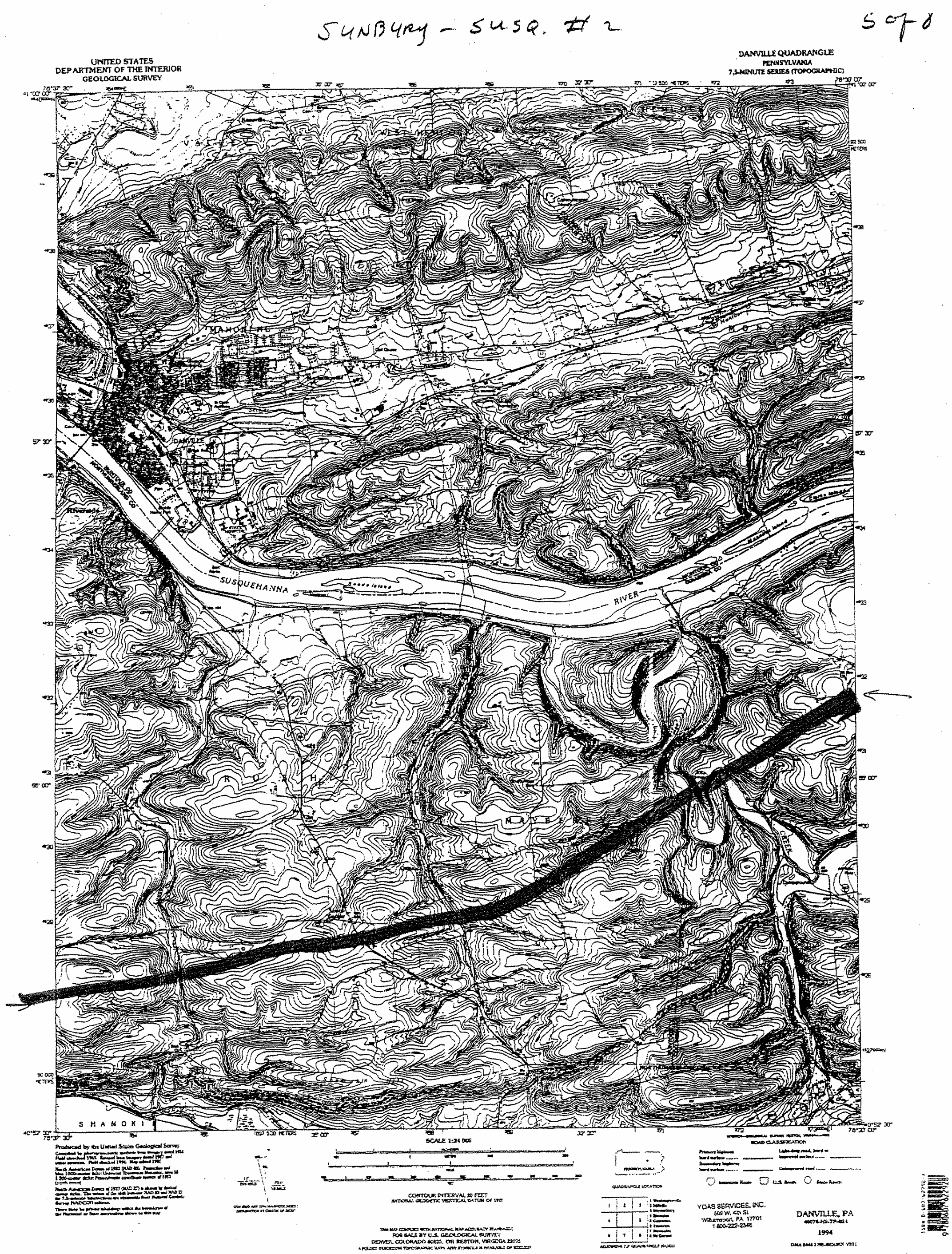
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SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
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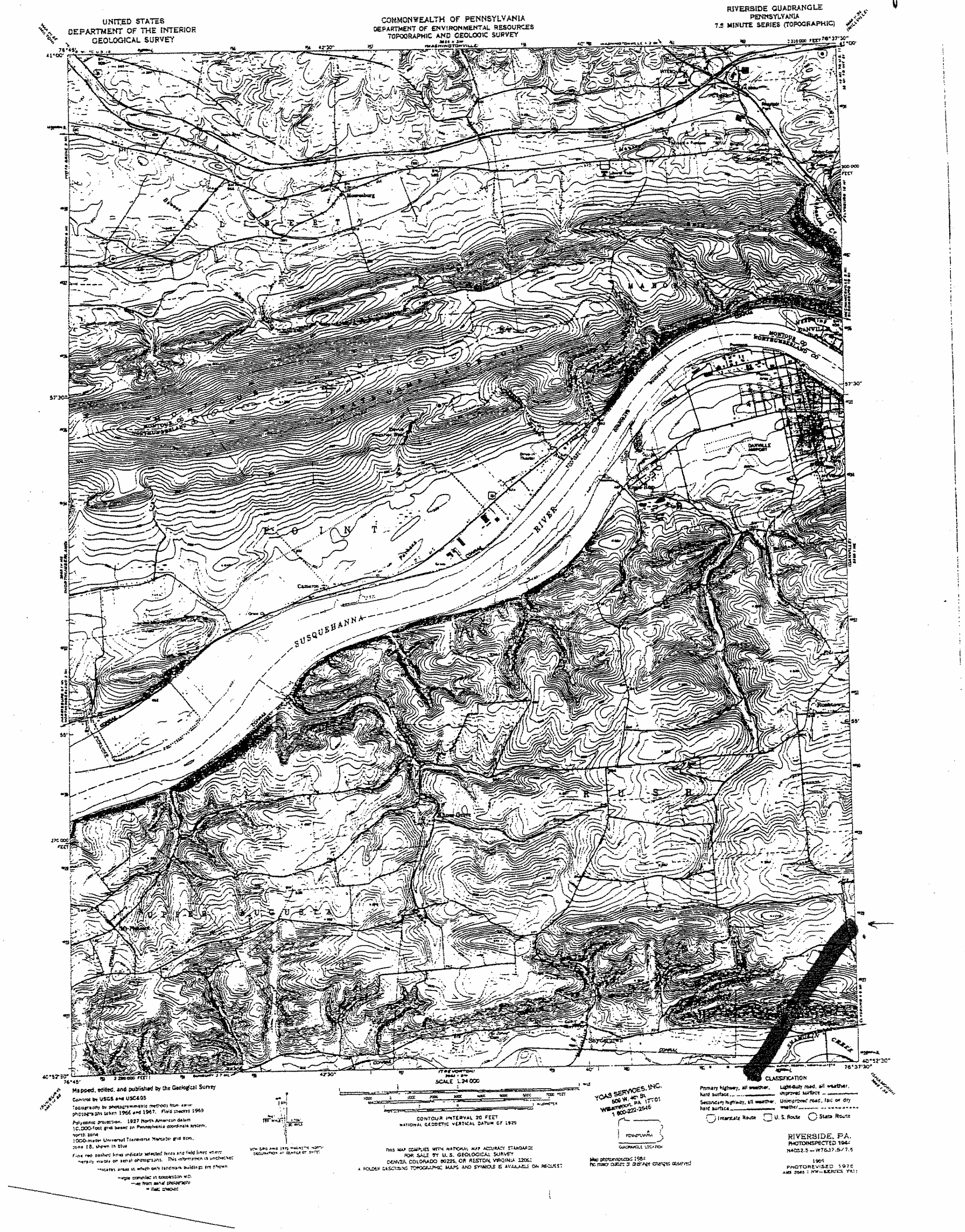
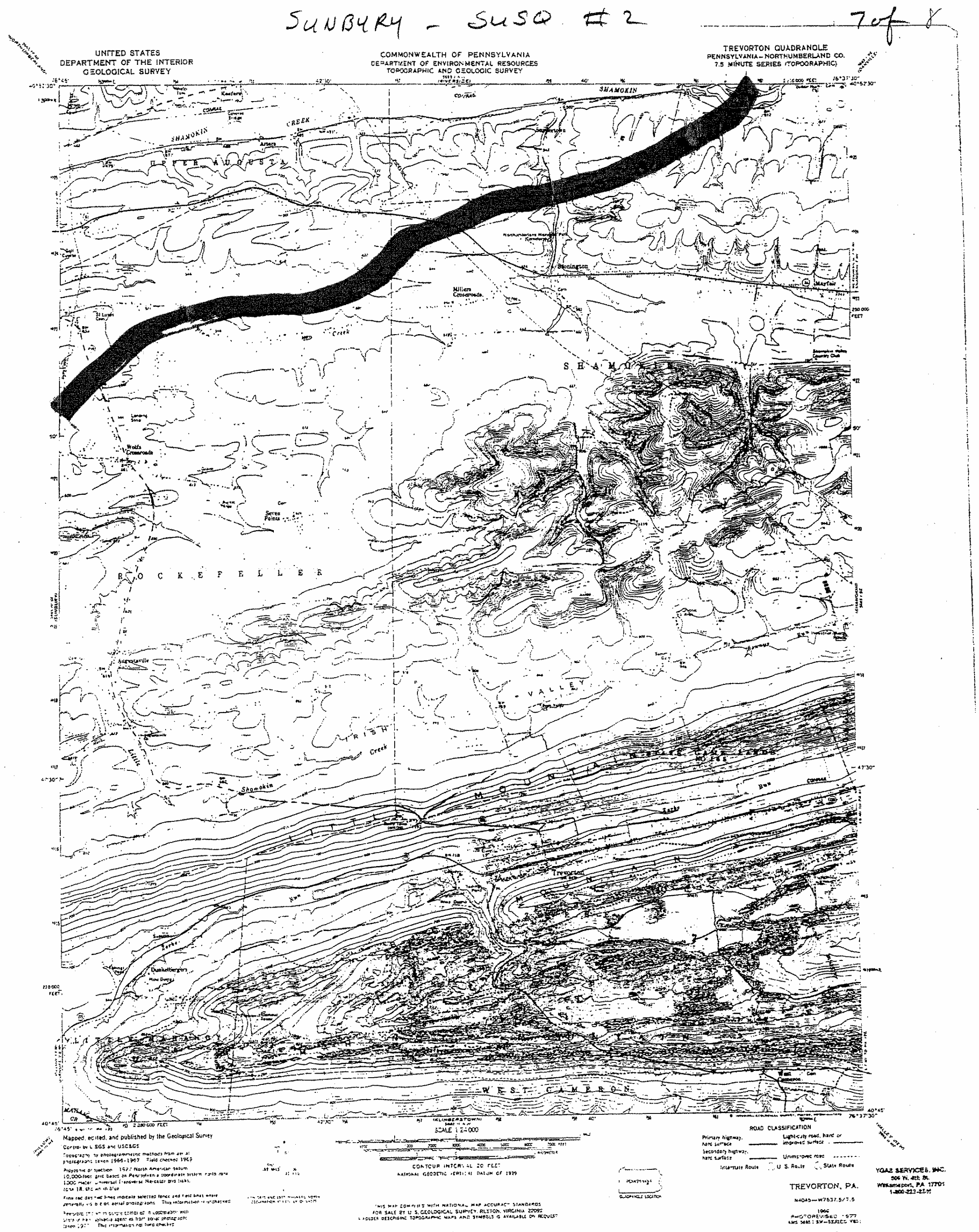
1994

SUNBURY - SUSQ. #2 6 of 8

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7 of 8
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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
TOPOGRAPHIC AND GEOLOGIC SURVEY
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PENNSYLVANIA - NORTHUMBERLAND CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
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ROCKEFELLER
VALLEY
WEST CAMERON
Mapped, edited, and published by the Geological Survey
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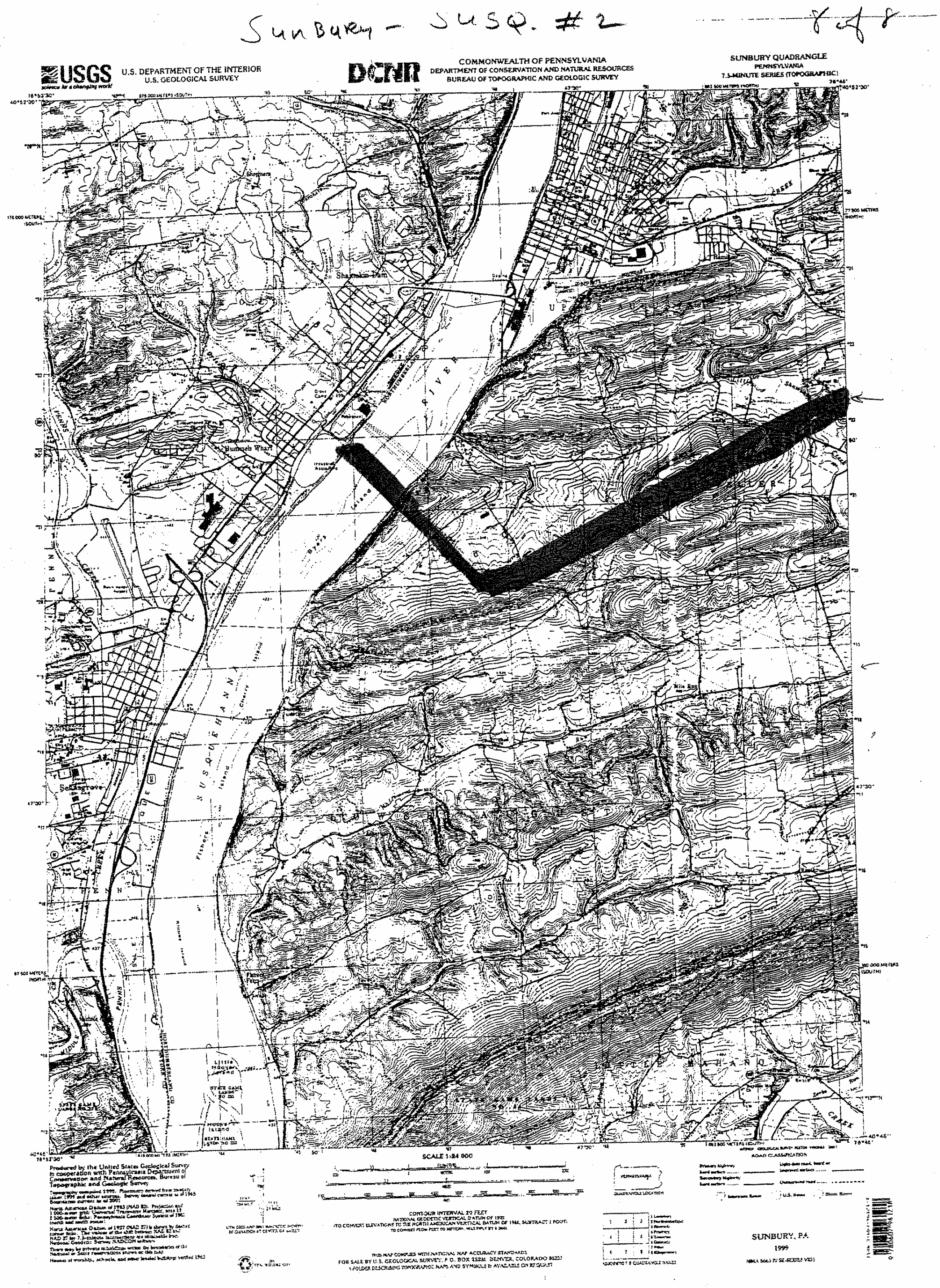
YOAZ SERVICES, INC.


Sunbury - Susq. #2
8 of 8
USGS
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
DCNR
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
SUNBURY QUADRANGLE
PENNSYLVANIA
7.5-MINUTE SERIES (TOPOGRAPHIC)
SUSQUEHANNA
RIVER
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
SUNBURY, PA
1999


SUSQ - STANTON
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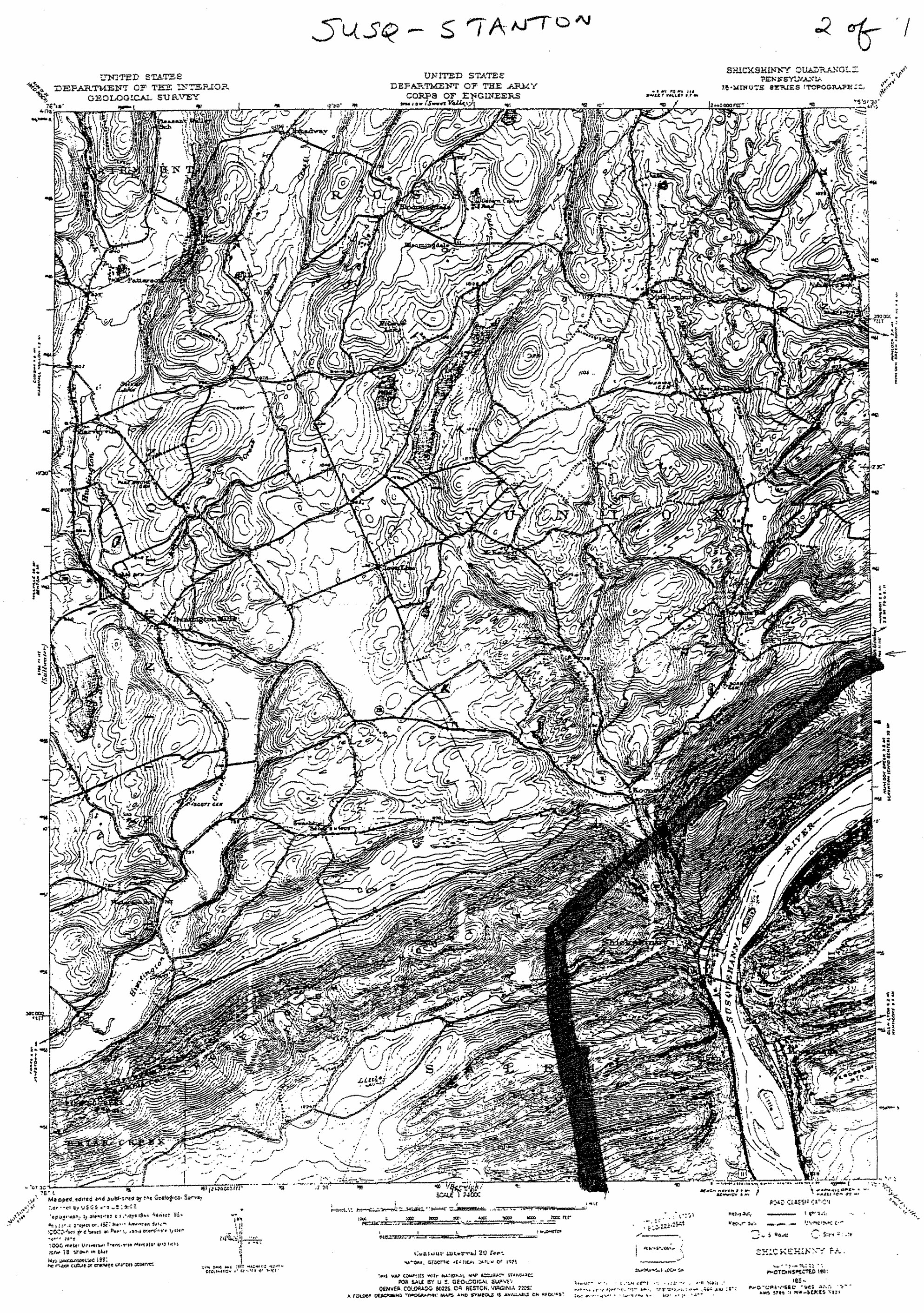
BERWICK, PA.


SUSQ - STANTON
2 of 1
UNITED STATES
DEPARTMENT OF THE INTERIOR
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PENNSYLVANIA
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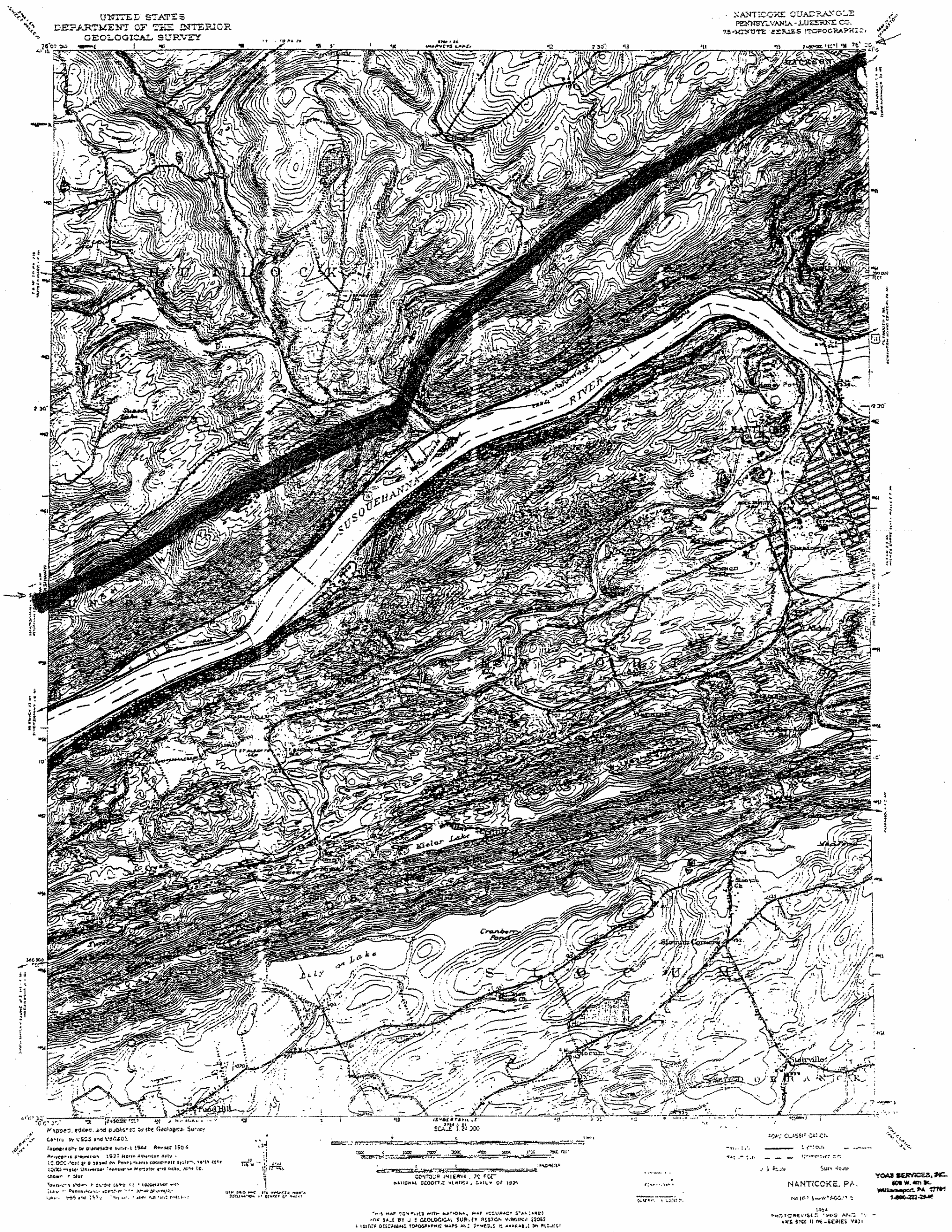
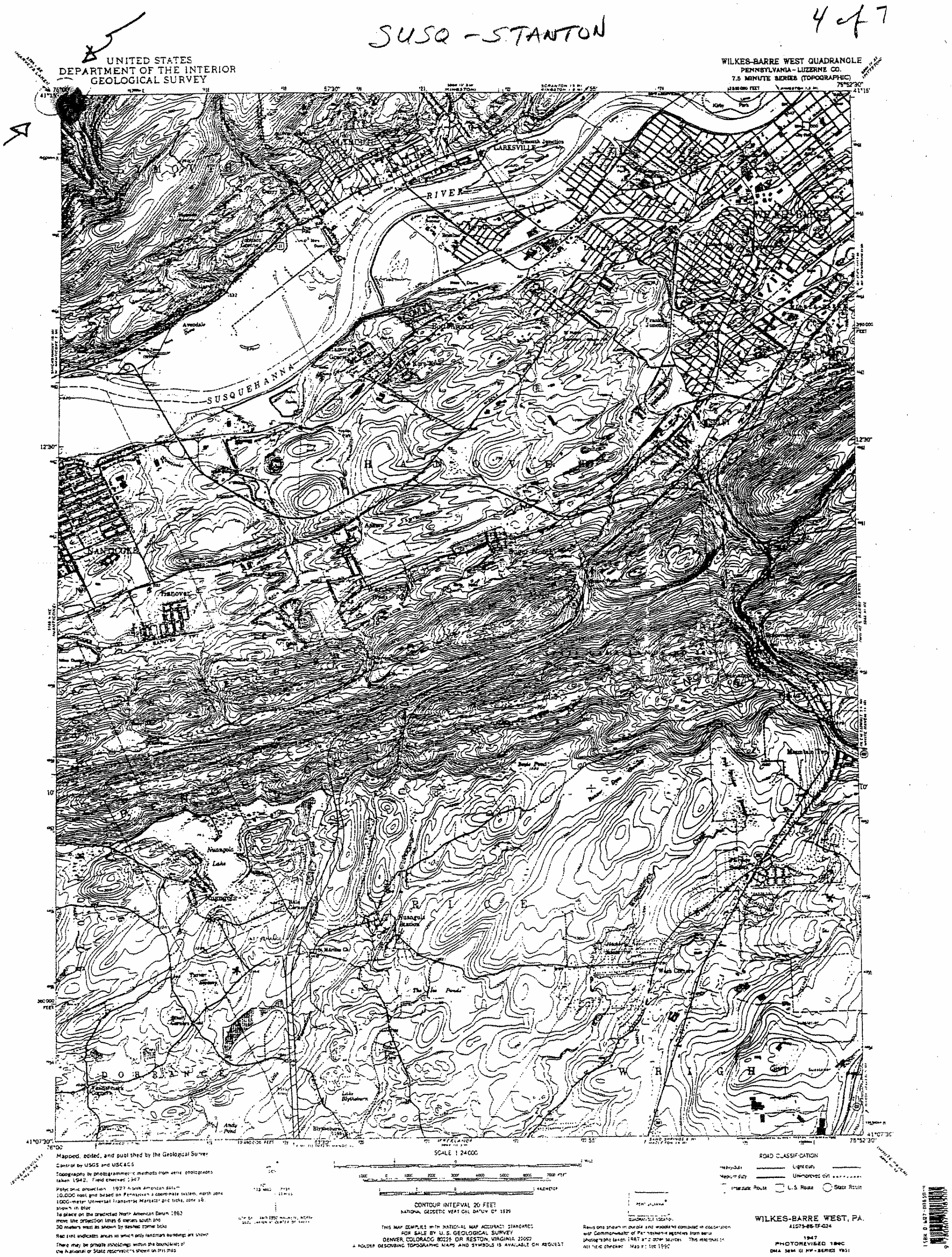
RIVER
SCALE 1:24000
CONTOUR INTERVAL 20 FEET
SHICKSHINNY, PA.

Susq - STANTON 3 of 7

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4 of 7
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DEPARTMENT OF THE INTERIOR
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7.5 MINUTE SERIES (TOPOGRAPHIC)
RIVER
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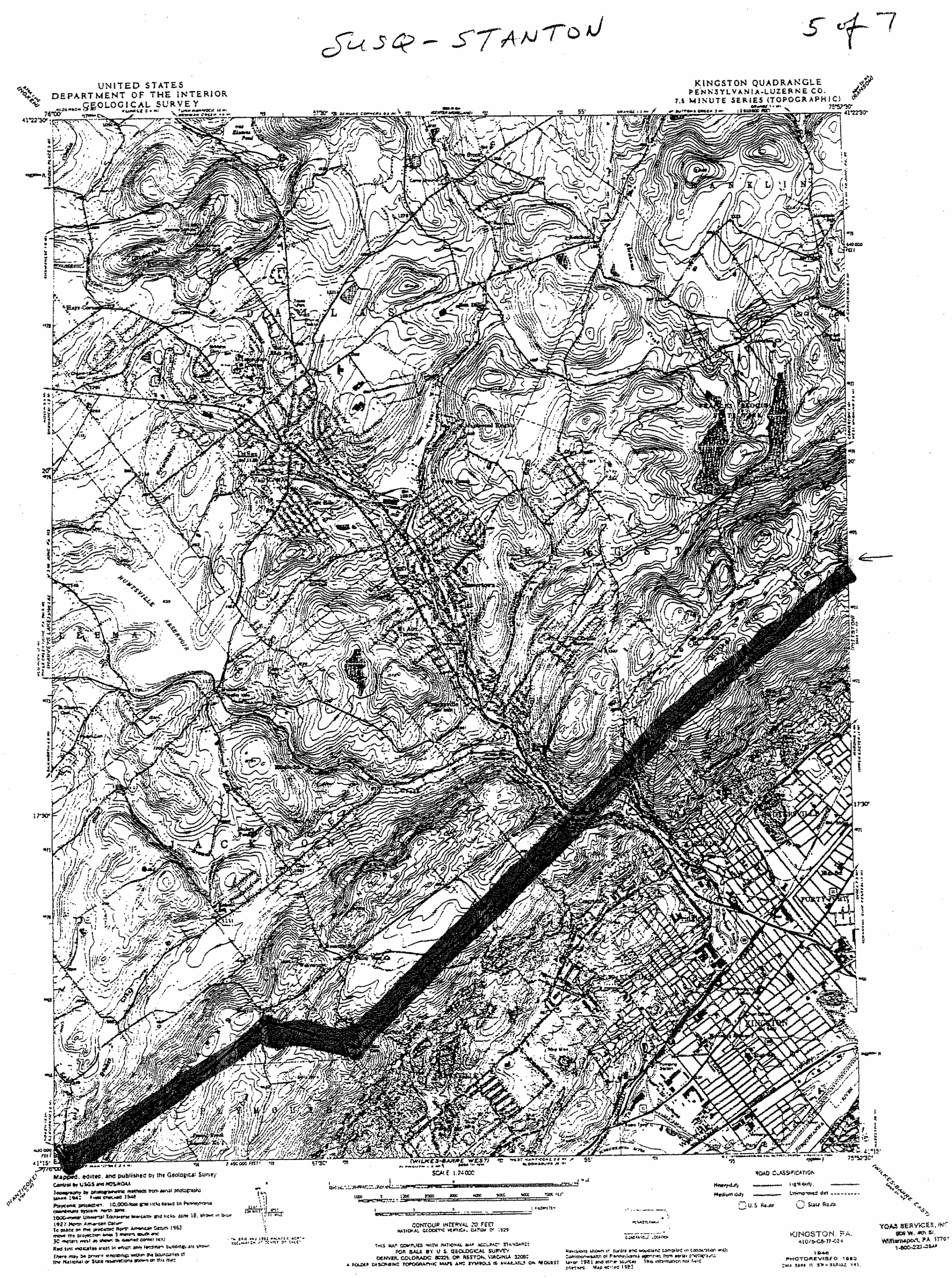
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5 of 7
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DEPARTMENT OF THE INTERIOR
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CONTOUR INTERVAL 20 FEET
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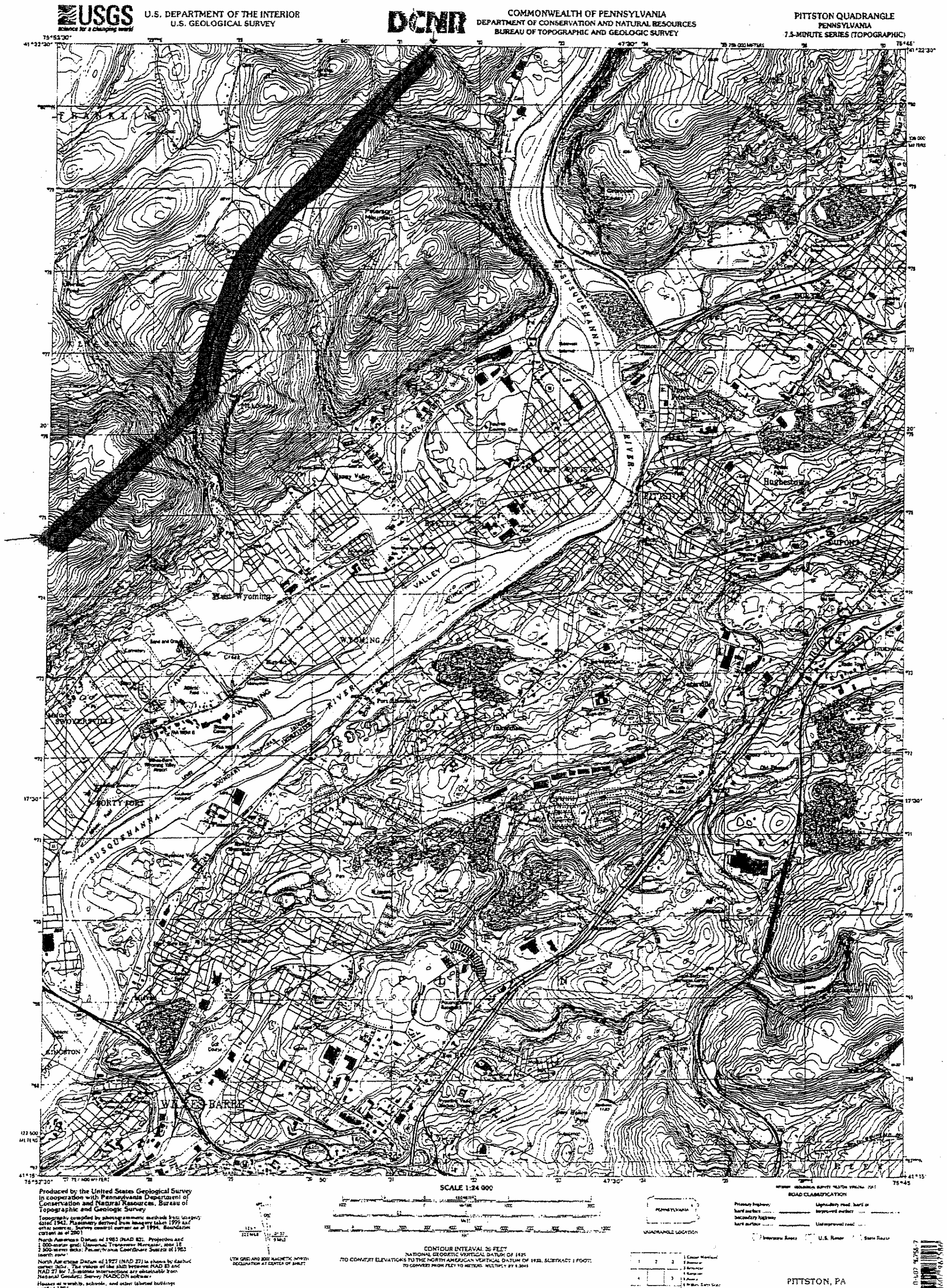
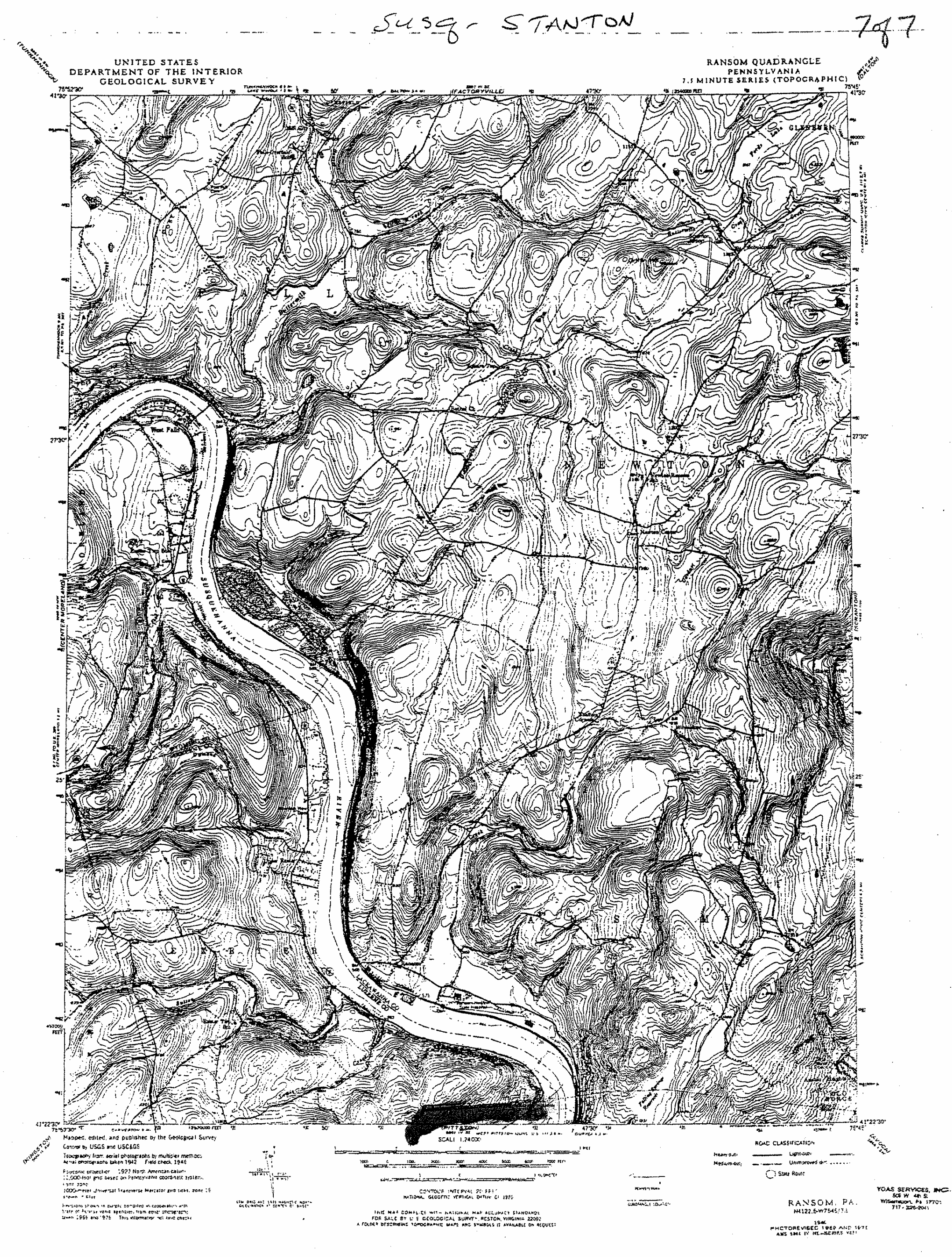
KINGSTON, PA.

SUSQ - STANTON 6 of 7

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PENNSYLVANIA
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SUSQUEHANNA
RIVER
ROAD CLASSIFICATION
RANSOM, PA.


SUSQ. — Wescosville
1 of 13
UNITED STATES
DEPARTMENT OF THE INTERIOR
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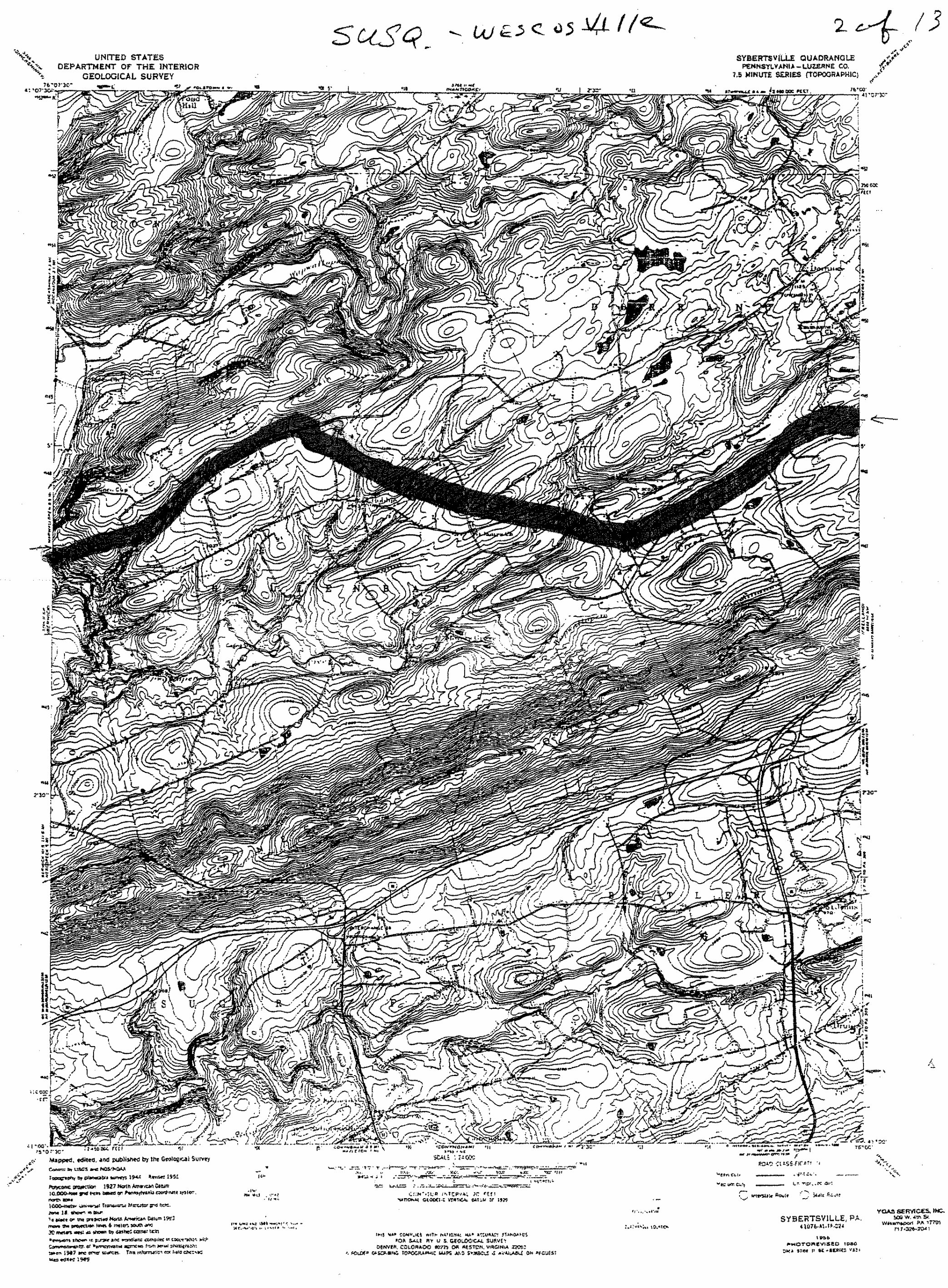
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2 of 13
UNITED STATES
DEPARTMENT OF THE INTERIOR
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PENNSYLVANIA – LUZERNE CO.
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Mapped, edited, and published by the Geological Survey
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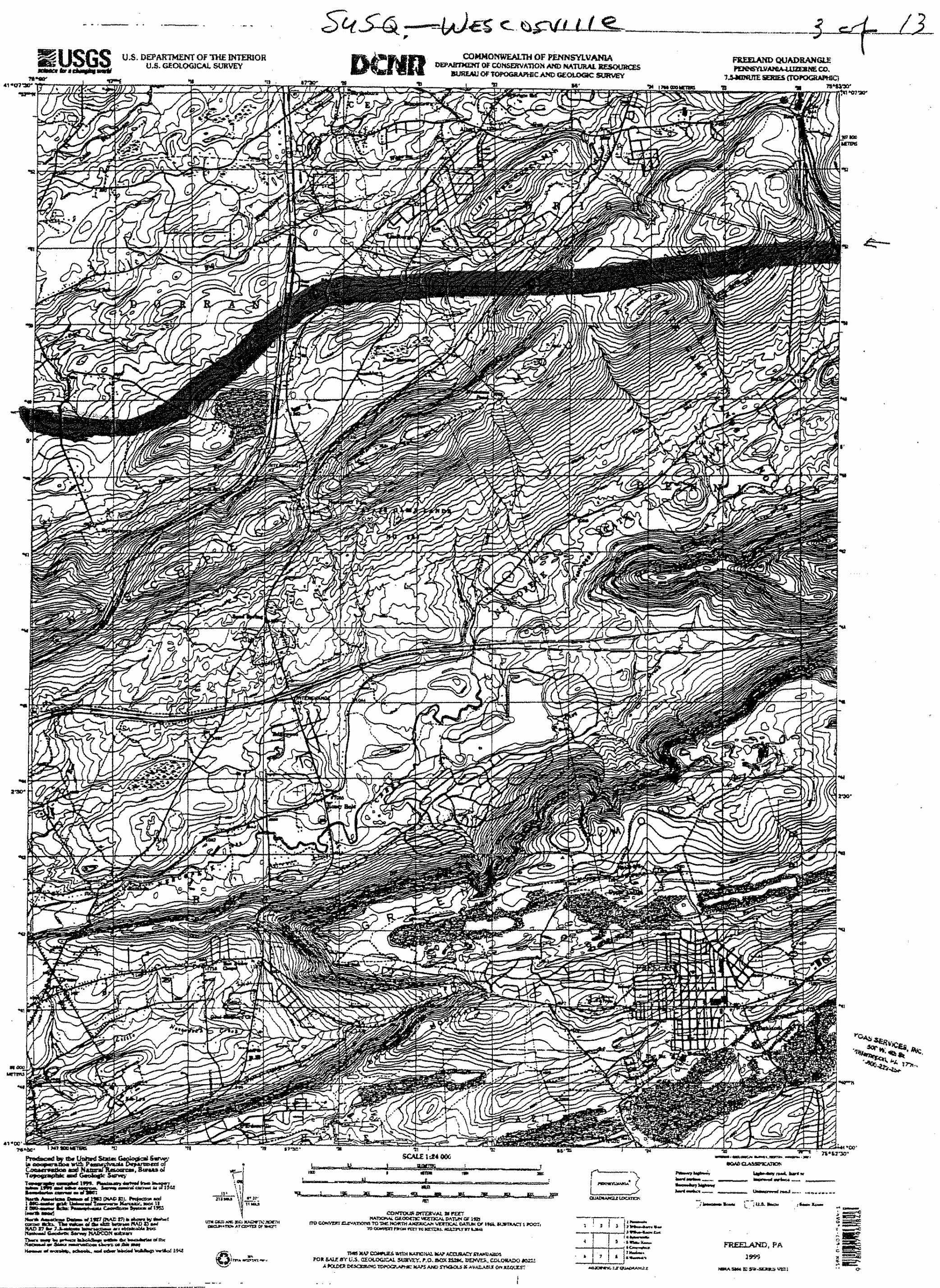
YGAS SERVICES, INC.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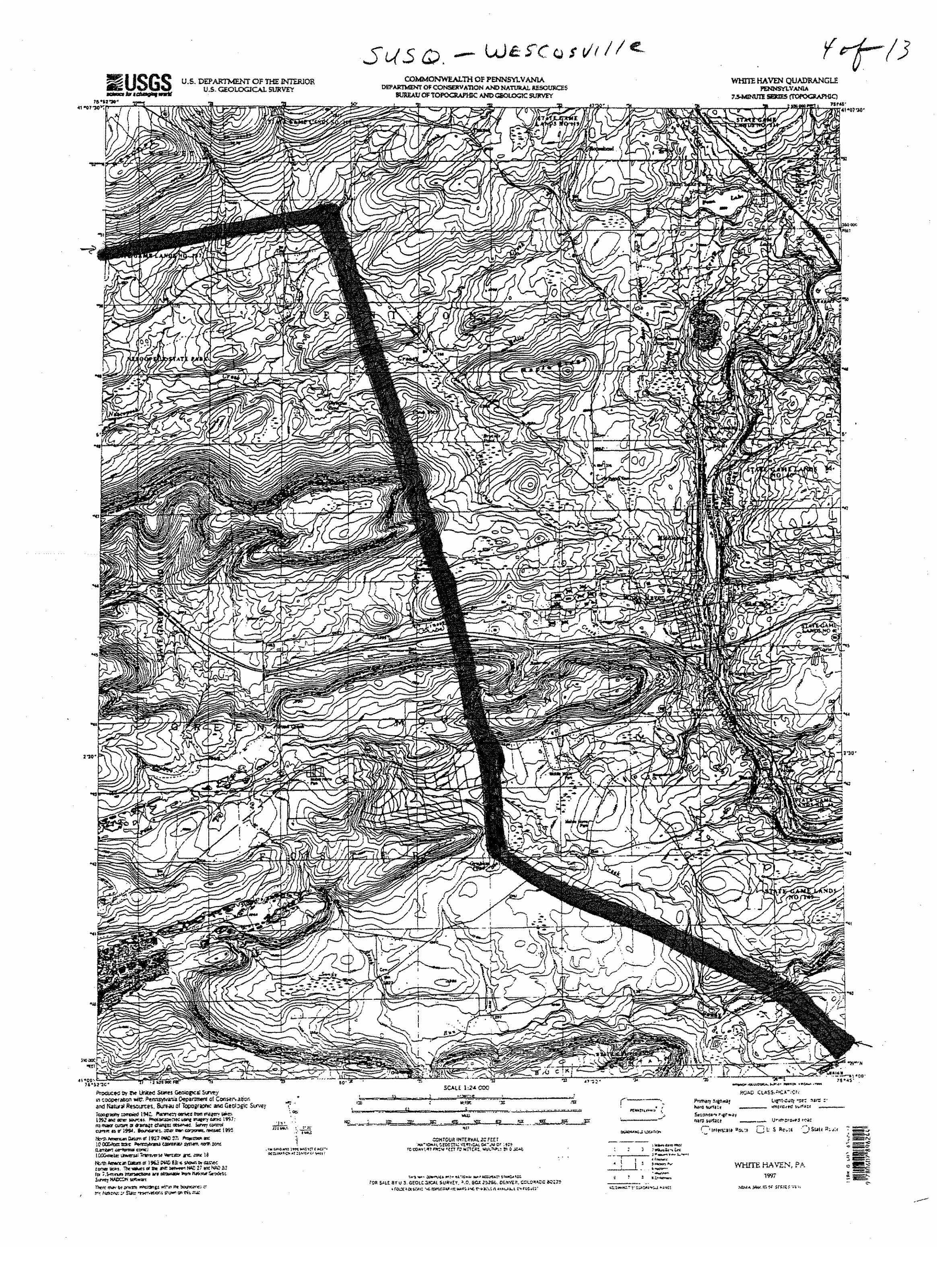
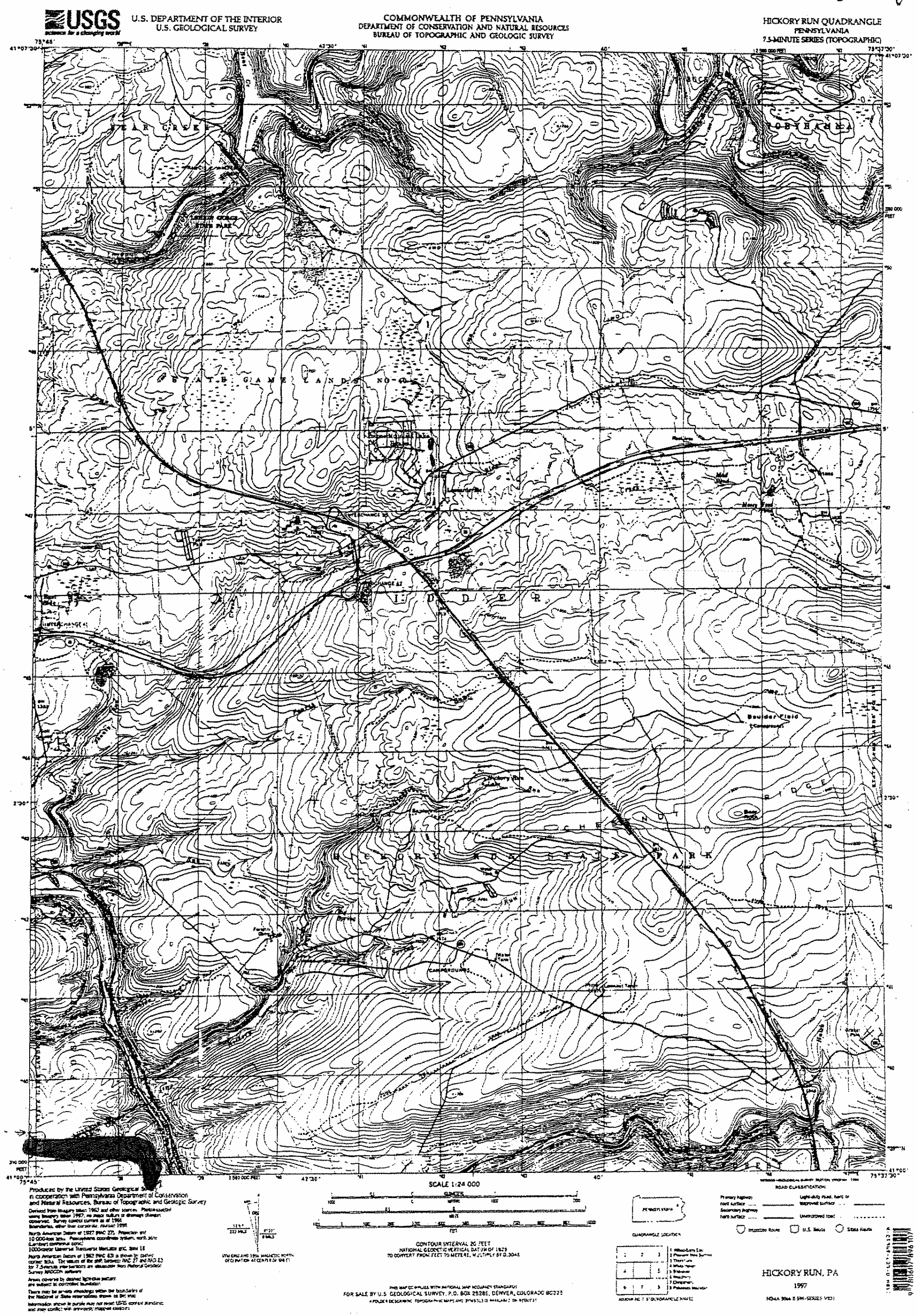
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
DCNR
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
FREELAND QUADRANGLE
PENNSYLVANIA-LUZERNE CO.
7.5-MINUTE SERIES (TOPOGRAPHIC)
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
ROAD CLASSIFICATION
FREELAND, PA
1999


SUSQ. — WESCOSVILLE
4 of 13
USGS
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
WHITE HAVEN QUADRANGLE
PENNSYLVANIA
7.5-MINUTE SERIES (TOPOGRAPHIC)
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
WHITE HAVEN, PA
1997

Susq. — Wescosville 5 of 13




SUSQ.-WESCOSVILLE
6 of 13
USGS
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
DCNR
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
CHRISTMANS QUADRANGLE
PENNSYLVANIA-CARBON CO.
7.5-MINUTE SERIES (TOPOGRAPHIC)
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JIM THORPE
FRANKLIN
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CHRISTMANS, PA
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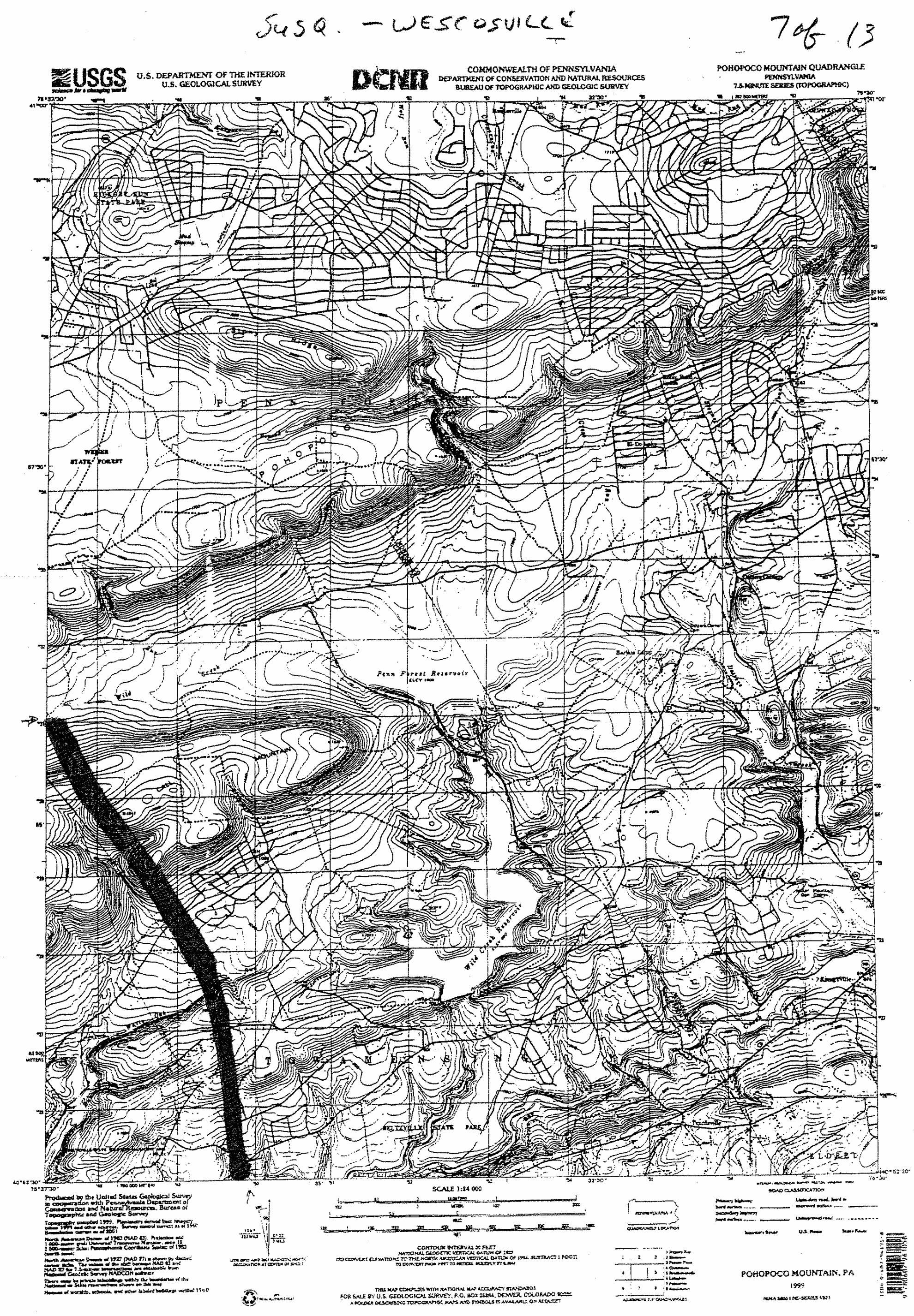
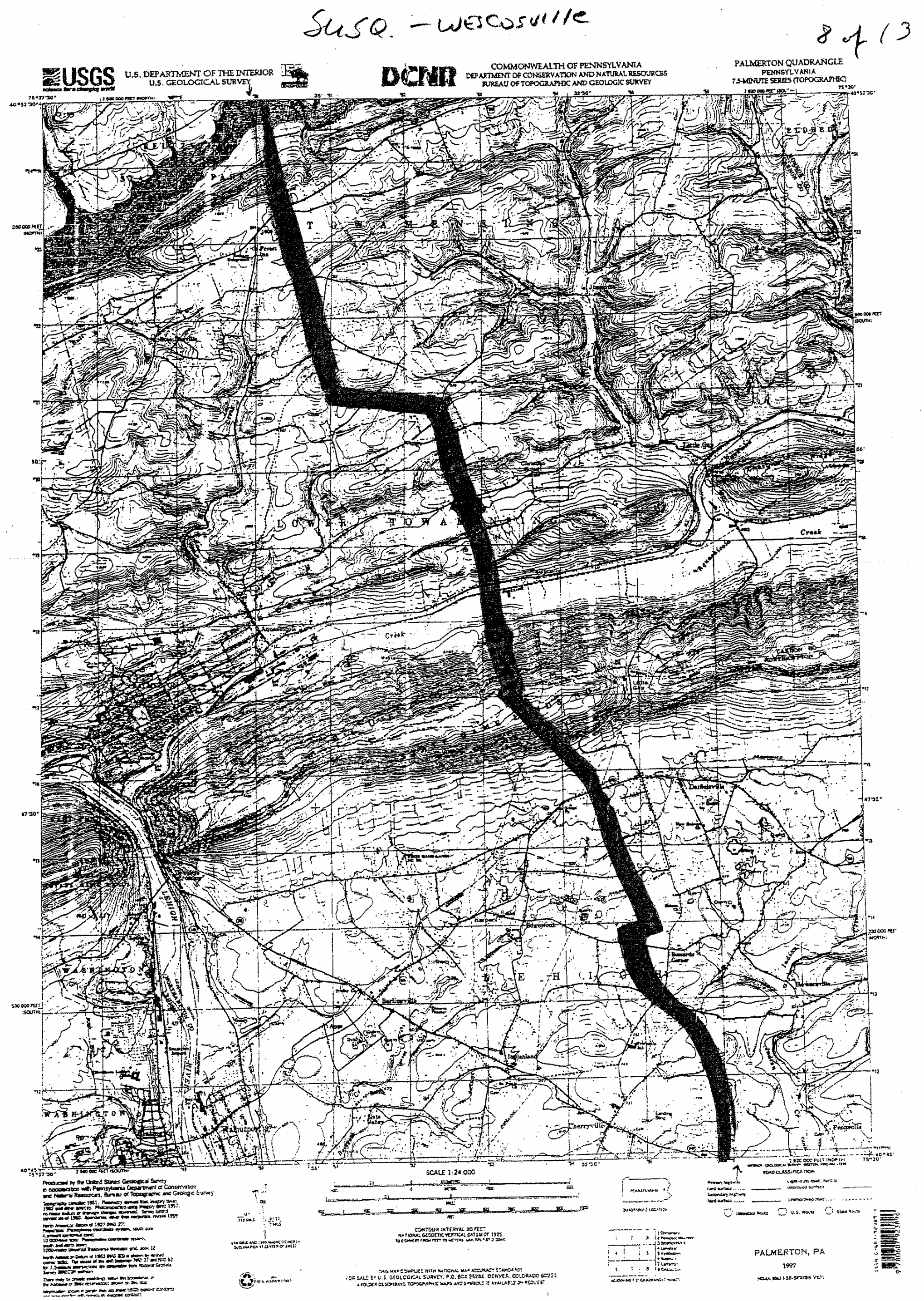
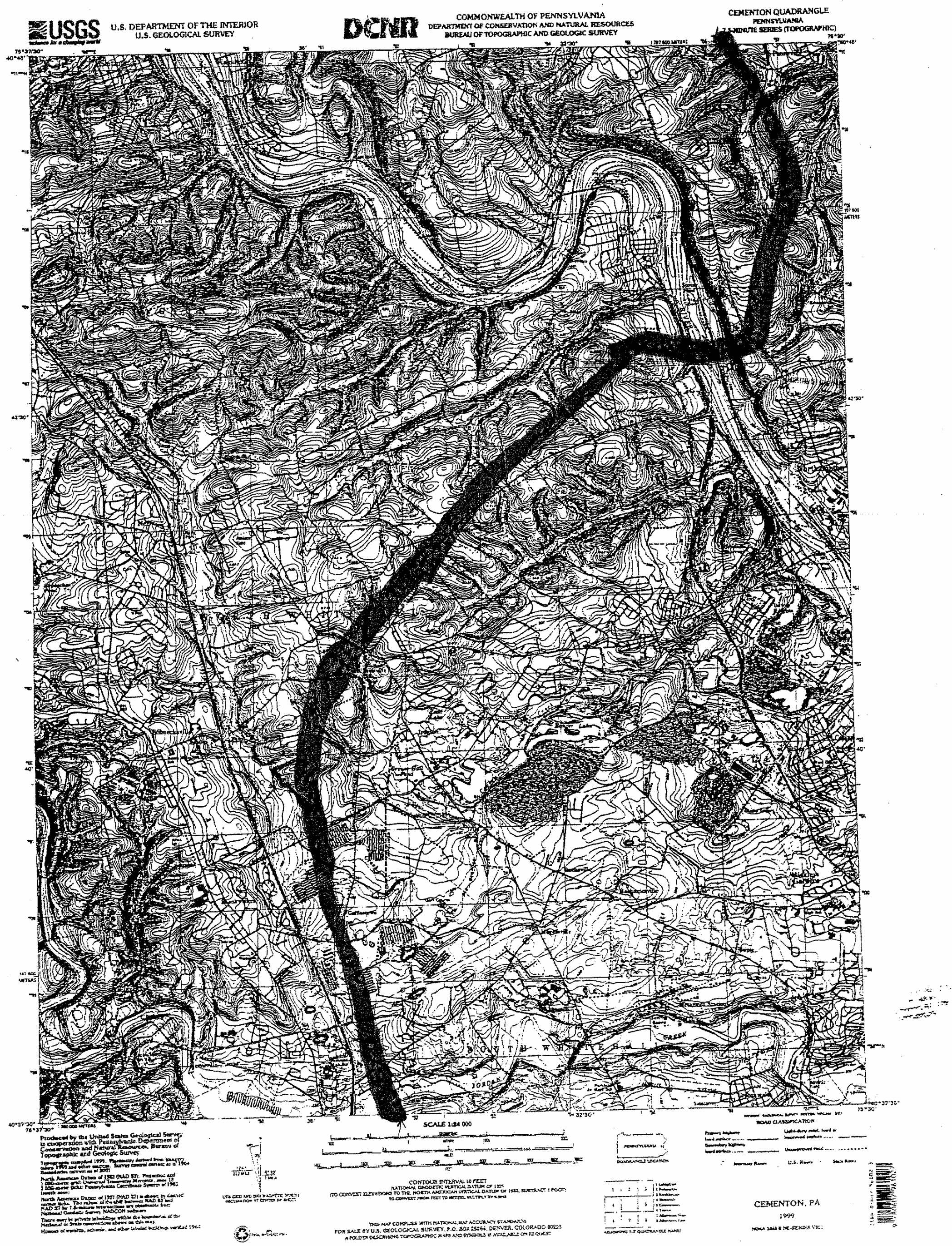
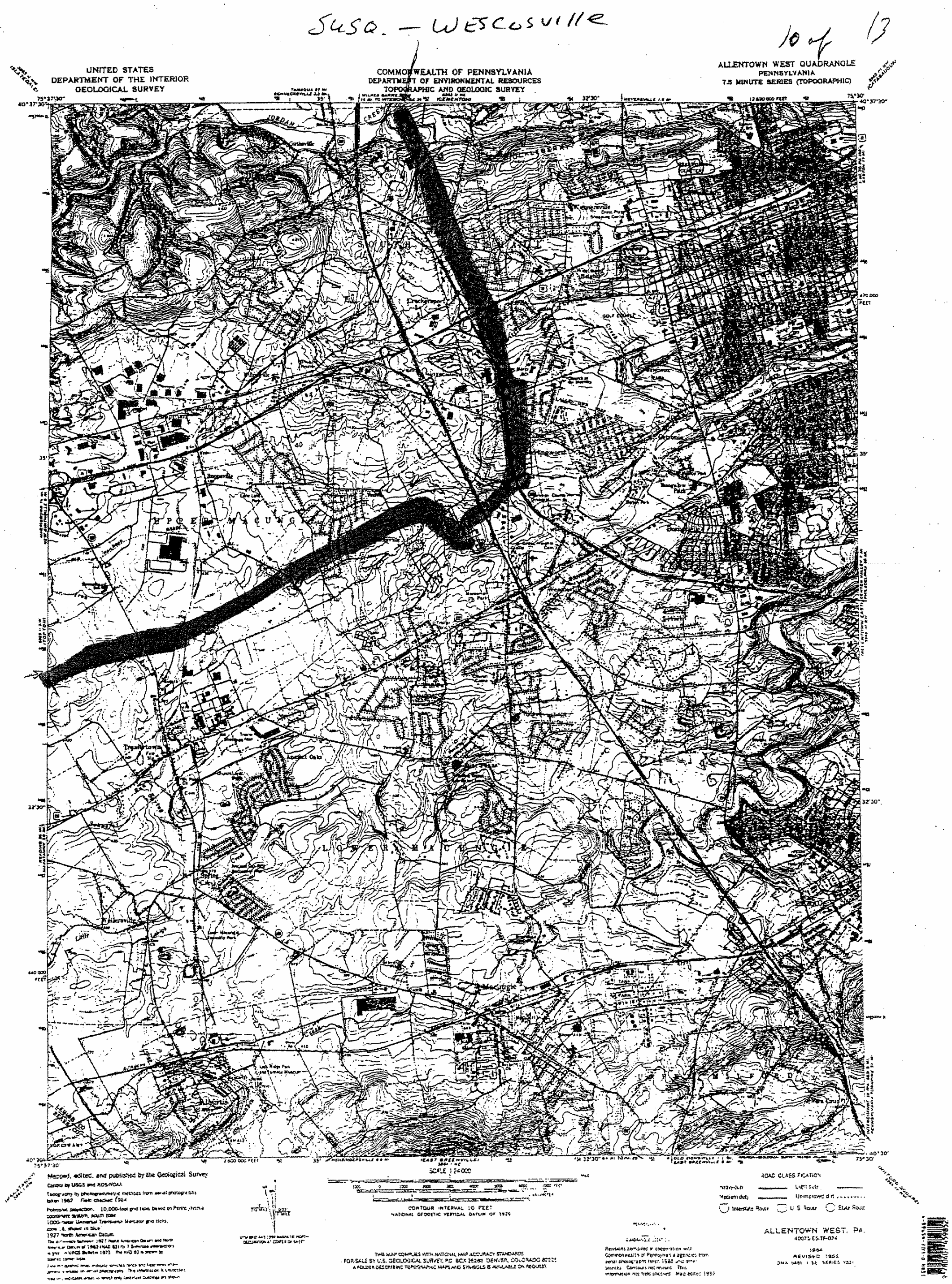

Susq. - Wescosville
7 of 13
USGS
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
DCNR
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
POHOPOCO MOUNTAIN QUADRANGLE
PENNSYLVANIA
7.5-MINUTE SERIES (TOPOGRAPHIC)
Penn Forest Reservoir
SCALE 1:24 000
POHOPOCO MOUNTAIN, PA
1999

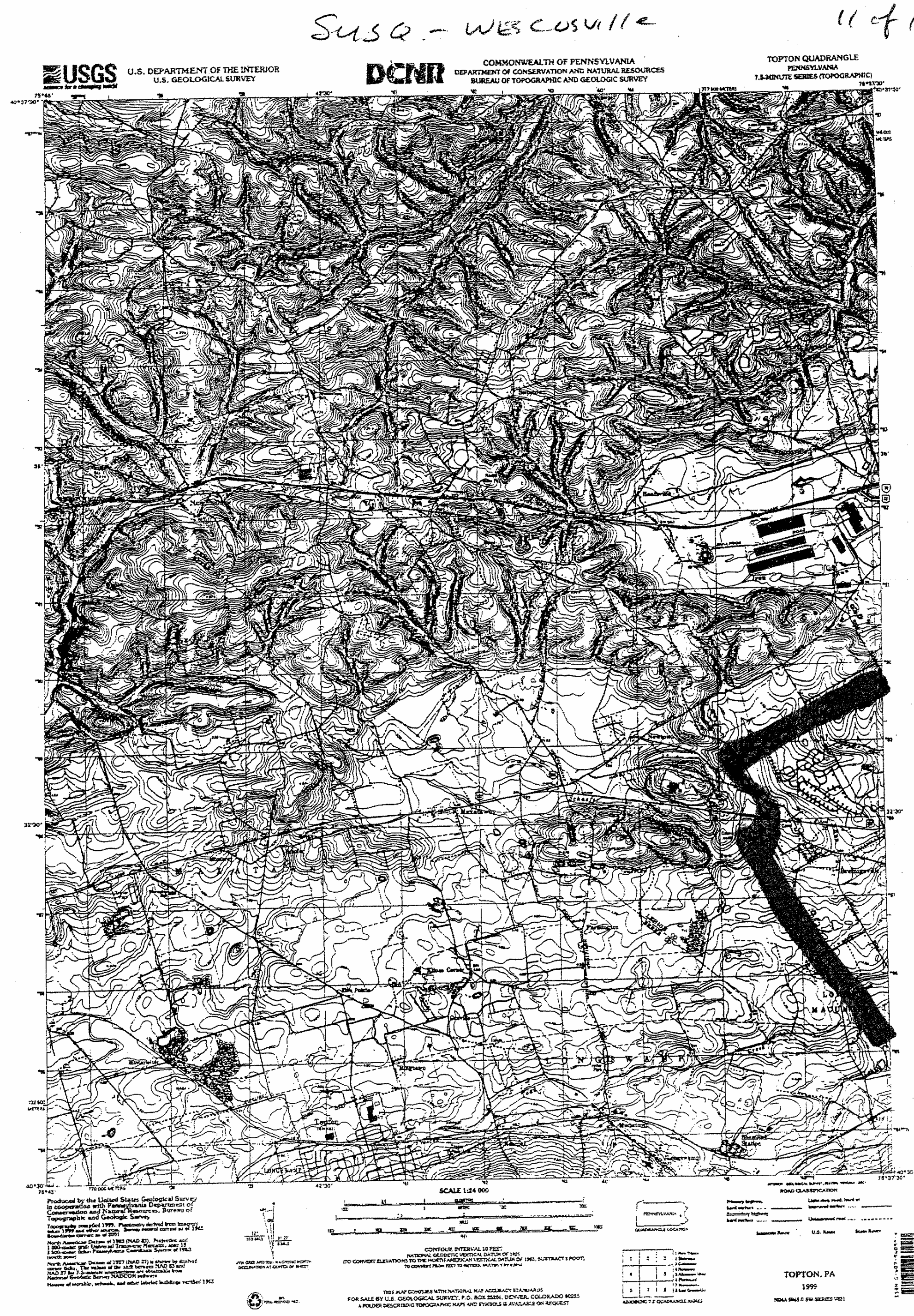

Susq. - Wescosville
8 of 13
USGS
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
DCNR
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
PALMERTON QUADRANGLE
PENNSYLVANIA
7.5-MINUTE SERIES (TOPOGRAPHIC)
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
PALMERTON, PA
1997

Susq. - Wescosville

9 of 13

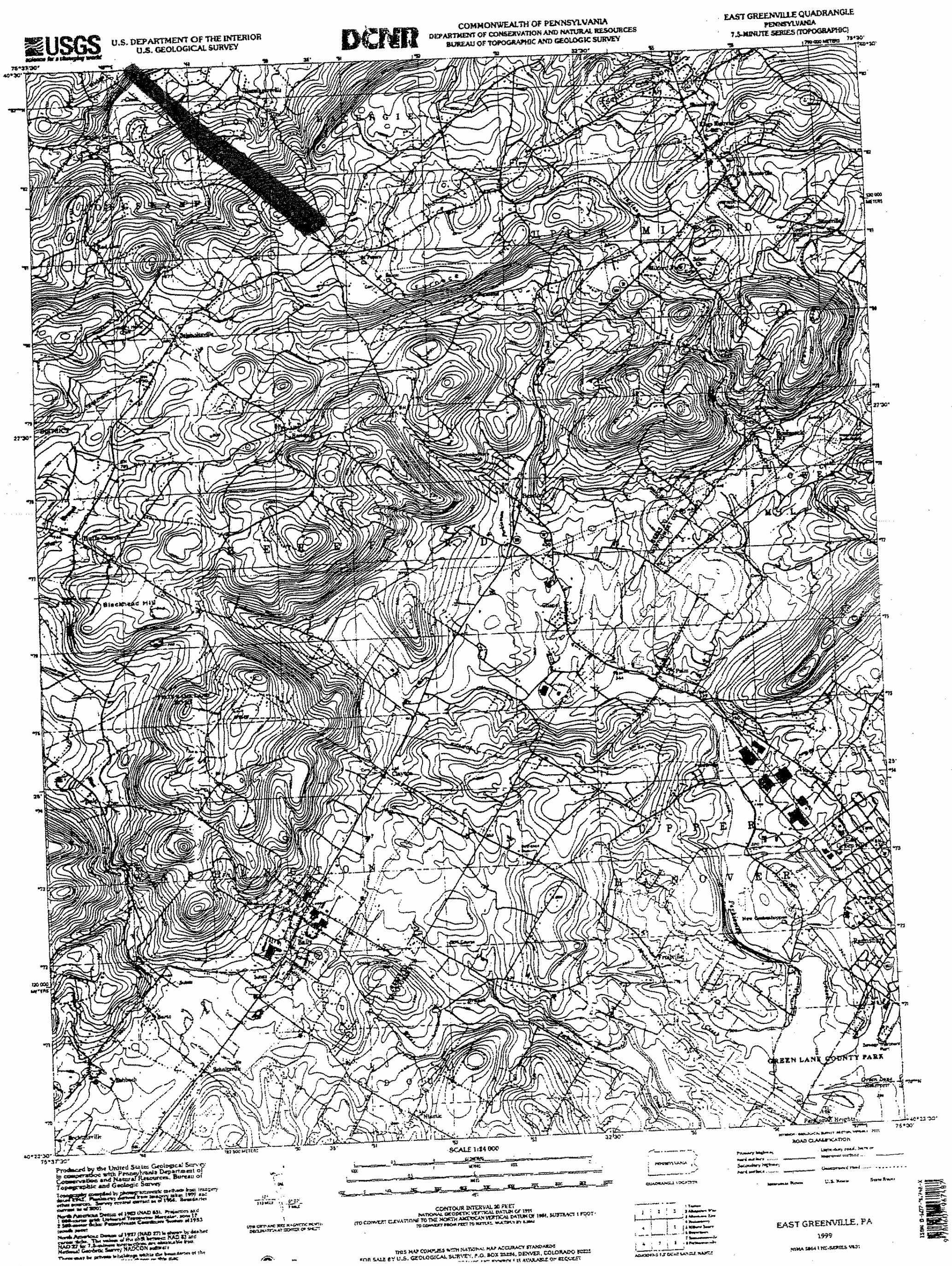



Susq. — Wescosville
10 of 13
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
TOPOGRAPHIC AND GEOLOGIC SURVEY
ALLENTOWN WEST QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
Mapped, edited, and published by the Geological Survey
SCALE 1:24 000
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, P.O. BOX 25286, DENVER, COLORADO 80225
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
ALLENTOWN WEST, PA.
1964
REVISED 1992


Susq. - Wescosville
11 of 13
USGS
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
DCNR
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY
TOPTON QUADRANGLE
PENNSYLVANIA
7.5-MINUTE SERIES (TOPOGRAPHIC)
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
TOPTON, PA
1999


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
TOPOGRAPHIC AND GEOLOGIC SURVEY
ALLENTOWN WEST QUADRANGLE
PENNSYLVANIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
Mapped, edited, and published by the Geological Survey
CONTOUR INTERVAL 10 FEET
ROAD CLASSIFICATION
ALLENTOWN WEST, PA.

Susq. - Wescosville 13 of 13



COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA GAME COMMISSION
2001 ELMERTON AVENUE, HARRISBURG, PA 17110-9797

June 23, 2005

Mr. George T. Jones
PPL Susquehanna, LLC
Two North Ninth Street
Allentown, PA 18101-1179

In re: Operating License Renewal
Susquehanna Steam Electric Station
Units 1 & 2 and Associated Transmission Lines
Salem Township, Luzerne County, PA

Dear Mr. Jones:

This is our response to your letter dated March 24, 2005 requesting information on the above referenced project.

We have completed an office review of the power plant area and the associated transmission lines that connect the power station to the regional grid. We have determined that the renewal of the operating license should not adversely impact any special concern species of birds or mammals recognized by the Pennsylvania Game Commission (PGC). Currently, our agency is not aware of any instances where the power plant operation and maintenance activities are causing adverse impacts to special concern species of birds and mammals, their habitat, or State Game Lands.

Please be advised that future maintenance and operation of the power plant and its associated transmission lines have the potential to adversely impact special concern species and State Game Lands. There are a number of endangered and threatened bird and mammal species and State Game Lands that occur along the transmission line routes. In order to protect special concern species of animals and plants, it is requested that all proposed maintenance site areas surrounding the power plant or located along the transmission line routes be screened using the new Department of Conservation and Natural Resources PNDI Environmental Review tool. It can be accessed at the following new web site: www.naturalheritage.state.pa.us. If the screening results indicate potential conflicts with species of special concern under the jurisdiction of the PGC or other resource agencies, you will need to follow the directions contained in the search results in order to resolve the potential conflicts.

ADMINISTRATIVE BUREAUS:
PERSONNEL: 717-787-7836 ADMINISTRATION: 717-787-5670 AUTOMOTIVE AND PROCUREMENT DIVISION: 717-787-6594
LICENSE DIVISION: 717-787-2084 WILDLIFE MANAGEMENT: 717-787-5529 INFORMATION & EDUCATION: 717-787-6286 LAW ENFORCEMENT: 717-787-5740
LAND MANAGEMENT: 717-787-6818 REAL ESTATE DIVISION: 717-787-6568 AUTOMATED TECHNOLOGY SYSTEMS: 717-787-4076 FAX: 717-772-2411
WWW.PGC.STATE.PA.US
AN EQUAL OPPORTUNITY EMPLOYER

Mr. George T. Jones -2- June 23, 2005

If additional information becomes available on endangered or threatened species, impacts to critical or unique habitats or State Game Lands, this determination may be reconsidered. If you have any questions, please contact me at (717) 783-5957.

Very truly yours,

James R. Leigey
Wildlife Impact Review Coordinator
Division of Environmental Planning
And Habitat Protection
Bureau of Land Management

JRL/jrl

Cc: File
Densmore (USFWS)

George T. Jones
Vice President
Special Projects

Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.7602 Fax 610.774.7797
gtjones@pplweb.com

March 24, 2005

Ms. Chris Firestone, Native Plant Program Manager
Pennsylvania Department of Conservation and Natural Resources
Bureau of Forestry (Plant Program)
Forest Advisory Services
P O Box 8552
Harrisburg, PA 17105-1673

PPL SUSQUEHANNA, LLC
REQUEST FOR INFORMATION ON STATE-LISTED SPECIES AND IMPORTANT HABITATS (PLANTS)
LICREN ER 101013
PLR-052

Dear Ms. Firestone:

PPL Susquehanna, LLC (PPL Susquehanna) is preparing an application to the U. S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Susquehanna Steam Electric Station (SSES) Units 1 and 2. Current operating licenses for the two-unit plant expire in 2022 and 2024. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, the NRC requires license applicants to "assess the impact of the proposed action on threatened or endangered species in accordance the Endangered Species Act" (10 CFR 51.53). The NRC will also request an informal consultation with your office at a later date under Section 7 of the Endangered Species Act. By contacting you early in the application process, we hope to identify any issues that we need to address or any information that we should provide to your office to expedite the NRC consultation.

PPL Susquehanna has operated SSES and associated transmission lines since 1982. The facility is located on the west bank of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania, approximately 5 miles northeast of Berwick, Pennsylvania (see attached map).

The Final Environmental Statement (FES) for construction prepared in 1973 by the U.S. Atomic Energy Commission and the FES prepared for operation prepared in 1981 by the U.S. Nuclear Regulatory Commission identified three short 230-kilovolt ties in the vicinity of SSES, one longer 230 kilovolt line (Stanton #2), and two longer 500 kilovolt lines (Sunbury #2 and Siegfried) that were built to connect SSES to the electric grid. The three short connections were to provide startup power for SSES from pre-existing 230-kilovolt lines in the immediate vicinity of the plant and to connect the Unit 1 output to the pre-existing 230-kilovolt Susquehanna Switchyard across the Susquehanna River.

After publication of the FES for operation, PPL Susquehanna made several changes in the transmission system. As a result of these system changes, the transmission lines are somewhat different than those described in the FES. The attached Figure shows the transmission system as currently configured. Six transmission lines connect the station to the regional grid, and are thus relevant to license renewal. They include:

- Short ties in the SSES vicinity (3) – These three lines (approximately 6.3 total miles) identified in the FES as necessary to connect SSES to the 230-kilovolt electrical system are primarily in areas controlled by SSES and not accessible to the public; however, U.S. Highway 11, Pennsylvania State Highway 239, and other paved roads in the immediate plant vicinity are crossed by the short ties.

- Stanton #2 – This single circuit 230-kilovolt line runs generally northeast from SSES for approximately 30 miles in a 100- to 400-footwide corridor.

- Wescosville – This 500-kilovolt line connects SSES with the Alburtis substation. It runs generally southeast for approximately 76 circuit miles in a corridor ranging from 100 to 350 feet wide.

- Sunbury #2 – This 500-kilovolt line shares a corridor with the pre-existing Sunbury #1 line and runs west-southwest. The corridor is about 325 feet wide and approximately 30 miles long.

In total, for the specific purpose of connecting SSES to the transmission system, PPL Susquehanna has approximately 150 miles of corridor that occupy approximately 3,341 acres. The corridors pass through land that is primarily agricultural or forest land. The areas are mostly remote, with low population densities. The longer lines cross numerous state and U.S. highways. Impact of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Pennsylvania counties crossed by the transmission lines include Luzerne (the location of SSES), Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, and Snyder. Based on our direct observations, a preliminary review of PPL Susquehanna records, a review of the Pennsylvania Natural Heritage Program, and a review of the U.S. Fish and Wildlife Service web site, we believe that the following species could occur in the vicinity of Susquehanna Steam Electric Station or its associated transmission lines identified above: 1) Indiana bats (*Myotis sodalis*), which are federally-listed as endangered, hibernate in Luzerne County; 2) Bald eagles (*Haliaeetus leucocephalus*), federally-listed as threatened, nest in Northumberland County; In addition to the Indiana bat, state-listed mammals recorded in counties crossed by the transmission lines are the Eastern woodrat (*Neotoma magister*), the small-footed myotis (*Myotis leibii*), and the Eastern fox squirrel (*Sciurus niger vulpinus*). The Eastern woodrat is known from Carbon and Snyder Counties, and the small-footed myotis has been recorded in Luzerne and Northumberland Counties.

PPL Susquehanna is committed to the conservation of significant natural habitats and protected species, and expects that operation of SSES, including maintenance of the identified transmission lines, through the license renewal period (an additional 20 years) would not adversely affect any listed species. PPL Susquehanna has no plans to alter current operations over the license renewal period. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas. No additional land disturbance is anticipated in support of license renewal.

Please do not hesitate to call Jerry Fields (610) 774-7889 if you have any questions or require any additional information. After your review, we would appreciate receiving your input by April 22, 2005, detailing any concerns you may have about any listed species or critical habitat in the area or confirming PPL Susquehanna's conclusion that operation of SSES over the license renewal term would have no effect on any threatened or endangered species. This will enable us to meet our application preparation schedule. PPL Susquehanna will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the SSES license renewal application.

Sincerely,

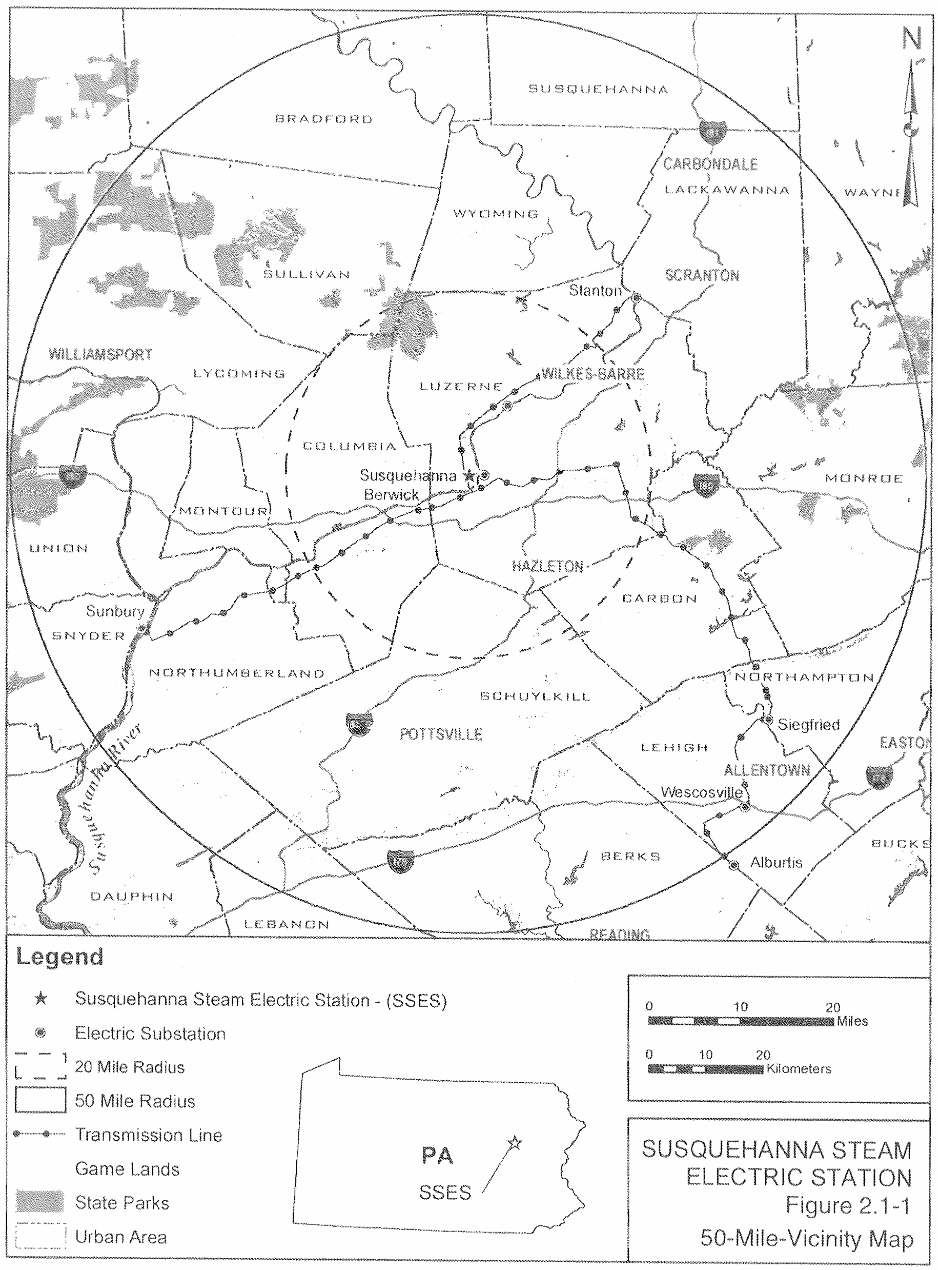
G.T. Jones

George T. Jones

Attachment – Figure 2.1-1, 50-Mile Vicinity Map

Response Requested: YES __X___ by April 22, 2005

g:\goadmin\licrenewal\plr\plr-052.doc


N
SUSQUEHANNA
BRADFORD
CARBONDALE
LACKAWANNA
WAYNE
WYOMING
SULLIVAN
SCRANTON
Stanton
WILLIAMSPORT
LYCOMING
LUZERNE
WILKES-BARRE
COLUMBIA
Susquehanna
Berwick
MONROE
MONTOUR
UNION
HAZLETON
CARBON
Sunbury
SNYDER
NORTHUMBERLAND
NORTHAMPTON
SCHUYLKILL
Siegfried
POTTSVILLE
LEHIGH
ALLENTOWN
Wescosville
Susquehanna River
BERKS
Alburtis
BUCKS
DAUPHIN
LEBANON
READING
Legend
Susquehanna Steam Electric Station - (SSES)
Electric Substation
20 Mile Radius
50 Mile Radius
Transmission Line
Game Lands
State Parks
Urban Area
PA
SSES
0 10 20 Miles
0 10 20 Kilometers
SUSQUEHANNA STEAM ELECTRIC STATION
Figure 2.1-1
50-Mile-Vicinity Map

APR 03 '06 11:58 FR BUREAU OF FORESTRY 717 783 5109 TO 916107747797 P.01/01

Pennsylvania Department of Conservation and Natural Resources

Bureau of Forestry April 3, 2006

George T. Jones
PP&L
FAX: 610-774-7797 (hard copy will NOT follow)

Pennsylvania Natural Diversity Inventory Review, PNDI 17665
Susquehanna Stream Electric Station
Salem Twp., Luzerne County

Dear Mr. Jones,

This responds to your request about a Pennsylvania Natural Diversity Inventory (PNDI) ER Tool "Potential Impact" or a species of special concern impact review. **We screened this project for potential impacts to species and resources of special concern under the Department of Conservation and Natural Resources' responsibility, which includes plants, natural communities, terrestrial invertebrates and geologic features only.**

☒ ***NO PROJECT IMPACT ANTICIPATED***

☐ PNDI records indicate that no known occurrences of species or resources of special concern under DCNR's jurisdiction occur in the vicinity of the project. Therefore, we do not anticipate the project referenced above will impact plants, natural communities, terrestrial invertebrates and geologic features of special concern. No further coordination with DCNR is needed for this project.

☒ PNDI records indicate special concern species or resources are located in the vicinity of the project. However, based on the information submitted to us concerning the nature of the project, the immediate location, and our detailed resource information, we determined that no impact is likely. No further coordination with DCNR is needed for this project.

☐ ***POTENTIAL PROJECT IMPACT - UNDER FURTHER REVIEW***
Based on our PNDI map review we determined potential impacts to species and/or resources of special concern. This project has been passed on to our review committee. The committee will contact the applicant/consultant directly if more information is needed to assess the project's potential impacts. Response time is typically less than a month after the date on this notification.

COMMENTS:

This response represents the most up-to-date summary of the PNDI data files and is good for one (1) year from the date of this letter. An absence of recorded information does not necessarily imply actual conditions on-site. A field survey of any site may reveal previously unreported populations. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered.

This finding applies to impacts to plants, natural communities, terrestrial invertebrates and geologic features only. To complete your review of state and federally-listed species of special concern, please be sure the U.S. Fish and Wildlife Service, the PA Game Commission and the Fish and Boat Commission has been contacted regarding this project either directly or by performing a search with the online PNDI ER Tool found at www.naturalheritage.state.pa.us.

Ellen Shultzabarger, Environmental Review Specialist FOR Chris Firestone, Plant Program Mgr
DCNR/BOF/PNDI, PO Box 8552, Harrisburg, PA 17105 ~ Ph: 717-772-0258 ~ F: 717-772-0271 ~ c-eshultza@state.pa.us

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** TOTAL PAGE.01 **

MAY-11-2005 15:02 PNDI 717 772 0271 P.01/03

Pennsylvania Natural Diversity Inventory

Scientific information and expertise for the conservation of Pennsylvania's native biological diversity

DCNR, Bureau of Forestry May 11, 2005

Jerry Fields
PPL
Two North Ninth St, Allentown, PA 18101
FAX: 610-774-7797 (hard copy will NOT follow)

Re: Pennsylvania Natural Diversity Inventory Review, **PER NO: 17665**
Susquehanna Steam Electric Station—change in FES transmission system
Carbon, Columbia, Lehigh, Luzerne and Northumberland Counties

Dear Mr. Feilds,

In response to your request received on March 30, 2005 the Pennsylvania Natural Diversity Inventory (PNDI) information system was used to gather information regarding the presence resources of special concern within the referenced site.

PNDI records indicate that occurrences of plant species of special concern under DCNR's jurisdiction are known to occur in the vicinity of the transmission lines. **Please see the list attached for species found in the vicinity of the project areas. If any construction or maintenance/disturbance activity is planned along these lines, please send our office more detailed information on the project (i.e. detailed site location maps, site plans, current land cover, etc.) so we can determine if a plant survey would be necessary.**

This finding applies to impacts to plants, natural communities, terrestrial invertebrates and geologic features only. For review of potential impacts to species of special concern not listed above and to complete your review of state and federal listed species of special concern, please forward this project to the three agencies listed below.

PA Game Commission	**PA Fish & Boat Commission**	**US Fish & Wildlife Service**
Bureau of Land Management	Bureau of Fisheries and Engineering	Bonnie Dershem
2001 Elmerton Avenue	450 Robinson Lane	315 South Allen Street, Suite 322
Harrisburg, PA 17110-9797	Bellefonte, PA 16823	State College, PA 16801
717-783-5957	814-359-5113	814-234-4090
birds & mammals	*fish, reptiles, amphibians, aquatic organisms*	*all federally listed species in PA*

This response represents the most up-to-date summary of the PNDI data files and is **good for one (1) year** from the date of this letter. An absence of recorded information does not necessarily imply actual conditions on-site. A field survey of any site may reveal previously unreported populations.

PNDI attempts to be a complete information resource on species of special concern within the Commonwealth. PNDI is the environmental review function of the Pennsylvania Natural Heritage Program, and uses a site-specific information system that describes significant natural resources within the Commonwealth. This system includes data descriptive of plant and animal species of special concern, exemplary natural communities and unique geological features. PNDI is a cooperative project of the Department of Conservation and Natural Resources, The Nature Conservancy and the Western Pennsylvania Conservancy.

Feel free to phone our office if you have questions concerning this response or the PNDI system, and please refer to the P.E.R. Reference Number at the top of the letter in future correspondence concerning this project.

Sincerely,

Ellen M. Shultzabarger
Environmental Review Specialist

ph: 717-772-0258 f: 717-772-0271

Western Pennsylvania Conservancy
209 Fourth Ave.
Pittsburgh, PA 15222
(412)288-2777
www.paconserve.org

Pennsylvania Dept. of Conservation and Natural Resources
Bureau of Forestry
P. O. Box 8552
Harrisburg, PA 17105-8552
(717)787-3444
www.dcnr.state.pa.us

The Nature Conservancy
208 Airport Drive
Middletown, PA 17057
(717)948-3962
www.tnc.org

PPL Susquehanna-SSES Transmission Lines

Plants, Invertebrates, Natural Communitites and Geologic Features along Project Areas by County

May 11, 2005

Scientific Name	Common Name	PA Current Status	PA Proposed Status
Carbon County			
Carex haydenii	Cloud Sedge	TU	PT
Carex longii	Long's Sedge	TU	TU
Carex polymorpha	Variable Sedge	PE	PT
Cuscuta cephalanthi	Button-bush Dodder	TU	TU
Dicentra eximia	Wild Bleeding-hearts	PE	PE
Eleocharis intermedia	Matted Spike-rush	PT	PT
Iris cristata	Crested Dwarf Iris	PE	PE
PA Natural Community	Acidic Shurb Swamp		
PA Natural Community	Scrub oak-heath-pitch pine barrens		
Polygonum careyi	Carey's Smartweed	PE	PE
Columbia County			
None			
Lehigh County			
Juncus torreyi	Torrey's Rush	PT	PE
Spiranthes lucida	Shining Ladies-tresses	N	TU
Polygonum careyi	Carey's Smartweed	PE	PE
Leucothoe racemosa	Swamp Doghobble	TU	PE
Lythum alatum	Winged Loosetrife	TU	PE
Luzerne County–Northern Transmission Line			
Carex disperma	Soft Leaved Sedge	PR	PR
Elymus trachycaulus	Slender Wheatgrass	N	TU
Hesperia leonardus	Leonard's Skipper	G4	
PA Natural Community	Talus Cave Community		
Prunus pumila var. susquehanae			PT

Page 1

PPL Susquehanna-SSES Transmission Lines

Plants, Invertebrates, Natural Communitites and Geologic Features along Project Areas by County

May 11, 2005

Scientific Name	Common Name	PA Current Status	PA Proposed Status
Luzerne County--Southern Transmission Line			
Carex polymorpha	Variable Sedge	PE	PT
Hemiluca maia	Barrens Buckmoth	G5	
Hesperia leonardus	Leonard's Skipper	G4	
Lonicera hirsuta	Hairy Honeysuckle	TU	PE
Lupine perennis	Lupine	PR	PR
Metaxaglaea semitaria	Footpath Sallow Moth	G5	
Nannothemis bella	Elfin Skimmer	G4	
PA Natural Community	Ridgetop dwarf tree forest		
Papaipema sp. 1	Flypoinson Borerer Moth	G2G3	
Rosa virginiana	Virginia Roase	TU	TU
Utricularia inflate	Floating Bladderwort	N	TU
Montour			
Nothing			
Northumberland			
Carex longii	Long's Sedge	TU	TU
Citheronia sepulcralis	Pine Devil	G5	
Xestia elimata	Southern Variable Dart Moth	G5	

Page 2

George T. Jones
Vice President
Special Projects

Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.7602 Fax 610.774.7797
gtjones@pplweb.com

March 24, 2005

Mr. Christopher A. Urban
Non-game and Endangered Species Unit
Pennsylvania Fish & Boat Commission
450 Robinson Lane
Bellefonte, PA 16823

PPL SUSQUEHANNA, LLC
REQUEST FOR INFORMATION ON STATE-LISTED SPECIES AND IMPORTANT HABITATS (FISH, REPTILES, AMPHIBIANS, AND AQUATIC INVERTEBRATES)
LICREN ER 101013
PLR-049

Dear Mr. Urban:

PPL Susquehanna, LLC (PPL Susquehanna) is preparing an application to the U. S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Susquehanna Steam Electric Station (SSES) Units 1 and 2. Current operating licenses for the two-unit plant expire in 2022 and 2024. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, the NRC requires license applicants to "assess the impact of the proposed action on threatened or endangered species in accordance the Endangered Species Act" (10 CFR 51.53). The NRC will also request an informal consultation with your office at a later date under Section 7 of the Endangered Species Act. By contacting you early in the application process, we hope to identify any issues that we need to address or any information that we should provide to your office to expedite the NRC consultation.

PPL Susquehanna has operated SSES and associated transmission lines since 1982. The facility is located on the west bank of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania, approximately 5 miles northeast of Berwick, Pennsylvania (see attached map).

-2- PLR-049

The Final Environmental Statement (FES) for construction prepared in 1973 by the U.S. Atomic Energy Commission and the FES prepared for operation prepared in 1981 by the U.S. Nuclear Regulatory Commission identified three short 230-kilovolt ties in the vicinity of SSES, one longer 230 kilovolt line (Stanton #2), and two longer 500 kilovolt lines (Sunbury #2 and Siegfried) that were built to connect SSES to the electric grid. The three short connections were to provide startup power for SSES from pre-existing 230-kilovolt lines in the immediate vicinity of the plant and to connect the Unit 1 output to the pre-existing 230-kilovolt Susquehanna Switchyard across the Susquehanna River.

After publication of the FES for operation, PPL Susquehanna made several changes in the transmission system. As a result of these system changes, the transmission lines are somewhat different than those described in the FES. Six transmission lines connect the station to the regional grid, and are thus relevant to license renewal. They include:

- <u>Short ties in the SSES vicinity (3)</u> – These three lines (approximately 6.3 total miles) identified in the FES as necessary to connect SSES to the 230-kilovolt electrical system are primarily in areas controlled by SSES and not accessible to the public; however, U.S. Highway 11, Pennsylvania State Highway 239, and other paved roads in the immediate plant vicinity are crossed by the short ties.

- <u>Stanton #2</u> – This single circuit 230-kilovolt line runs generally northeast from SSES for approximately 30 miles in a 100- to 400-footwide corridor.

- <u>Wescosville</u> – This 500-kilovolt line connects SSES with the Alburtis substation. It runs generally southeast for approximately 76 circuit miles in a corridor ranging from 100 to 350 feet wide.

- <u>Sunbury #2</u> – This 500-kilovolt line shares a corridor with the pre-existing Sunbury #1 line and runs west-southwest. The corridor is about 325 feet wide and approximately 30 miles long.

In total, for the specific purpose of connecting SSES to the transmission system, PPL Susquehanna has approximately 150 miles of corridor that occupy approximately 3,341 acres. The corridors pass through land that is primarily agricultural or forest land. The areas are mostly remote, with low population densities. The longer lines cross numerous state and U.S. highways. Impact of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Pennsylvania counties crossed by the transmission lines include Luzerne (the location of SSES), Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, and Snyder. Based on our direct observations, a preliminary review of PPL Susquehanna records, a review of the Pennsylvania Natural Heritage Program, and a review of the U.S. Fish and Wildlife Service web site, we believe that the Bog turtle (*Clemmys muhlenbergii*), federally-listed as threatened and state-listed as endangered, occurs in Lehigh and Northampton Counties.

PPL Susquehanna is committed to the conservation of significant natural habitats and protected species, and expects that operation of SSES, including maintenance of the identified transmission lines, through the license renewal period (an additional 20 years) would not adversely affect any listed species. PPL Susquehanna has no plans to alter current operations over the license renewal period. Any maintenance activities necessary to support license renewal would be limited to previously disturbed areas. No additional land disturbance is anticipated in support of license renewal.

Please do not hesitate to call Jerry Fields (610) 774-7889 if you have any questions or require any additional information. After your review, we would appreciate receiving your input by April 22, 2005, detailing any concerns you may have about any listed species or critical habitat in the area or confirming PPL Susquehanna's conclusion that operation of SSES over the license renewal term would have no effect on any threatened or endangered species. This will enable us to meet our application preparation schedule. PPL Susquehanna will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the SSES license renewal application.

Sincerely,

George T. Jones

Attachment – Figure 2.1-1, 50-Mile Vicinity Map

Response Requested: YES __X__ by April 22, 2005

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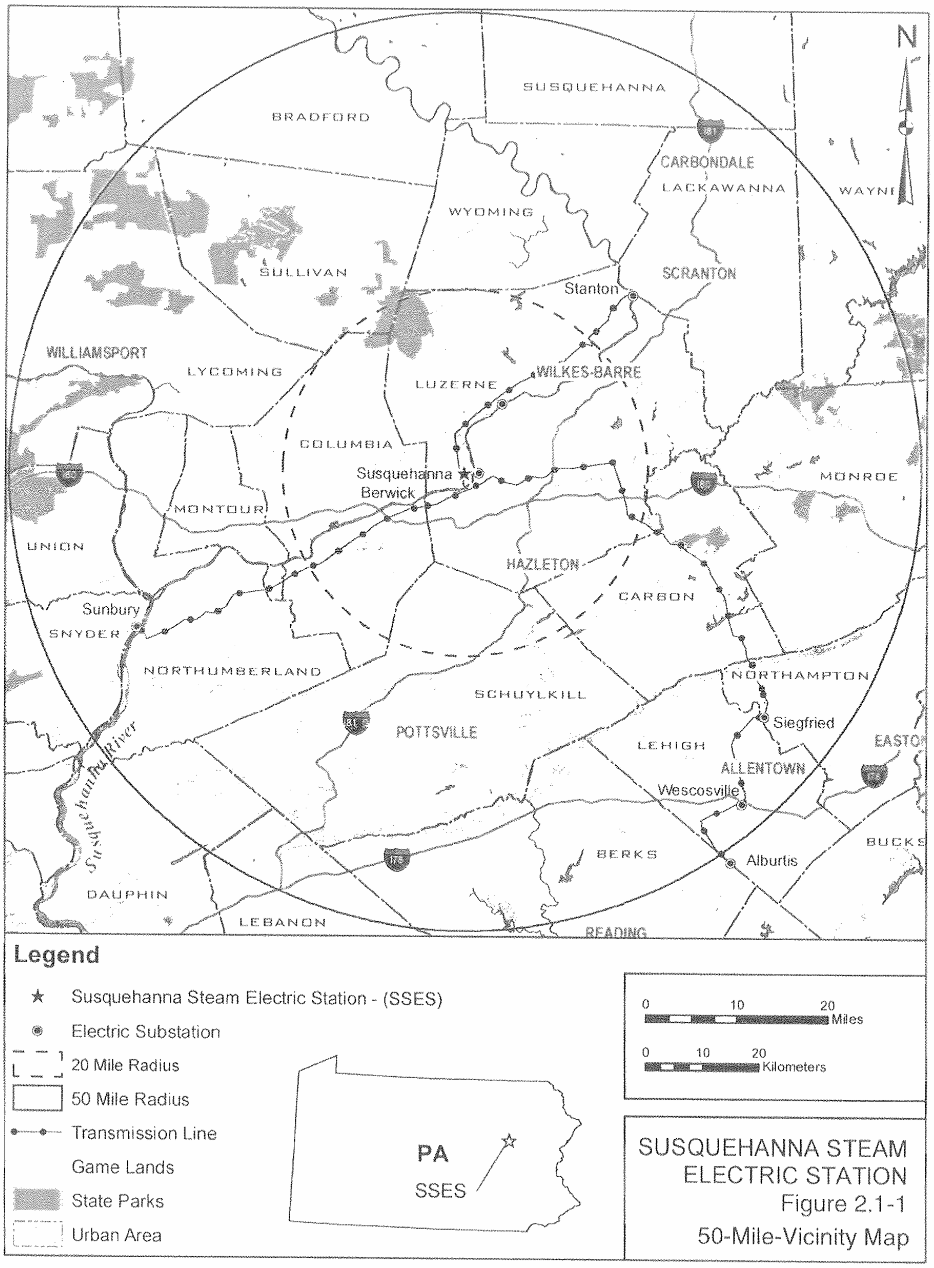

SUSQUEHANNA STEAM ELECTRIC STATION
Figure 2.1-1
50-Mile-Vicinity Map

established 1866

Pennsylvania Fish & Boat Commission

Division of Environmental Services
Natural Diversity Section
450 Robinson Lane
Bellefonte, PA 16823-9620
(814) 359-5237 Fax: (814) 359-5175

April 19, 2005

IN REPLY REFER TO
SIR # 18976

PPL
GEORGE T. JONES
TWO NORTH NINTH ST
ALLENTOWN, PA 18101

RE: Species Impact Review (SIR) - Rare, Candidate, Threatened and Endangered Species
PPL SUSQUEHANNA LICENSE RENEWAL FOR SUSQUEHANNA STEAM ELECTRIC STATION
SALEM Township/Borough, LUZERNE County, Pennsylvania

This responds to your inquiry about a Pennsylvania Natural Diversity Inventory (PNDI) Internet Database search "potential conflict" or a threatened and endangered species impact review. These projects are screened for potential conflicts with rare, candidate, threatened or endangered species under Pennsylvania Fish & Boat Commission jurisdiction (fish, reptiles, amphibians, aquatic invertebrates only) using the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files. These species of special concern are listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, and the Pennsylvania Fish & Boat Code (Chapter 75), or the Wildlife Code. The absence of recorded information from our files does not necessarily imply actual conditions on site. Future field investigations could alter this determination. The information contained in our files is routinely updated. A Species Impact Review is valid for one year only.

_X_ ***NO ADVERSE IMPACTS EXPECTED FROM THE PROPOSED PROJECT***

___ Except for occasional transient species, rare, candidate, threatened or endangered species under our jurisdiction are not known to exist in the vicinity of the project area. Therefore, no biological assessment or further consultation regarding rare species is needed with the Commission. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

_X_ An element occurrence of a rare, candidate, threatened, or endangered species under our jurisdiction is known from the vicinity of the proposed project. However, given the nature of the proposed project, the immediate location, or the current status of the nearby element occurrence(s), no adverse impacts are expected to the species of special concern.

If you have any questions regarding this review, please contact the biologist indicated below:

___	Jeff Schmid	814-359-5236	___	J.R. Holtsmaster	814-359-5194
_X_	Kathy Derge	814-359-5186	___	Bob Morgan	814-359-5129

I am enclosing a copy of our "SIR Request Form", which is to be used for all future species impact review requests. Please make copies of the attached form and use with all future project reviews. Thank you in advance for your cooperation and attention to this important matter of species conservation and habitat protection.

SIGNATURE: [signature] DATE: April 19, 2005
Christopher A. Urban
Chief, Natural Diversity Section

Our Mission: **www.fish.state.pa.us**

To provide fishing and boating opportunities through the protection and management of aquatic resources.

PFBC-DES-NDS-1 (5/2/03)

COMMONWEALTH OF PENNSYLVANIA
FISH AND BOAT COMMISSION
NATURAL DIVERSITY SECTION
SPECIES IMPACT REVIEW (SIR) REQUEST FORM

A. This form provides the site information necessary to perform a computer database search for species of special concern listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, the Pennsylvania Fish and Boat Code or the Wildlife Code.

B. Use only *one form* for each proposed project or location. Complete the information below and <u>**mail**</u> form to:

Natural Diversity Section
Division of Environmental Services
PA Fish and Boat Commission
450 Robinson Lane
Bellefonte, PA 16823
Fax: (814) 359-5175

C. This form, a cover letter including a project narrative, and accompanying maps should be sent to the above address for environmental reviews that *only* concern ***reptiles, amphibians, fishes and aquatic invertebrates.*** Reviews for other natural resources must be submitted to other appropriate agencies.

D. The absence of recorded information from our databases and files does not necessarily imply actual conditions on site. Future field investigations could alter this determination. The information contained in our files is routinely updated. A review is valid for one year.

E. ***Please send us only one (1) copy of your request*** – either by fax or by mail – not both. Mail is preferred to improve legibility of maps. Facsimile submission will not improve our response turn-around time.

F. ***Allow 30 days for completion of the review from the date of PFBC receipt.*** Large projects and workload may extend this review timeframe.

G. ***In any future correspondence with us following your receipt of the SIR response, please refer to the assigned SIR number at the top left of our cover letter.***

H. **FORMS THAT ARE NOT COMPLETED IN FULL WILL NOT BE REVIEWED.**

PLEASE PRINT OR TYPE: If available, provide the potential conflict PNDI **Search Number:**__________

PFBC response should be sent to:

Company/Agency:____________________ Form Preparer:______________

Address:______________________________

____________________ Phone (8:00 AM to 4:00 PM):____________

Project Description:______________________________

Indicate if the project is: Transportation ☐ or Non-transportation ☐ (check one)

Will the proposed project encroach directly or indirectly (e.g., runoff) upon wetlands or waterways? Circle one for each:

<u>Wetlands</u>: Yes No Unknown <u>Waterways</u>: Yes No Unknown

County:____________________ Township/Municipality:____________________

Name of the United States Geological Survey (U.S.G.S.) 7.5 Minute Quadrangle Map where project is located:

____________________ Project size (in acres):__________

Attach an 8.5" by 11" photocopy (**DO NOT REDUCE**) of the section of the U.S.G.S. Quadrangle Map which identifies the project location. On this map, indicate the location of the project center (if linear, depict both ends) and outline the approximate boundaries of the project area.

Specify latitude/longitude of the project center. **Latitude:** ____° /____'/____" N

Indicate latitude/longitude in degrees-minutes-seconds format only. **Longitude:** ____° /____'/____" W

Three steps are needed to convert from decimal degrees to degrees-minutes-seconds: (1) Degrees will be the whole number. (2) To get minutes, multiply the decimal degree portion by 60. (3) Multiply the decimal minute portion by 60 to get seconds.
Example: (Latitude) 40.93748 = **40°**; 0.93748 x 60 = 56.2488'= **56'**; 0.2488 x 60 = 14.928 = **15"** = **40°56'15" N**
(Longitude) 75.94740 = **75°**; 0.94740 x 60 = 56.844' = **56'**; 0.844 x 60 = 50.64 = **51"** = **75°56'51" W**

FOR PFBC USE ONLY

SIR#	Quad Name	Data Source	Search Result-Potential Species Conflict	Action

ATTACHMENT C
THERMOPHILIC ORGANISM CORRESPONDENCE

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George T. Jones
Vice President
Special Projects

Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.7602 Fax 610.774.7797
gtjones@pplweb.com

ppl

March 24, 2005

Mr. Frederick Marrocco
Director of Bureau of Water Supply and
Wastewater Management
Pennsylvania Department of Environmental Protection
400 Market Street
PO Box 8467, 11th Floor
Rachel Carson State Office Building
Harrisburg, PA 17105-8467

PPL SUSQUEHANNA, LLC
REQUEST FOR INFORMATION ON THERMOPHILIC MICROORGANISMS
LICREN ER 101013
PLR-054

Dear Mr. Marrocco:

PPL Susquehanna, LLC (PPL Susquehanna) is preparing an application to the U. S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Susquehanna Steam Electric Station (SSES) Units 1 and 2. Current operating licenses for the two-unit plant expire in 2022 and 2024. Renewing the licenses would provide for an additional 20 years of operation beyond the original license expiration dates. NRC requires license applicants to provide "…an assessment of the impact of the proposed action {license renewal} on public health from thermophilic organisms in the affected water" (10 CFR 51.53). Organisms of concern include the enteric pathogens Salmonella and Shigella, the *Pseudomonas aeruginosa* bacterium, thermophilic Actinomycetes ("fungi"), the many species of Legionella bacteria, and pathogenic strains of the free-living Naegleria amoeba.

As part of the license renewal process, PPL Susquehanna is consulting with your office to determine whether there is any concern about the potential occurrence of these organisms in the Susquehanna River at the SSES location. By contacting you early in the application process, we hope to identify any issues that we need to address or any information that we should provide to your office to expedite the NRC consultation.

PPL Susquehanna has operated SSES since 1982. The facility is located on the west bank of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania, approximately 5 miles northeast of Berwick, Pennsylvania (see attached map). SSES uses two natural draft cooling towers to transfer waste heat from the condensers to the atmosphere. Thermal modeling conducted for the initial operation of SSES indicated that outside of a small (less than one acre) mixing zone, the station's discharge would have a modest (0.5 to 2.0˚F) effect on downstream river temperature in summer. The SSES NPDES permit does not require monitoring of blowdown or discharge temperatures, but temperatures measured at the Bell Bend monitoring station immediately downstream of the station's discharge to the Susquehanna River are typically indistinguishable from those measured upstream of the plant's intake.

Maximum daily mean temperatures at a monitoring station upstream of the plant's intake were 25.3˚C (77.5˚F) in 2000 (September 4), 29.1˚C (84.4˚F) in 2001 (August 8), and 28.9˚C (84.0˚F) in 2002 (August 4). The highest temperature measured over the same period at the Bell Bend monitoring station, downstream of SSES, was 26˚C (78.8˚F). Water temperatures between 77˚F and 85˚F are well below the optimal temperature range (122˚F-140˚F) for growth and reproduction of thermophilic microorganisms.

Fecal coliform bacteria are regarded as indicators of other pathogenic microorganisms, and are the organisms normally monitored by state health agencies. The NPDES permit for SSES requires monitoring of fecal coliforms in sewage treatment plant effluent. Samples are collected once per month for fecal coliform analysis and other parameters. The SSES NPDES permit calls for "effective disinfection" to control disease-producing organisms during the swimming season (May 1 through September 30) and imposes a limit of 200 fecal coliform cells (geometric average value) per 100 ml sample. The NPDES permit also stipulates that no more than 10 percent of samples tested may contain 1,000 cells.

Given the thermal characteristics of the Susquehanna River at the SSES thermal discharge and disinfection of the station's sewage treatment plant effluent, PPL does not expect station operations to stimulate growth or reproduction of thermophilic microorganisms. Under certain circumstances, these organisms might be present in limited numbers in the station's discharge, but would not be expected in concentrations high enough to pose a threat to recreational users of the Susquehanna River.

We would appreciate your relating any concerns you may have about these organisms and potential public health effects over the license renewal term by April 22, 2005, or your confirming PPL Susquehanna's conclusion that operation of SSES over the license renewal term would not stimulate growth of thermophilic pathogens. This will enable us to meet our application preparation schedule. PPL Susquehanna will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the SSES license renewal application. Please do not hesitate to call Jerry Fields (610) 774-7889 if you have any questions or require any additional information.

Sincerely,

George T. Jones

Attachment – Figure 2.1-1, 50-Mile Vicinity Map

Response Requested: YES __X___ by April 22, 2005

Cc:
Ms. Kate Crowley
Water Management Program Manager
Pennsylvania Department of Environmental Protection
Northeast Regional Office
2 Public Square
Wilkes-Barre, PA 18711-0790

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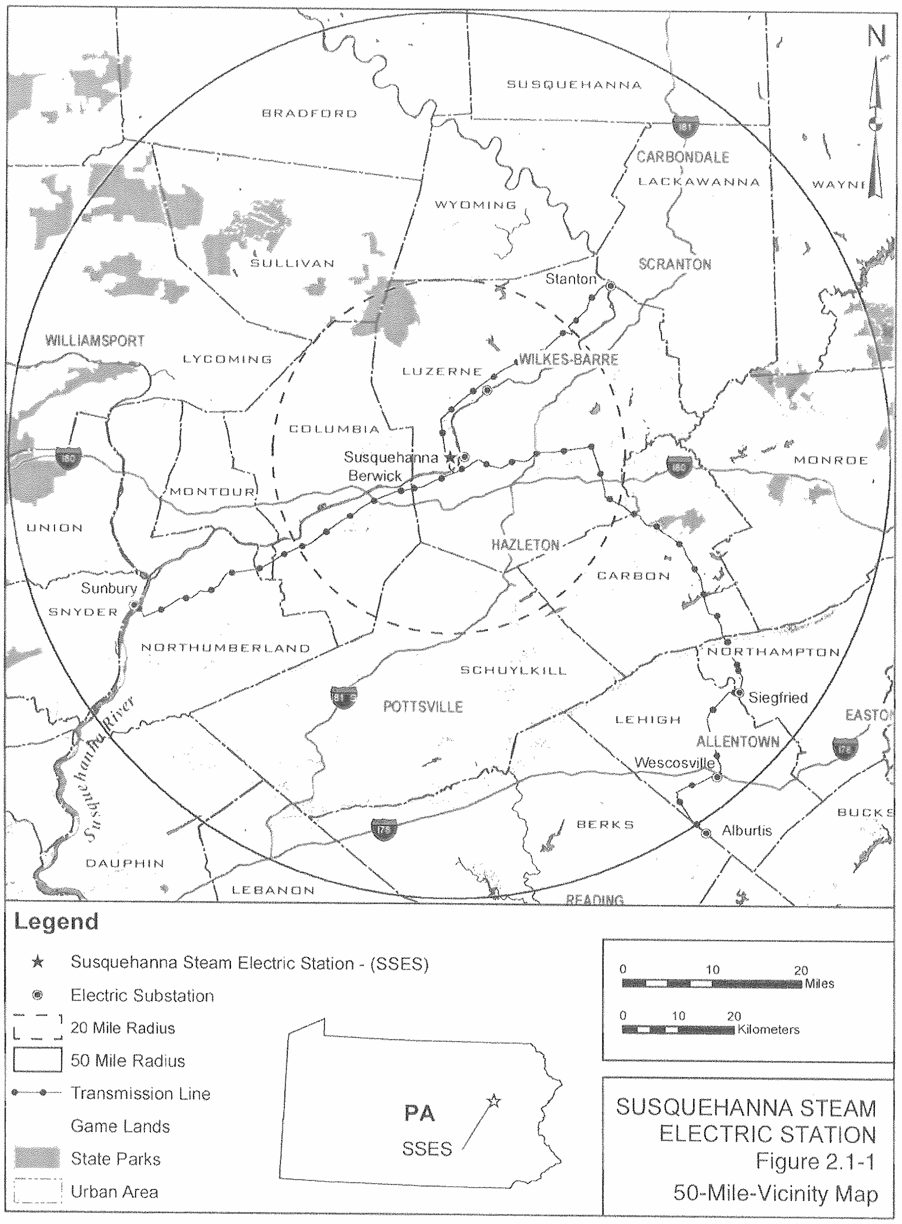

SUSQUEHANNA STEAM ELECTRIC STATION
Figure 2.1-1
50-Mile-Vicinity Map

Pennsylvania Department of Environmental Protection

Rachel Carson State Office Building
P. O. Box 8457
Harrisburg, PA 17105-8457
June 2, 2005

Bureau of Water Supply and Wastewater Management 717-787-9637

George T. Jones
Vice President Special Projects
PPL-Susquehanna, LLC
2 North 9th Street
Allentown, PA 18101-1179

Dear Mr. Jones:

This letter is a follow-up to your request for microorganism data on the North Branch Susquehanna River. Currently, the Pennsylvania Department of Environmental Protection, Bureau of Water Supply and Wastewater Management, Division of Water Quality Assessment and Standards does not collect any microorganism data (i.e., Salmonella) at your site on the North Branch Susquehanna River.

If you have questions or concerns or need further assistance, please feel free to contact me at 717-787-9637.

Sincerely,

for [signature]

Richard H. Shertzer
Acting Chief
Division of Water Quality Assessment and Standards

cc: Jerry Fields

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ATTACHMENT D
STATE HISTORIC PRESERVATION OFFICER CORRESPONDENCE

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George T. Jones
Vice President
Special Projects

Two North Ninth Street
Allentown, PA 18101-1179
Tel. 610.774.7602 Fax 610.774.7797
gtjones@pplweb.com

March 24, 2005

Ms. Jean Cutler, Deputy State Historic Preservation Officer
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0093

PPL SUSQUEHANNA, LLC
REQUEST FOR INFORMATION ON HISTORIC AND ARCHAEOLOGICAL RESOURCES
LICREN ER 101013
PLR-053

Dear Ms. Cutler:

PPL Susquehanna, LLC (PPL Susquehanna) is preparing an application to the U. S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Susquehanna Steam Electric Station (SSES) Units 1 and 2. Current operating licenses expire in 2022 and 2024. The renewal term would be for an additional 20 years beyond the original license expiration date. As part of the license renewal process, NRC requires license applicants to "assess whether any historic or archaeological properties will be affected by the proposed project." NRC may also request an informal consultation with your office at a later date under Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470), and Federal Advisory Council on Historic Preservation regulations (36 CFR 800). By contacting you early in the application process, we hope to identify any issues that need to be addressed or any information your office may need to expedite the NRC consultation.

PPL Susquehanna has operated SSES and associated transmission lines since 1982. The facility is located on the west bank of the Susquehanna River in Salem Township, Luzerne County, Pennsylvania, approximately 5 miles northeast of Berwick, Pennsylvania (see attached map).

Six transmission lines connect the station to the regional grid, and are thus relevant to license renewal. They include:

- Short ties in the SSES vicinity (3) – These three lines (approximately 6.3 total miles) identified in the FES as necessary to connect SSES to the 230-kilovolt electrical system are primarily in areas controlled by SSES and not accessible to the public; however, U.S. Highway 11, Pennsylvania State Highway 239, and other paved roads in the immediate plant vicinity are crossed by the short ties.

- Stanton #2 – This single circuit 230-kilovolt line runs generally northeast from SSES for approximately 30 miles in a 100- to 400-footwide corridor.

- Wescosville – This 500-kilovolt line connects SSES with the Alburtis substation. It runs generally southeast for approximately 76 circuit miles in a corridor ranging from 100 to 350 feet wide.

- Sunbury #2 – This 500-kilovolt line shares a corridor with the pre-existing Sunbury #1 line and runs west-southwest. The corridor is about 325 feet wide and approximately 30 miles long.

In total, for the specific purpose of connecting SSES to the transmission system, PPL Susquehanna has approximately 150 miles of corridor that occupy approximately 3,341 acres. The corridors pass through land that is primarily agricultural or forest land. The areas are mostly remote, with low population densities. The longer lines cross numerous state and U.S. highways. Impact of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Pennsylvania counties crossed by the transmission lines include Luzerne (the location of SSES), Carbon, Columbia, Lehigh, Northampton, Northumberland, Montour, and Snyder. Using the National Register Information System (NRIS) on-line database, we have compiled a list of sites on the National Register of Historic Places within a six-mile radius of the SSES property. The Bittenbender Covered Bridge, Benjamin Evans House, Berwick Armory, Fowlersville Covered Bridge, and Jackson Mansion and Carriage House all fall within a 6-mile radius of the Station. We will provide this information to the NRC to aid in its evaluation of the license application.

Additionally, two PPL Susquehanna-funded cultural resource studies of SSES property have taken place since the construction of the SSES units.

The first study, *The Knouse Site, an Historical Site in Luzerne County, Pennsylvania (McIntyre 1979)*, was conducted in 1978 in response to an effort by PPL Susquehanna to develop land across the Susquehanna River from the SSES site. It was a study and salvage excavation of an historic Native American cemetery in an area called the Knouse site. Twenty-one burials and associated artifactual materials were removed by the Pennsylvania Historical and Museum Commission for further study.

The second study, *Archeological Investigations at the Susquehanna Steam Electric Station (CAI 1981)*, was conducted in 1980. The investigation identified prehistoric cultural resources on the floodplain below the site and within SSES boundaries. Eight sites were identified. Of the eight sites, three were considered to be significant and offered possibilities for recommendation to the National Register by the Pennsylvania State Archaeologist. One additional site was considered to be potentially significant. Of the three significant sites, only one was considered to be in danger of adverse impact. Mitigating actions were recommended and, at the time of publication, PPL Susquehanna was in the process of implementing the recommendations. The other two significant sites and the potential site required preservation only from future re-landscaping and construction activities. It was concluded that, "[n]one of these recommendations should significantly alter Pennsylvania Power and Light's plans or schedule of activities for completion of the SES project."

A field review of the four archeological sites of interest at the SSES was conducted on October 11, 2004. These sites have been monitored periodically since the initial report of 1981.

The first site is located along the access road to the Environmental Laboratory. The site has not been disturbed and is covered either by the access road or dense shrub vegetation maintained under the power lines. No future disturbance is anticipated.

The second site is located along a drainage way between agricultural fields opposite Lake Took-a-while. Although this area was flooded during Hurricane Ivan in September, 2004, there was no erosion and planted vegetative cover remains in place. The banks of the cut have been covered with grass after grading pursuant to the recommendations in the Commonwealth Associates (1981) report. There are no plans to disturb this area.

The third site is located in agricultural fields. At the time of this survey, field corn and potatoes were present (neither had been harvested). This area has been in continuous agriculture, but no disturbance below the plow line is evident.

-4- PLR-053

The fourth site lies in a secondary floodplain forest near the Susquehanna River opposite Gould Island. This area has been undisturbed and is vegetated with a young forest of river birch, silver maple, and black cherry. No disturbance is evident or is planned at this site.

PPL Susquehanna does not expect SSES operation through the license renewal term (an additional 20 years) to adversely affect cultural resources in the area because PPL Susquehanna has no plans to alter current operations over the license renewal period. No expansion of existing facilities is planned, and no major structural modifications have been identified for the purpose of supporting license renewal.

Please do not hesitate to call Jerry Fields [(610) 774-7889] if you have any questions or require any additional information. After your review, we would appreciate receiving your input by April 22, 2005, detailing any concerns you may have about cultural resources in the area or confirming PPL Susquehanna's conclusion that operation of SSES over the license renewal term would have no effect on cultural resources. This will enable us to meet our application preparation schedule. PPL Susquehanna will include a copy of this letter and your response in the Environmental Report that will be submitted to the NRC as part of the SSES license renewal application.

Sincerely,

G. T. Jones

George T. Jones

Attachment – Figure 2.1-1, 50-Mile Vicinity Map

Response Requested: YES __X__ by April 22, 2005

References:

McIntyre, J. 1979. *The Knouse Site, an Historical Site in Luzerne County, Pennsylvania. 1978.* WCORPO Dayton Museum of Natural History and Pennsylvania Historical and Museum Commission. March 1979.

CAI (Commonwealth Associates, Inc.). 1981. Archeological Investigations at the Susquehanna Steam Electric Station. The Susquehanna SES Floodplain. Management Summary. R-2282B. Pennsylvania Power and Light Company. March 26.

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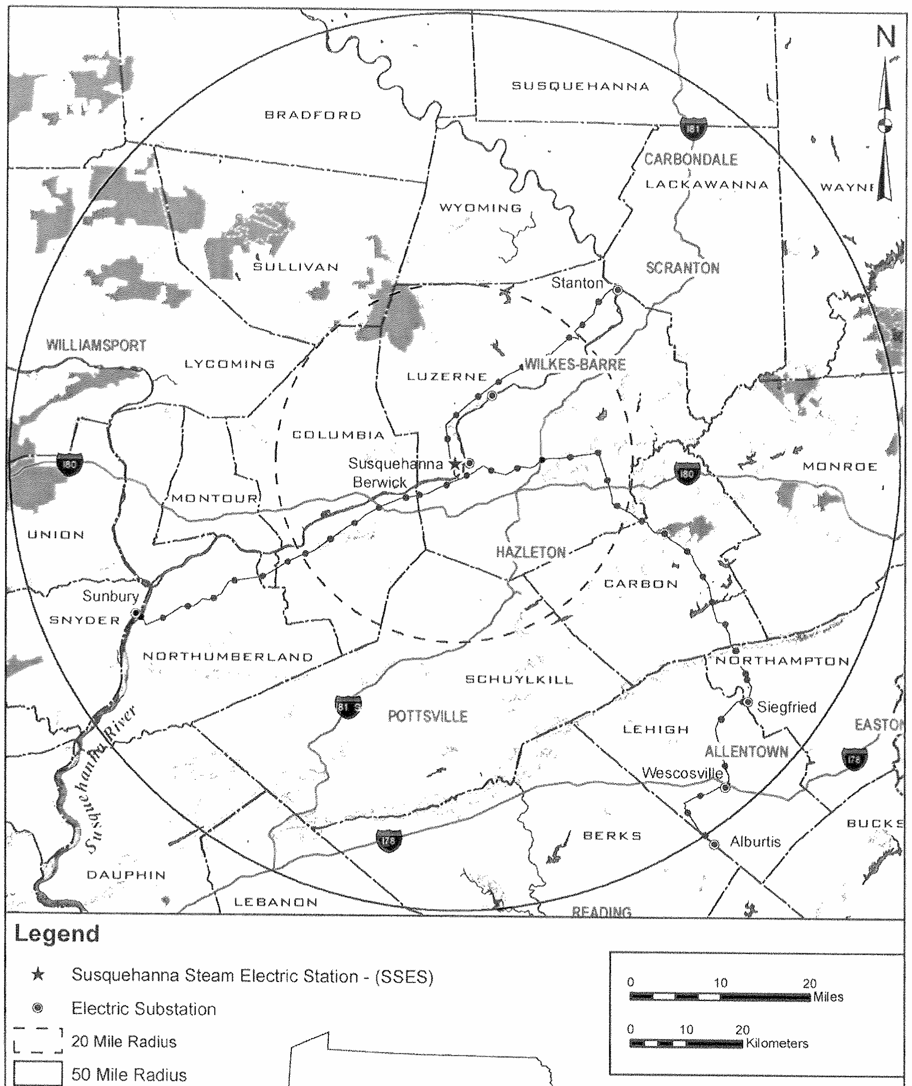
Susquehanna Steam Electric Station Units 1 & 2
License Renewal Application



SUSQUEHANNA STEAM ELECTRIC STATION
Figure 2.1-1
50-Mile-Vicinity Map

Location and Features Page 2.1-2 September 2006

Commonwealth of Pennsylvania
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, 2nd Floor
400 North Street
Harrisburg, PA 17120-0093
www.phmc.state.pa.us

May 20, 2005

PPL
Attn: George T. Jones, Vice President, Special Projects
Two North Ninth Street
Allentown, PA 18101-1179

TO EXPEDITE REVIEW USE
BHP REFERENCE NUMBER

RE: 05-1588-079-A
NRC: PPL Susquehanna, License Renewal,
Susquehanna Steam Electric Station Units 1 and 2,
Salem Township, Luzerne County

Dear Mr. Jones:

The Bureau for Historic Preservation (the State Historic Preservation Office) has reviewed the above named project in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended in 1980 and 1992, and the regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation as revised in 1999. Our comments are as follows:

The information you submitted indicates PPL Susquehanna has no plans to alter current operations over the renewal period and no expansion of existing facilities is planned. Based on this we agree that the license renewals shall have no adverse effect on significant cultural resources within the project area.

Should you become aware, from any source, that historic or archaeological properties are located at or near the project site, please notify the Bureau for Historic Preservation at (717) 783-8946.

Sincerely,

Douglas C. McLearen, Chief
Division of Archaeology & Protection

cc: NRC

ATTACHMENT E
SEVERE ACCIDENT MITIGATION ALTERNATIVES

TABLE OF CONTENTS

List of Tables

Table **Page**

Acronyms Used in Attachment E

ABWR	Advanced Boiling Water Reactor
ADS	Automatic Depressurization System
ARI	Alternate Rod Insertion
ATWS	Anticipated Transient Without Scram
BOC	Break Outside Containment
BWR	Boiling Water Reactor
CCF	Common Cause Failure
CDF	Core Damage Frequency
CIG	Containment Instrument Gas
COPF	Containment Overpressure Failure
CRD	Control Rod Drive
CST	Condensate Storage Tank
DCH	Direct Containment Heating
DFP	Diesel Fire Pump
DG	Diesel Generator
DW	Drywell
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EOC RPT	End Of Cycle - Recirculation Pump Trip
EOPs	Emergency Operating Procedures
EPZ	Emergency Planning Zone
ESW	Emergency Service Water
F&Os	Facts and Observations
FP	Fire Protection
FPS	Fire Protection System
FW	Feedwater
GSW	General Service Water
HCTL	Heat Capacity Temperature Limit
HEP	Human Error Probability
HP	High Pressure
HPCI	High Pressure Coolant Injection
HPI	High Pressure Injection
HPSI	High Pressure Safety Injection
HRA	Human Reliability Analysis
HVAC	Heating Ventilating Air Conditioning
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination – External Events
ISI	In-Service Inspection
ISLOCA	Interfacing Systems Loss of Coolant Accident
LDWC	Loss of Drywell Cooling
LERF	Large Early Release Frequency

Acronyms Used in Attachment E

LOCA	Loss of Coolant Accident
LOAI	Loss of Instrument Air
LOOP	Loss of Offsite Power
LP	Low Pressure
LPCI	Low Pressure Coolant Injection
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequences Code System, Version 2
MACR	Maximum Averted Cost-Risk
MCC	Motor Control Center
MMACR	Modified Maximum Averted Cost-Risk
MRI	Manual Rod Insertion
MSIV	Main Steam Isolation Break
NPSH	Net Positive Suction Head
NRC	U.S. Nuclear Regulatory Commission
OECR	Off-site economic cost risk
OSP	Off Site Power
PMF	Probable Maximum Flood
PPL	PPL Susquehanna, LLC*
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PSL	Pressure Suppression Limit
RCIC	Reactor Core Isolation Cooling
RDR	Real Discount Rate
RHR	Residual Heat Removal
RHRSW	Residual Heat Removal Service Water
RLE	Review Level Earthquake
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel
RRW	Risk Reduction Worth
RWCU	Reactor Water Cleanup
RWST	Refueling Water Storage Tank
SAMA	Severe Accident Mitigation Alternative
SAMDA	Severe Accident Mitigation Design Alternative
SBLC	Standby Liquid Control
SBO	Station Blackout
SER	Safety Evaluation Report
SLC	Standby Liquid Control
SLCS	Standby Liquid Control System
SP	Suppression Pool
SPC	Suppression Pool Cooling
SORV	Stuck Open Relief Valve
SRV	Safety Relief Valve

Acronyms Used in Attachment E

SSES	Susquehanna Steam Electric Station
SW	Service Water
ZPA	Zero Period Acceleration

*** PPL Susquehanna, LLC is the present name of the owner (90%) and operator of the Susquehanna Steam Electric Station. Previous names included Pennsylvania Power and Light Co. and PP&L, Inc. Allegheny Electric Cooperative Inc. owns the remaining 10% of the station.**

E.0 SEVERE ACCIDENT MITIGATION ALTERNATIVES

The severe accident mitigation alternatives (SAMA) analysis discussed in Section 4.20 of the Environmental Report is presented below.

E.1 METHODOLOGY

The methodology selected for this analysis involves identifying SAMA candidates that have potential for reducing plant risk and determining whether or not the implementation of those candidates is beneficial on a cost-risk reduction basis. The metrics chosen to represent plant risk include the core damage frequency (CDF), the dose-risk, and the offsite economic cost-risk. These values provide a measure of both the likelihood and consequences of a core damage event.

The SAMA process consists of the following steps:

- Susquehanna Steam Electric Station (SSES) Probabilistic Risk Assessment (PRA) Model – Use the SSES Internal Events PRA model as the basis for the analysis (Section E.2). Incorporate External Events contributions as described in Section E.5.1.8.

- Level 3 PRA Analysis – Use SSES Level 1 and 2 Internal Events PRA output and site-specific meteorology, demographic, land use, and emergency response data as input in performing a Level 3 PRA using the MELCOR Accident Consequences Code System Version 2 (MACCS2) (Section E.3). Incorporate External Events contributions as described in Section E.5.1.8.

- Baseline Risk Monetization – Use U.S. Nuclear Regulatory Commission (NRC) regulatory analysis techniques to calculate the monetary value of the unmitigated SSES severe accident risk. This becomes the maximum averted cost-risk that is possible (Section E.4).

- Phase 1 SAMA Analysis – Identify potential SAMA candidates based on the SSES Probabilistic Risk Assessment (PRA), Individual Plant Examination – External Events (IPEEE), and documentation from the industry and the NRC. Screen out SAMA candidates that are not applicable to the SSES design or are of low benefit in boiling water reactors (BWRs) such as SSES, candidates that have already been implemented at SSES or whose benefits have been achieved at SSES using other means, and candidates whose estimated cost exceeds the maximum possible averted cost-risk (Section E.5).

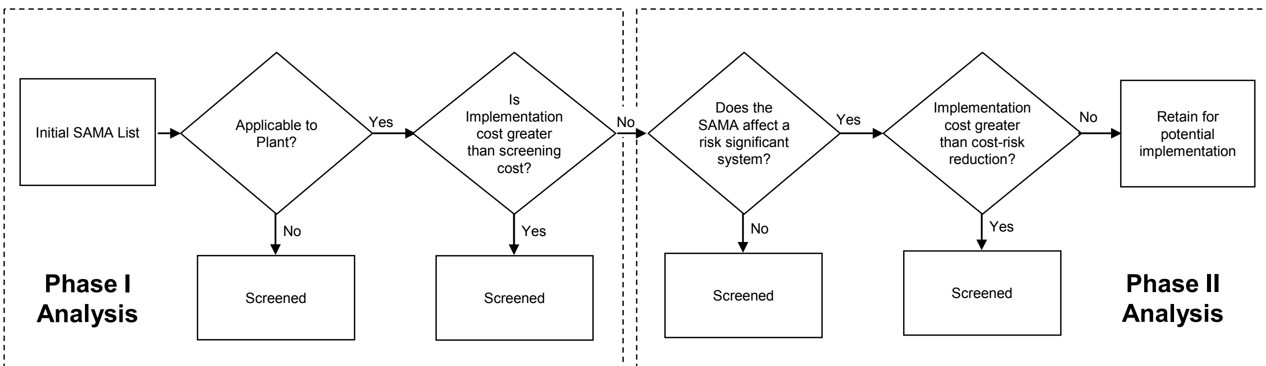
- Phase 2 SAMA Analysis – Calculate the risk reduction attributable to each remaining SAMA candidates and compare to a more detailed cost analysis to identify the net cost-benefit. PRA insights are also used to screen SAMA candidates in this phase (Section E.6).

- Uncertainty Analysis – Evaluate how changes in the SAMA analysis assumptions might affect the cost-benefit evaluation (Section E.7).

- Conclusions – Summarize results and identify conclusions (Section E.8).

The steps outlined above are described in more detail in the subsections of this appendix. The graphic below summarizes the high level steps of the SAMA process.

SAMA Screening Process



For SSES, the SAMA process is complicated by the concurrent Extended Power Uprate (EPU) application. The EPU application implies that future operation of the plant will not necessarily be consistent with what is modeled in the current PRA. While there may be many issues in the future life of the plant that fall into this category, EPU has been identified as a likely change; therefore, the SAMA analysis has been developed to account for EPU implementation.

For completeness, two parallel SAMA analyses have been performed in order to address both the pre-EPU and post-EPU[1] conditions for SSES. The calculations and results for both of these analyses are documented in the following subsections.

[1] Post-EPU occurs after implementation of EPU changes to the station.

E.2 SSES PRA MODEL

This section provides a summary of the PRA model used to support the SAMA analysis and the changes that have been made to the model since the individual plant examination (IPE). The external events models are not specifically discussed in this section; however Sections E.5.1.6 through E.5.1.8 provide a description of the process used to integrate the external events contributions into the SSES SAMA process.

E.2.1 Current Level 1 SSES PRA Models

In order to clearly represent the impact of EPU implementation, two different versions of the PRA were developed (FEB06preEPU and FEB06EPU). The only differences between the models are those based on EPU implementation. The SAMA analysis uses both models in a parallel evaluation to document how the proposed EPU could impact the results.

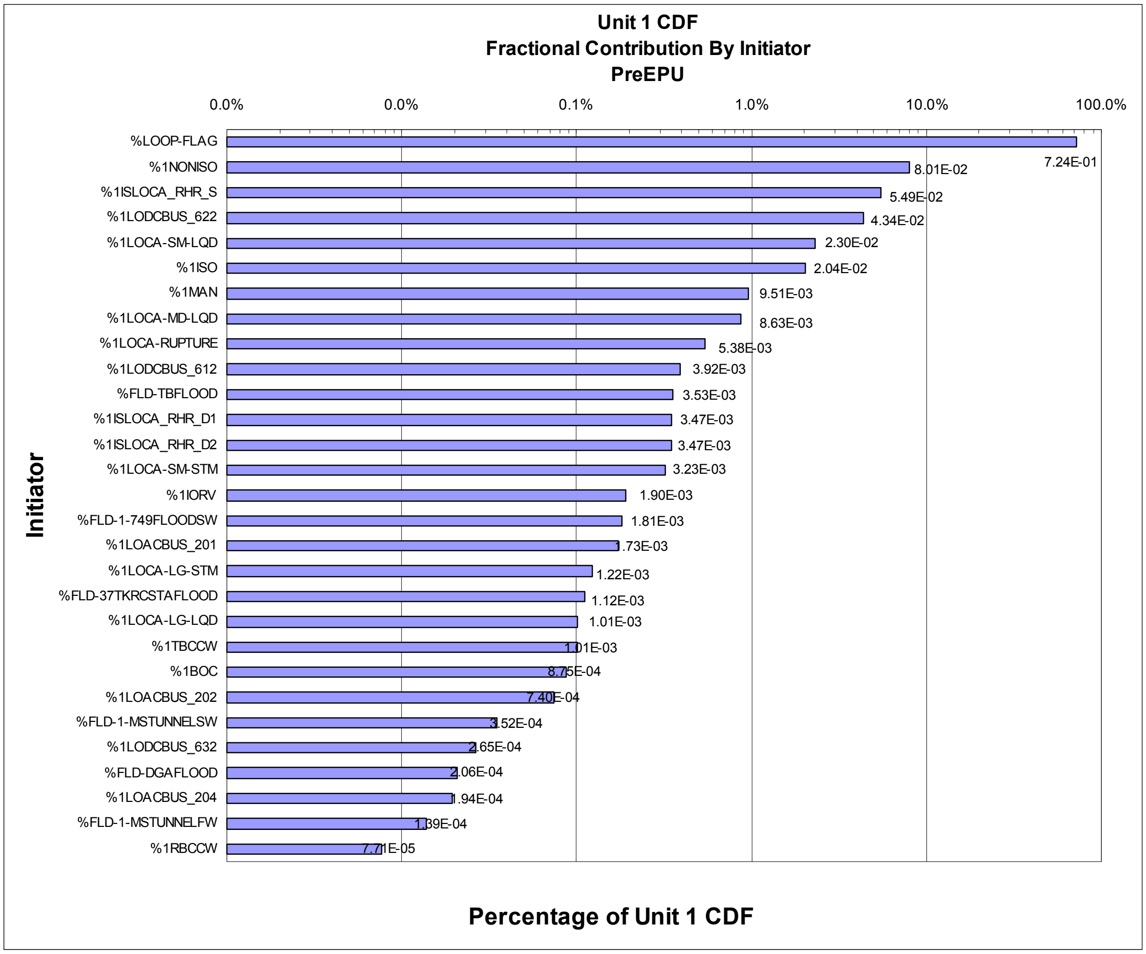
While the two models are similar, there are some differences in the calculated CDFs, as shown in the following table:

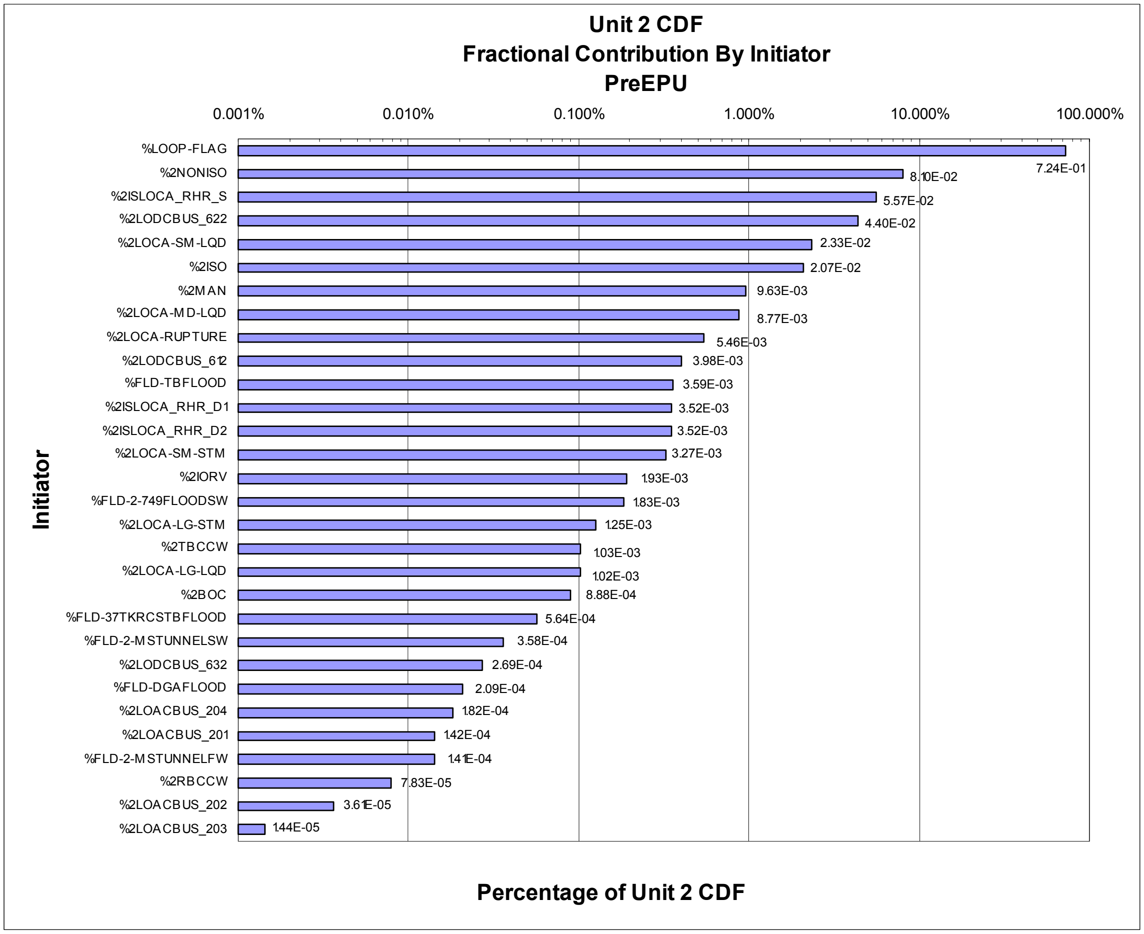
SSES CDF Summary

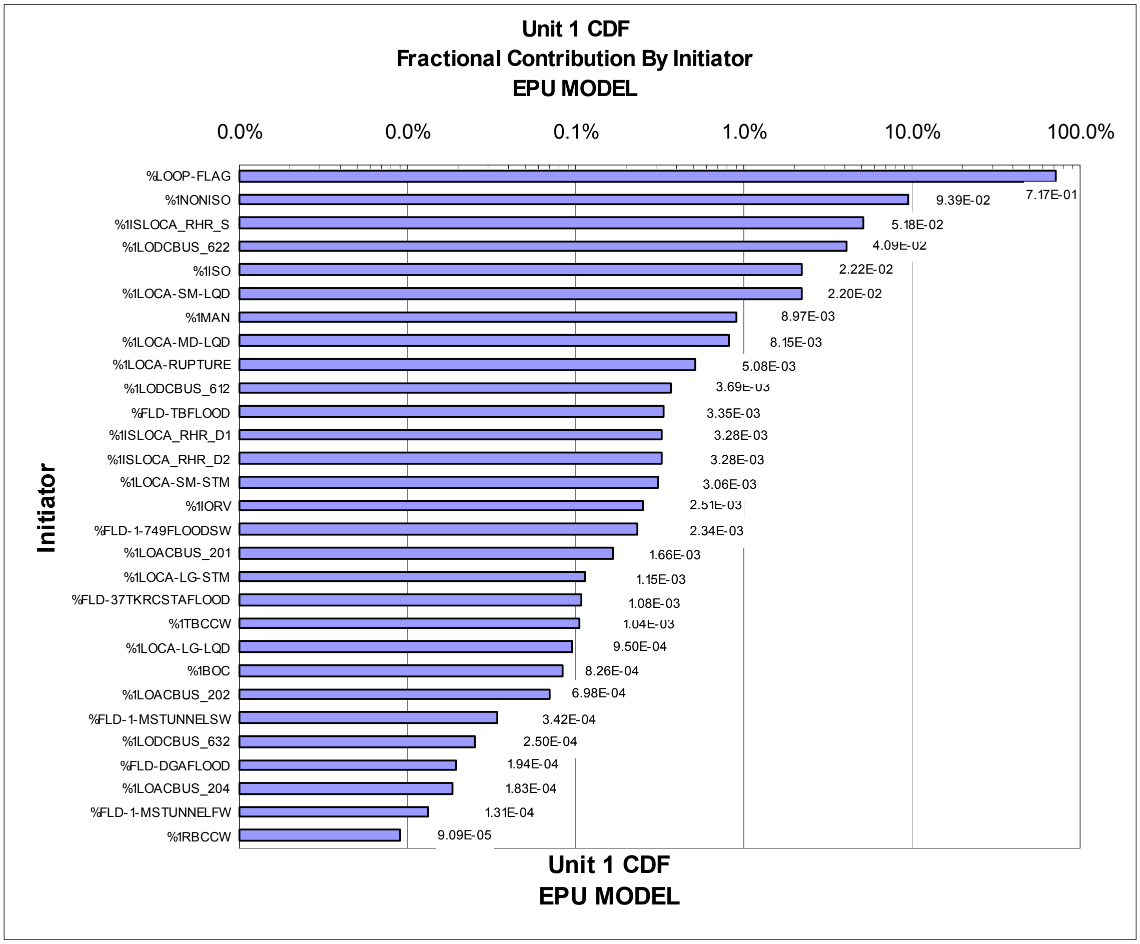
Unit	FEB06preEPU	FEB06EPU
Unit 1	1.86E-06	1.97E-06
Unit 2	1.83E-06	1.94E-06

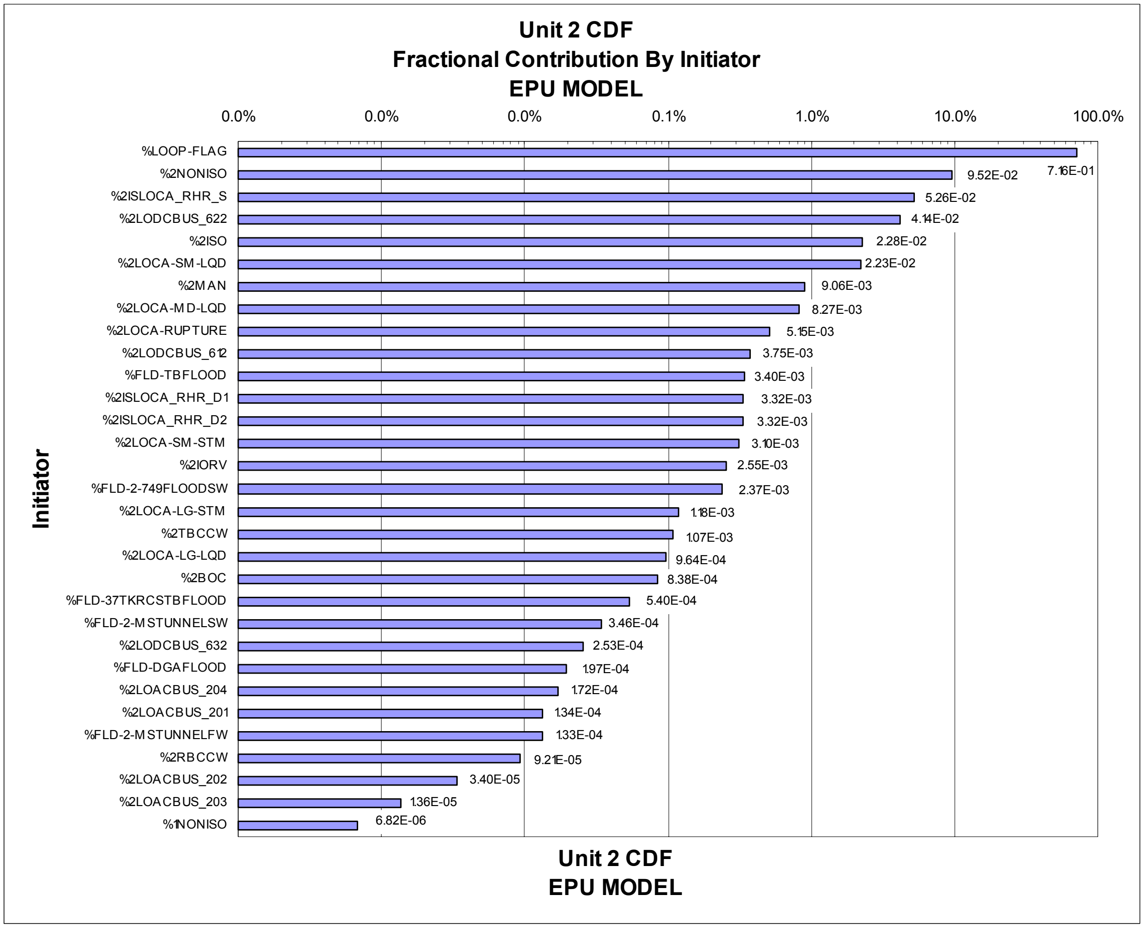
These models are the average maintenance models and includes the plant specific, average maintenance terms that were developed by SSES.

The following graphs summarize the initiating event contributions to CDF for each unit for both pre and post EPU conditions. As shown in the graphs, the loss of offsite power (LOOP) events (%LOOP-FLAG) dominate the profiles for both units. The table following the graphs provides a description of the initiating event names used in the graphs for Unit 1. Unit 2 events are similar.


Unit 1 CDF
Fractional Contribution By Initiator
PreEPU
0.0%
0.0%
0.1%
1.0%
10.0%
100.0%
Initiator
%LOOP-FLAG
7.24E-01
%1NONISO
8.01E-02
%1ISLOCA_RHR_S
5.49E-02
%1LODCBUS_622
4.34E-02
%1LOCA-SM-LQD
2.30E-02
%1ISO
2.04E-02
%1MAN
9.51E-03
%1LOCA-MD-LQD
8.63E-03
%1LOCA-RUPTURE
5.38E-03
%1LODCBUS_612
3.92E-03
%FLD-TBFLOOD
3.53E-03
%1ISLOCA_RHR_D1
3.47E-03
%1ISLOCA_RHR_D2
3.47E-03
%1LOCA-SM-STM
3.23E-03
%1IORV
1.90E-03
%FLD-1-749FLOODSW
1.81E-03
%1LOACBUS_201
1.73E-03
%1LOCA-LG-STM
1.22E-03
%FLD-37TKRCSTAFLOOD
1.12E-03
%1LOCA-LG-LQD
1.01E-03
%1TBCCW
1.01E-03
%1BOC
8.75E-04
%1LOACBUS_202
7.40E-04
%FLD-1-MSTUNNELSW
3.52E-04
%1LODCBUS_632
2.65E-04
%FLD-DGAFLOOD
2.06E-04
%1LOACBUS_204
1.94E-04
%FLD-1-MSTUNNELFW
1.39E-04
%1RBCCW
7.71E-05
Percentage of Unit 1 CDF


Unit 2 CDF
Fractional Contribution By Initiator
PreEPU
0.001%
0.010%
0.100%
1.000%
10.000%
100.000%
Initiator
%LOOP-FLAG
7.24E-01
%2NONISO
8.10E-02
%2ISLOCA_RHR_S
5.57E-02
%2LODCBUS_622
4.40E-02
%2LOCA-SM-LQD
2.33E-02
%2ISO
2.07E-02
%2MAN
9.63E-03
%2LOCA-MD-LQD
8.77E-03
%2LOCA-RUPTURE
5.46E-03
%2LODCBUS_612
3.98E-03
%FLD-TBFLOOD
3.59E-03
%2ISLOCA_RHR_D1
3.52E-03
%2ISLOCA_RHR_D2
3.52E-03
%2LOCA-SM-STM
3.27E-03
%2IORV
1.93E-03
%FLD-2-749FLOODSW
1.83E-03
%2LOCA-LG-STM
1.25E-03
%2TBCCW
1.03E-03
%2LOCA-LG-LQD
1.02E-03
%2BOC
8.88E-04
%FLD-37TKRCSTBFLOOD
5.64E-04
%FLD-2-MSTUNNELSW
3.58E-04
%2LODCBUS_632
2.69E-04
%FLD-DGAFLOOD
2.09E-04
%2LOACBUS_204
1.82E-04
%2LOACBUS_201
1.42E-04
%FLD-2-MSTUNNELFW
1.41E-04
%2RBCCW
7.83E-05
%2LOACBUS_202
3.61E-05
%2LOACBUS_203
1.44E-05
Percentage of Unit 2 CDF


Unit 1 CDF
Fractional Contribution By Initiator
EPU MODEL
0.0%
0.0%
0.1%
1.0%
10.0%
100.0%
Initiator
%LOOP-FLAG
%1NONISO
%1ISLOCA_RHR_S
%1LODCBUS_622
%1ISO
%1LOCA-SM-LQD
%1MAN
%1LOCA-MD-LQD
%1LOCA-RUPTURE
%1LODCBUS_612
%FLD-TBFLOOD
%1ISLOCA_RHR_D1
%1ISLOCA_RHR_D2
%1LOCA-SM-STM
%1IORV
%FLD-1-749FLOODSW
%1LOACBUS_201
%1LOCA-LG-STM
%FLD-37TKRCSTAFLOOD
%1TBCCW
%1LOCA-LG-LQD
%1BOC
%1LOACBUS_202
%FLD-1-MSTUNNELSW
%1LODCBUS_632
%FLD-DGAFLOOD
%1LOACBUS_204
%FLD-1-MSTUNNELFW
%1RBCCW
7.17E-01
9.39E-02
5.18E-02
4.09E-02
2.22E-02
2.20E-02
8.97E-03
8.15E-03
5.08E-03
3.69E-03
3.35E-03
3.28E-03
3.28E-03
3.06E-03
2.51E-03
2.34E-03
1.66E-03
1.15E-03
1.08E-03
1.04E-03
9.50E-04
8.26E-04
6.98E-04
3.42E-04
2.50E-04
1.94E-04
1.83E-04
1.31E-04
9.09E-05
Unit 1 CDF
EPU MODEL


Unit 2 CDF
Fractional Contribution By Initiator
EPU MODEL
0.0%
0.0%
0.0%
0.1%
1.0%
10.0%
100.0%
Initiator
%LOOP-FLAG
7.16E-01
%2NONISO
9.52E-02
%2ISLOCA_RHR_S
5.26E-02
%2LODCBUS_622
4.14E-02
%2ISO
2.28E-02
%2LOCA-SM-LQD
2.23E-02
%2MAN
9.06E-03
%2LOCA-MD-LQD
8.27E-03
%2LOCA-RUPTURE
5.15E-03
%2LODCBUS_612
3.75E-03
%FLD-TBFLOOD
3.40E-03
%2ISLOCA_RHR_D1
3.32E-03
%2ISLOCA_RHR_D2
3.32E-03
%2LOCA-SM-STM
3.10E-03
%2IORV
2.55E-03
%FLD-2-749FLOODSW
2.37E-03
%2LOCA-LG-STM
1.18E-03
%2TBCCW
1.07E-03
%2LOCA-LG-LQD
9.64E-04
%2BOC
8.38E-04
%FLD-37TKRCSTBFLOOD
5.40E-04
%FLD-2-MSTUNNELSW
3.46E-04
%2LODCBUS_632
2.53E-04
%FLD-DGAFLOOD
1.97E-04
%2LOACBUS_204
1.72E-04
%2LOACBUS_201
1.34E-04
%FLD-2-MSTUNNELFW
1.33E-04
%2RBCCW
9.21E-05
%2LOACBUS_202
3.40E-05
%2LOACBUS_203
1.36E-05
%1NONISO
6.82E-06
Unit 2 CDF
EPU MODEL

Event Name	Description
%LOOP-FLAG	LOOP FLAG FOR INITIATING EVENT
%1NONISO	TRIP W/O MSIV CLOSURE
%1ISLOCA_RHR_S	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK
%1LODCBUS_622	LOSS OF 1D622
%1LOCA-SM-LQD	SMALL LIQUID LINE BREAK LOCA
%1ISO	INADVERTENT ISOLATION - MSIV
%1MAN	MANUAL SHUTDOWN
%1LOCA-MD-LQD	MEDIUM LIQUID LINE BREAK LOCA
%1LOCA-RUPTURE	VESSEL RUPTURE OR EXCESSIVE LOCA
%1LODCBUS_612	LOSS OF 1D612
%FLD-TBFLOOD	MAJOR TURBINE BUILDING FLOODING EVENT OCCURS IN U1 OR U2
%1ISLOCA_RHR_D1	INTERFACING SYSTEM LOCA FOR RHR PUMP DISCHARGE DIVISION I
%1ISLOCA_RHR_D2	INTERFACING SYSTEM LOCA FOR RHR PUMP DISCHARGE DIVISION II
%1LOCA-SM-STM	SMALL STEAM LINE BREAK LOCA
%1IORV	INADVERTENT OPENING OF A RELIEF VALVE
%FLD-1-749FLOODSW	ROOM I-500 FLOOD (63%)
%1LOACBUS_201	LOSS OF AC BUS 1A201
%1LOCA-LG-STM	LARGE STEAM LINE BREAK LOCA
%FLD-37TKRCSTAFLOOD	CST A RUPTURES OR RWST RUPTURES (2 TANKS X 1 YEAR)
%1LOCA-LG-LQD	LARGE LIQUID LINE BREAK LOCA
%1TBCCW	INITIATING EVENT FLAG - LOSS OF TURBINE BUILDING CLOSED COOLING WATER 3E-02
%1BOC	BREAK OUTSIDE CONTAINMENT
%1LOACBUS_202	LOSS OF BUS 1A202
%FLD-1-MSTUNNELSW	WING SLAB FLOOD (11%) ROOM I-411
%1LODCBUS_632	LOSS OF 1D632
%FLD-DGAFLOOD	ESW BREAK AT DG A
%1LOACBUS_204	LOSS OF AC BUS 1A204
%FLD-1-MSTUNNELFW	FW BREAK IN WING SLAB
%1RBCCW	INITIATING EVENT FLAG - LOSS OF REACTOR BUILDING CLOSED COOLING WATER

E.2.2 Current Level 2 SSES PRA Model

The FEB05RA model focused on discriminating between large early release frequency (LERF) and non-LERF end states consistent with the ASME Probabilistic Risk Analysis (PRA) Standard (ASME 2003), the Regulatory Guides 1.174 (NRC 2002), 1.177 (NRC 1998b), etc., and the PSA Application Guide (EPRI 1995). However, for license

renewal and EPU, an extended set of radionuclide release categories is desired to support the cost benefit evaluation required as part of the SAMA assessment.

The release end states have been expanded from previous SSES PRA versions to include multiple radionuclide release end states to support the SAMA evaluation by extending the FEB05RA model event trees to consider additional Level 2 phenomenon logic and system based top events.

The frequency of radionuclide release is characterized by the quantification of the integrated Level 1 and Level 2 PRA model event trees. For SAMA, the Level 2 radioactive release frequency event tree end states are delineated by the magnitude and timing bins of the calculated radionuclide release as shown in Table E.2-1.

Integrating the severity and timing categories yields twelve separate event tree release category end states using a two-term matrix (severity, time) as shown in the Table E.2-2.

Each of the event tree end states are assigned to one of these categories and a representative release is assigned to each category. The “H/E” category is assigned as the representative LERF category. The change in frequencies of all of the individual release categories are used as one of the inputs in determining the potential cost-benefit for the SAMA analysis. The baseline release category frequencies for the SAMA model are provided in Table E.2-3 for both pre-EPU and Post-EPU conditions. The baseline source term information for the release categories considered in the SAMA analysis is provided in Tables E.2-4a and E.2-4b for pre-EPU and Post-EPU conditions, respectively.

E.2.3 PRA Model Review and Evolution Summary

The Level 1 and Level 2 SSES PRA analyses were originally submitted to the NRC in December 1991 as the SSES IPE Submittal. Pennsylvania Power and Light’s (PPL 1991) IPE received an NRC safety evaluation report (SER) in 1998. Since the time the IPE was submitted, there have been several extensive revisions produced prior to the Boiling Water Reactor Owners Group (BWROG) Peer Review in 2003. The model that underwent the Peer Review was not an upgrade to the IPE but, a new model based on thermal hydraulic calculations for the current fuel type and current rated power. New event trees were developed based on the calculated accident progression and current emergency operating procedures (EOPs). Subsequent to the BWROG Peer Review, the SSES model was updated to address the comments generated from that review.

The significant, recent reviews of the SSES PRA model include the NRC activities related to the development of the SSES IPE SER and the 2003 BWROG Peer Review. The major findings of these reviews are summarized below.

E.2.3.1 Critical Review Overview

PPL's IPE was submitted to the NRC and received an SER on August 11, 1998. There were three weaknesses identified in the SER, which were related to the following issues:

- The evaluation of sequences with containment failure prior to core damage ended with the assumption of core damage and did not analyze the consequences of these sequences,
- The impact on conditional containment failure probability of some severe accident phenomena and resulting containment failure modes appeared to have been understated,
- The treatment of Interfacing System LOCA (ISLOCA) was not as robust as required.

These issues were addressed and corresponding changes were incorporated into the PRA prior to the 2003 BWROG Peer Review, as described in Section E.2.3.2.

The consensus of the Peer Review team, as stated in the exit meeting, was that the SSES PRA was "top quartile" in the industry. The BWROG peer review provided PPL Susquehanna, LLC (PPL) with Level B, C, D and S Facts and Observations (F&Os). PPL did not receive any Level A F&Os. The definition of each level is listed in the following table.

Importance Level	Definition
A.	Extremely important and necessary to address to assure the technical adequacy of the PRA or the quality of the PRA or the quality of the PRA update process. (Contingent Item for Certification).
B.	Important and necessary to address, but may be deferred until the next PRA update. (Contingent Item for Certification).
C.	Marginal importance, but considered desirable to maintain maximum flexibility in PRA Applications and consistency in the Industry.
D.	Editorial or Minor Technical Items left to the discretion of the host utility.
S.	Considered a major strength of the PRA.

PPL incorporated approximately half of the B level F&Os and some of the C Level F&Os into the FEB05RA model, as described in Section E.2.3.3.

PPL also performed a self-assessment using the guidance included in RG 1.200 (NRC 2004) that supplements NEI 00-02 (NEI 2000). This review indicated the necessity to address some of the remaining ‘B’ open items to adequately support EPU implementation. Other identified ‘Gaps’ to Capability Category II of the ASME PRA Standard (ASME 2003) were judged to not have an impact on the EPU evaluation. The remaining open B level comments were reviewed to determine if any outstanding F&Os had the potential to significantly impact the EPU results. The result of the review is summarized in Table E.2-5. All issues that were identified as important for resolution in the model prior to performing the EPU application were resolved in the FEB06preEPU and FEB06EPU models. It was determined that the remaining items and Gaps would not to have a significant impact on the EPU application and were therefore deferred until the next update.

E.2.3.2 Resolution of IPE SER Weaknesses

Three major weaknesses were identified as result of the NRC’s review of the SSES IPE. As described below, these issues were addressed in subsequent model updates and are no longer open items for SSES.

Identified Weakness #1

“In the licensee’s analysis, the accident sequence progression was terminated if the containment failed prior to core damage; all sequences were then assumed to go to core damage in the reported CDF. Radionuclide releases were not calculated for these containment failures nor was a detailed understanding of the plant response obtained.”

Response

Subsequent to the SER on PPL’s IPE, substantial changes to the event trees were made that addressed the issue of accident sequence progression. In PPL’s Peer Review model and the model used for this submittal, events progress beyond containment failure given no prior core damage. In the case of containment failure and no prior core damage, available sources of injection into the core are evaluated. If injection is successful, the end-state is no core damage and containment failure. If injection is not successful, core damage occurs and a Level 2 release category is assigned depending on the sequence timing and expected magnitude of the release.

The event trees used for the Peer Review and for this submittal include injection from sources outside the reactor building given containment failure and no prior core damage. The success criteria are based on detailed thermal hydraulic analyses. The event trees are also annotated with the timing for a General Emergency declaration and timing for containment failure and core damage, if it occurs. Thus, the sequence can be readily identified as a LERF sequence if appropriate. Additional non-LERF release categories are also assigned in the updated Level 2 model. The event tree logic is reflected in the fault tree model.

Identified Weakness #2

"The impact on conditional containment failure probability of some severe accident phenomena and resulting containment failure modes appear to have been understated. As a result, all early and late containment failures, other than the containment failures resulting from loss of decay heat removal (DHR) discussed in item 1 above, are reported by the licensee to occur in less than one percent of core damage events, including anticipated transient without scram (ATWS) and station blackout.

Appendix 1 to GL 88-20 recommended that licensees consider a maximum coolable debris bed to be 25 cm. For depths in excess of that (as proposed by the SSES IPE) both coolable and noncoolable outcomes should be considered and documented, even in the presence of a water layer provided by the drywell sprays, because of the possibility of the formation of a noncoolable debris crust. Noncoolable outcomes may lead to the occurrence of phenomena such as COPF from noncondensible gas generation due to core-concrete interaction or containment failure from corium attack on the drywell liner/concrete containment boundary (PPL 1991).

The licensee assumed, however, that core debris released from the vessel post-accident will always be quenched on the drywell floor and, consequently, core-concrete interactions with the drywell floor, steel liner, or concrete containment will be prevented, as long as the drywell sprays provide a water pool on the drywell floor. Similarly, core debris attack on other structures, such as the downcomer vents, resulting in suppression pool bypass or loss of pool scrubbing, would not be possible, according to the licensee, given spray operation. Additionally, the licensee did not consider the possible negative effects of water on the drywell floor, such as containment pressurization due to ex-vessel steaming resulting from fuel-coolant interactions."

Response:

Subsequent to the SER on PPL's IPE, substantial changes to the event trees were made that address the issues of containment failure modes. The current SSES PRA model considers the following containment failure modes:

a. Containment Overpressure
b. Containment isolation failure
c. In-vessel steam explosion (Alpha Mode failure)
d. Ex-vessel steam explosion (Shock loading)
e. Direct containment heating (DCH)
f. Failure Induced by Corium Attack on the Containment Structures, including:
    1. Drywell head flange failure
    2. Loss of vapor suppression due to downcomer melt through
    3. Drywell liner melt through
    4. Overpressure failure due to non-condensable gas generation

The Susquehanna containment design is not susceptible to in-vessel and ex-vessel steam explosions. In addition, evidence from NUREG/CR-5623 exists to show that any core debris generated is not expected to cover a uniform area greater than that extending to the innermost ring of downcomers. Therefore, the drywell liner is not susceptible to failure in the event of vessel melt-through. Each of the other containment failure mechanisms is considered in the current PRA model.

NUREG/CR-5623 calculates containment conditions for core melt core-concrete interaction and the production of non-condensable gases. These calculations conclude that containment pressure will remain less than the ultimate pressure capacity, as long as sufficient drywell spray is available to establish a water pool on the drywell floor up to the downcomer overflow. The drywell spray flow must also continue in sufficient quantity to remove decay heat from the corium. This drywell spray requirement is transferred to the event tree model by requiring that the containment spray function be available in sufficient time to generate the required pool on the drywell floor prior to reactor vessel failure.

Under loss of coolant accident (LOCA) sequences, a further requirement for containment integrity is that the vacuum breakers between drywell and suppression chamber are required to operate following the initiation of the containment spray function. It is assumed in the LOCA evaluations that, at the time when drywell spray is initiated, the drywell will be devoid of non-condensable gases and filled with steam from the break. Therefore, the drywell spray will cause a rapid drywell depressurization and

at least one vacuum breaker must operate in order to prevent containment failure resulting from implosion.

Based on this discussion, it is concluded that the current PRA model does include both the coolable geometry issue and the potential negative effects of water vapor and noncondensable gas generation following core melt extrusion from the reactor vessel.

Identified Weakness #3

"The treatment of interfacing systems LOCA (ISLOCA) was characterized as limited in the staff's October 27, 1997, SER. The licensee has not revisited its ISLOCA analysis and, consequently, it remains a weakness."

Response

PPL has fully addressed ISLOCA in the model used for the Peer Review. PPL has performed a formal calculation to evaluate the initiation frequency of an ISLOCA for the following systems:

- RCIC
- HPCI
- Core Spray
- Reactor Water Cleanup
- RHR

PPL has included in the model ISLOCA initiators, which are greater than the ISLOCA cutoff frequency outlined in NUREG-CR-5928 (NRC 1993).

The contribution of ISLOCAs to the CDF is about 6% and the contribution to the LERF is about 66%. The location of the ISLOCA in both cases is from the RHR system.

E.2.3.3 Peer Review Results and F&O Dispositions for the FEB05RA Model

The October 2003 BWROG peer review provided PPL with Level B, C, D and S F&Os; PPL did not receive any Level A F&Os. As part of the next model revision, PPL resolved the Level B F&Os that were determined to be the most significant in their effect on PRA results (more than half of the Level B F&Os) and incorporated them into the FEB05RA model. The remainder of the Level B F&Os were scheduled to be resolved prior to the next scheduled model periodic update. As mentioned in Section E.2.3.1,

these comments were reviewed and addressed to support EPU and SAMA implementation.

The peer review team used NEI draft "Probabilistic Risk Assessment (PRA) Peer Review Process Guidance" (NEI 2000) as the basis for the review.

The Peer Review process uses grades to assess the relative technical merits and capabilities of each technical element and sub-element reviewed. The grades and criteria were developed, in the BWROG program, considering attributes of a PRA necessary to ensure quality, elements of a PRA that are critical to its technical adequacy, and elements needed to support PRA applications. The grades and criteria, which have been adopted for this program, provide guidance on appropriate use of the information covered by the sub-element for risk-informed applications, and convey the ability of the PRA sub-element to support particular types of applications. Four grade levels are used to indicate the relative quality level of each technical element and sub-element based on the criteria at hand. The grading and criteria are:

- Grade 1 – Supports Assessments of Plant Vulnerabilities
- Grade 2 – Supports Risk-Ranking Applications
- Grade 3 – Supports Risk Significance Evaluations w/Deterministic Input (Risk-Informed Decisions)
- Grade 4 – Provides Primary Basis For Application (Risk-Based Decisions)

It is important to note that the PRA does not receive one overall grade. Each element is graded based on the criteria for the element. Then, based on the criteria grades, a summary grade is provided for each of the eleven technical elements.

The minimum grade, the average grade, and the summary grade for each of the eleven elements are listed in the following table along with the overall assessment [extracted from the 2003 Peer Review Report (ERIN 2003)]:

PRA PEER REVIEW REPORT
OVERALL ASSESSMENT

PRA ELEMENT	GRADE BASED ON SUB-ELEMENTS		
	Minimum	Average	Summary
Initiating Events	2	2.86	3
Accident Sequence Evaluation	2	2.92	3
Thermal Hydraulic Analysis	2	3.00	3
System Analysis	3	3.04	3
Data Analysis	2	2.94	3
Human Reliability Analysis (HRA)	2	2.89	3
Dependencies	2	3.00	3
Structural Response	3	3.40	3
Quantification	2	2.97	3
Containment Performance	2	2.57	2
Maintenance & Update	2	2.27	2

Overall Assessment: Based on the PRA Peer Review Team review, the PRA can be effectively used to support applications involving absolute risk determination. The Level 1 PRA is fully supportive of Grade 3 applications when the footnotes identified on sub-elements are dispositioned. Level 2 is a useful screening tool to assess applications.

Areas Requiring Enhancement:

Re-examine the following specific issues.

Conservatisms:

The human reliability analysis (HRA) Peer review identified the quantitative assessment of dependencies among HEPs as an area potential of improvement that could reduce excess conservatisms for absolute risk determination.

Reassess the DCH conditional probability.

Reassess the over-temperature failure assumption used in Level 2.

LERF and CDF definitions.

PRA PEER REVIEW REPORT
OVERALL ASSESSMENT

Non-Conservatisms:

Station blackout (SBO) events may have sequence dependencies not fully accounted for. This may adversely impact the SBO sequence frequency.

Other Issues:

- The accident sequence evaluation should be reviewed to ensure that the key safety functions are included [e.g., consider including reactivity control, safety relief valve (SRV) reset (i.e., no stuck open relief valve (SORV) for ATWS, and control rod drive (CRD) as a long-term "required" injection method] in those sequences that would challenge the safety functions].
- A search for plant-unique uncertainties and the associated sensitivity studies to support the uncertainty ranges should be performed.
- The Level 2 analysis has a number of items that would appear useful to re-examine. These include:
- Inclusion of containment isolation in selected sequences.
- Inclusion of energetic failure modes including hydrodynamic loads.
- Removal of excess conservatisms in the LERF definition.

Areas Recommended For Enhancement: See Facts and Observations sheets for specific recommendations.

E.2.3.3.1 Level B Facts and Observations

In addition to the high level comments discussed above, the SSES Level B Facts and Observations are provided below along with the corresponding resolutions from the FEB05PRA model for information purposes. Amendments to the responses have been added to include the current disposition based on the FEB06PreEPU and FEB06EPU models. The Level C and D F&Os are not provided as they are not considered to have a meaningful impact on the conclusions of the SAMA analysis.

Element AS Subelement 5 Observation 1A INDES 2

250V DC Load Shed

One of the assumptions used in the model is that procedure EO-100-030 is implemented to shed 250V DC loads. There is currently not an explicit HEP in the model to represent the failure of this action and the consequential inability to achieve at least 4 hours of HPCI/RCIC operation. The procedure directs this to be accomplished after 30 min. and before 45 min.

Disposition:

Created new HEP where the operator fails to shed 250VDC loads. This 250VDC load shed only impacts Unit 1. Unit 2 does not require 250VDC load shed because Unit 2 has a separate non-1E battery bank. Incorporated the new basic event into the PRA model and updated the HRA Notebook with all information relevant to this HEP. This F&O and resolution is a duplicate of F&O Index 59.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: AS Subelement: 5 Observation 1B INDEX: 3

Control of HPCI/RCIC

After 4 hours into an SBO, 250V DC may be unavailable, this creates the need to control HPCI and RCIC flow such that they do not trip and require restart. The ability to perform such control actions does not appear to be included as a HEP.

Disposition:

An HEP for operator failure to control level was developed, analyzed, documented, and included in the PRA model. Nothing further required for this F&O.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: AS Subelement: 5 Observation 4 INDEX: 5

ATWS – Sequence TR-6, TR-7

These sequences assume HPCI operated initially but SLC has failed and Manual Rod Insertion (MRI) is underway. If such a scenario could be successful, it would likely make pool temperature above HCL.

The SSES EOPs deviate from the BWROG recommended guidelines by allowing operation under ATWS conditions above PSP and HCL. The consequences of subsequent RPV emergency depressurization due to low RPV water level does not currently account for the plant conditions above PSP and above HCL on the accident sequence impacts.

Disposition:

The ATWS event tree has been revised to require success of high-pressure injection and suppression pool cooling in order to have a successful outcome for sequences where SLCS is failed and MRI is available for reactor shutdown.

Simulation of reactor shutdown with MRI shows that pool temperature is well above the HCTL (Heat Capacity Temperature Limit) and suppression chamber pressure is well above the Pressure Suppression Limit. If high-pressure makeup were to fail in an accident sequence where MRI alone accomplishes shutdown, it is likely that RPV depressurization would cause containment pressure to exceed 82 psig, the pressure at which SRVs close on insufficient pneumatic supply. This would lead directly to core melt, vessel failure, and containment failure.

Venting of the containment at 65 psig would also be a concern in this situation if sufficient time were available to carry out the venting. Venting would disable all low-pressure ECCS due to the harsh environment in the reactor building. Consequently, there are no ATWS success paths that involve failure of high-pressure makeup and SLCS, which is reflected in the event trees.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: AS Subelement: 5 Observation 10 INDEX: 11

The RPT is credited in ATWS to prevent early core damage. There is logic to generate an RPT on Level 2, EOC turbine trip[1], and high RPV pressure. The Level 2 trip occurs too late to be effective in preventing very high RPV pressure under certain accident sequences. Therefore, it should not be credited in the model[2]. The risk model credits the high RPV pressure trip and the EOC RPT. The present structure of the model, has these two trips as redundant methods for the RPT. The fault tree should be revised for the RPT to remove the EOC RPT for non-turbine-trip events. The PRA group identified this would be incorporated into the model.

[1] Turbine stop valve position.
[2] This has been confirmed by the PRA group.

Disposition:

PPL agrees with the comment that the Rx level 2 trip will come in too late to be effective for mitigating an ATWS, and that the EOC - RPT (End Of Cycle - Recirculation Pump Trip) is ineffective for non-turbine-trip events.

The resolution of the Rx level 2 issue requires no changes to the RPT logic. The fault tree does not credit Rx level 2 for RPT. However, Rx level 2 was credited in the PRA for automatic ARI initiation. PPL's review of level 2 for ARI automatic initiation indicated that this input should be removed, since the reactor may not reach level 2 for some ATWS transients (e.g., those with feedwater available. Hence, the Rx level 2 gates were removed as inputs from the ARI logic gates.

The resolution of the EOC-RPT issue required adding input to fail the EOC-RPT "OR" gate for non-turbine-trip events. Gate %1MSIVATWS was added as input to EOC-RPT. %1MSIVATWS is an "OR" gate including all initiators that would close the MSIVs (i.e. non-turbine-trip events).

The described changes have been incorporate into the current PRA.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: AS Subelement: 6 Observation 1 INDEX: 13

SRVs

The successful prevention of overpressure failure under ATWS conditions requires RPT and SRVs opening. The ATWS event tree should include both.

Disposition:

The ATWS event tree has been revised to require successful RPT and SRV operation in order to have a successful outcome. The ATWS event tree in the revised Event Tree Notebook contains a branch which goes to core damage, vessel failure, and containment over-pressure failure if the ATWS RPT and a sufficient number of SRVs are not both successful.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. The evaluation for the number of SRV failures that are acceptable in ATWS conditions has been reassessed for EPU conditions as described in the updated Event Tree Notebook.

Element: AS Subelement: 6 Observation 3 INDEX: 15

ATWS (E.T. Notebook p. H.2 and p. H.21) Sequence TR-6-1

End State sequence TR-6-1 appears to be optimistic given the fact that no reactivity control method has been successful.

It is judged important to incorporate an evaluation of a successful reactivity control method before assigning success.

Disposition:

A requirement for reactivity control, either SLCS or MRI, was added to the ATWS event trees replacing TR6-1 with three new sequences. The three new sequences are: level reduction with SLCS success (no core damage), level reduction with SLCS failure and MRI success (no core damage), and level reduction with both SLCS and MRI failure (core damage).

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: AS Subelement: 6 Observation 4 INDEX: 16

ATWS

There are a number of functional failures that are not addressed in the ATWS event tree. These include the following:

- Reactivity Control for Main Condenser Available
- Failure of all high pressure and low pressure injection

Initiation of Containment Vent and consequential failure of ECCS is not asked on Branches 27, 29, 37, and 39 of the ATWS tree where pressure is above 82 psig. The procedural direction to open the containment vent does not appear to be accounted for in the ATWS scenarios for Branches 27, 29, 37, and 39. This could lead directly to core damage due to the loss of ECCS makeup.

Disposition:

1. A requirement for reactivity control, either SLCS or MRI, was added to the ATWS event trees replacing TR6-1 with three new sequences. The three new sequences are: level reduction with SLCS success (no core damage), level reduction with SLCS failure and MRI success (no core damage), and level reduction with both SLCS and MRI failure (core damage).

2. A branch corresponding to failure of all high-pressure and low-pressure injection has been added to the ATWS event tree. The additional branch is Branch 34 described in the Event Tree Notebook.

3. On ATWS Event Tree branches 27 and 29, the containment vent would not be opened because core damage from power/flow instabilities exists on these branches. Plant procedures recommend against containment venting with large core damage, however, the venting decision still resides with the TSC. As such, venting with prior core damage is conservatively not credited in the PRA model. Similarly, core damage exists on Branches 37 and 39. On branch 37, core damage exists from the operator failing to throttle low-pressure injection after reactor depressurization. While on branch 39 of the ATWS event tree calculation, core damage exists from operation of a critical reactor in a depressurized state without reactivity control (SLCS is failed and MRI is too slow to stabilize core when depressurization is required).

4. Branch 27 of the peer-reviewed ATWS event tree is equivalent to branches 39 and 41 in the revised event tree. On branches 39 and 41, core damage exists and, as discussed above, the containment would not be vented at 65 psig. The equivalent of branch 29 in the peer-reviewed event tree does not exist in the revised ATWS event tree because credit is no longer taken for MRI when core damage exists. Branches 37 and 39 in the peer-reviewed event tree correspond to branches 36 and 22, respectively, in the revised event tree. Branch 36 goes to LERF because failure of the operator to control low-pressure injection is now assumed to lead to loss of the RPV and containment integrity. Branch 22 also goes directly to LERF because credit is no longer taken for MRI in scenarios involving RPV depressurization and failure of SLCS. In scenarios where SLCS is failed and RPV depressurization is required, containment pressure will likely exceed 82 psig, the pressure at which SRVs go closed. Closure of the SRVs will cause loss of low-pressure injection, which will lead to vessel failure and containment over-pressurization.

EPU/SAMA PRA Model Comment: For the most part, the original disposition is still applicable. However, the branches have been renumbered and expanded to include more than just LERF and non-LERF end states as described in the updated event tree notebook.

Element: AS Subelement: 7 Observation 1 INDEX: 18

MRI as an option for successful control of reactivity requires control rods to be individually inserted into the core.

There may be mechanical common cause failure modes that defeat both the scram function and MRI. The combination of all of these mechanical modes of failure (e.g., channel obstruction possibly due to high fuel burn-up effects or interference due to movement of vessel internals) should be factored into the assessment regarding whether MRI offers a truly independent method of reactivity insertion.

Disposition:

Previously at Susquehanna, control rod friction due to channel bow was identified as a potentially significant issue. Although there is no expectation that channel bow would prevent control rods from inserting to at least notch position 02 during a scram, it could cause significant degradation in the insertion speed when rods are driven manually using the CRD system. Calculations show that there is little margin available to the containment venting pressure (65 psig) in an isolation ATWS where SLCS is failed and shutdown is achieved by MRI (manual rod insertion). If control cell friction causes rods to insert significantly slower than the 60 sec/rod, then the containment will reach the venting pressure before hot shutdown is achieved. Venting of the containment would lead to failure of RCIC, HPCI, and all low-pressure ECCS. In the ATWS event tree, these sequences proceed to LERF. In order to account for failure of MRI to achieve shutdown before the containment vent pressure is reached, a failure probability of 0.5 associated with control cell friction is included in the MRI fault tree. The probability of MRI failure due to movement of vessel internals is expected to be orders of magnitude smaller than for channel bow, and therefore, this effect is already included in the specified failure probability of 0.5.

Discussion addressing MRI failure due to high control cell friction has been included in the Event Tree Notebook.

EPU/SAMA PRA Model Comment: Based on MAAP calculations for both pre-EPU and EPU conditions and a revised success criteria requirement to maintain the pool temperature below 260^{O}F for early ATWS conditions, MRI is not credited for success at all in these scenarios. MRI is only credited for success if the condenser is maintained available.

Element: AS Subelement: 7 Observation 4 INDEX: 21

RPV Rupture

The excessive LOCA evaluation has been included as an initiating event in the quantification. Core damage and LERF is assumed. This is conservative because core spray would be a potential success for prevention of core damage by design of the core spray system. Containment should remain intact and capable of mitigating the event, i.e., vapor suppression is adequate for mitigation of the initial pressurization for the spectrum of excessive LOCAs, except possibly the largest of postulated instantaneous ruptures of the RPV.

Disposition:

The evaluation for peak containment pressure following a complete reactor vessel rupture has been written into the event tree notebook (Appendix O). The conclusion is that peak containment pressure exceeds 250 psig following complete reactor vessel rupture, therefore, reactor vessel rupture leads directly to LERF. The frequency for reactor vessel rupture has been documented in the initiating event notebook.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. Additionally, the frequency of this initiator has been re-evaluated to be 1.0E-8/yr instead of 1.0E-7/yr for consistency with many other industry BWR PRA models.

Element: AS Subelement: 8 Observation 3 INDEX: 24

ATWS Event Tree (Appendix H) Section H.23

The discussion of the low pressure makeup use in ATWS response is subject to the following comments:

- The success of LP injection conflicts with discussions in Section 2.8 of the main report.
- The sequences with controlling RPV level too low are neglected as probabilistically insignificant,

The assertion that containment failure can be prevented even though there is a loss of control of low pressure injection would appear optimistic without significantly more

analysis regarding boron washout, RPV integrity during the reactivity excursion, and the power level following loss of low pressure injection control.

Disposition:

1. The conflict between the discussion in Section 2.8 of the Event Tree Notebook and the success criteria for low-pressure injection during ATWS appears to be caused by unclear wording in Section 2.8. Based on wording in the EOP calculation that formed the basis of the event tree success criterion, it could have been concluded that use of LP ECCS always leads to early containment failure and core damage regardless of RPT success, but this was not the intent. The wording in Section 2.8 has been clarified to indicate that low-pressure makeup cannot prevent core damage if the RPT is failed.

2. Accident sequences that lead to core damage from insufficient low-pressure injection have been added to the ATWS event tree. The ATWS event tree also includes sequences that lead to core damage if the operator fails to take control of LP RPV injection.

3. The ATWS event tree has been revised to specify core damage, vessel failure, and COPF if the operator fails to take control of low-pressure makeup.

EPU/SAMA PRA Model Comment: For the most part, the original disposition is still applicable. Additionally, the sequence modeling following core damage has been expanded to include more than just LERF and non-LERF end states as described in the updated event tree notebook.

Element: AS Subelement: 9 Observation 1 INDEX: 26

Injection Without Heat Removal

Sequences involving no available heat removal result in SRVs reclosing as containment pressure exceeds 82 psig. For such sequences, a high pressure injection source is required for core damage prevention. CRD is such a viable long term injection source.

CRD should be credited consistently in the ability to prevent core damage when no heat removal is available and adequate core cooling has been maintained for an extended time by other means.

For TR-3 Branch 35 – only CRD is a success?

For TR-8 Following Branch 14 – Should CRD be credited as a success?

On branch 35 of TR-3, any of the following are currently credited as success: 1 CRD pump, condensate pump, fire pump, or RHRSW pump. This appears incorrect since the SRVs would reclose on high containment pressure causing SRVs to close and the RPV to repressurize. For TR-3 Branch 35, only CRD is capable of injection prior to containment overpressure failure because the RPV repressurizes. This node should be re-evaluated because it apparently credits a low pressure system as a success (i.e., RHRSW).

On branch 14 of TR-8, availability of 1 CRD pump would provide success, but at this time it is only credited on Branch 1 along with the other low pressure injection systems. The fact that CRD will continue to inject after SRVs close on High DW pressure is not included in the event tree logic. It is recommended to include CRD as a separate Top, after the containment vent top. If CRD is available and the vent fails, then core damage could be avoided on the COPF branch. For TR-8, CRD would be a success following Branch 14. This should be credited. This will reduce conservatism in this sequence. A branch for late injection should be added to credit CRD here.

PPL indicated that this is currently under investigation to be added to the model. Note CRD pumps are located in the Turbine Building and are therefore not subjected to the adverse environment in the R.B. following vent or containment overpressure failure (COPF).

Disposition:

Event Tree TR-2, High-pressure boil off, has been modified to include a top event which checks for availability of 2 CRD pumps to save the vessel in scenarios where HPCI, RCIC, FW, and ADS are failed.

Success criteria for extended high-pressure makeup (HP makeup after 4 hours) in the Event Tree Notebook have been revised to include 2 CRD pumps. Two CRD pumps can maintain the core covered at high reactor pressure for times greater than 4 hours.

Therefore, the extended high pressure makeup top event (LATE_INJ2) has been revised to include functional success (i.e., no core damage) if 2 CRD pumps are available in sequences where the vent fails and SP Cooling is unavailable. Failure of the containment vent leads to DW pressure >82 psig which causes SRVs to close on insufficient gas supply pressure. The reactor repressurizes until SRVs open in safety mode via springs. Injection from 2 CRD pumps prevents core damage in sequences of

this type. LATE_INJ2 has been revised to fail injection from Condensate, RHRSW, and fire pumps if the vent fails because SRVs will close and reactor will repressurize. This revision has been incorporated into the event trees (TR-3, TR-5, and TR-8).

It is not necessary to check for availability of CRD injection after branch 14 on TR-8 because extended high-pressure makeup (high-pressure makeup after 4 hours) has been revised to be successful if 2 CRD pumps are available (see Revision 5 to §A.9). Since it has already been determined that extended high-pressure makeup is failed before TR-8 is entered (determination is made on branch 10 of main transient tree in Appendix A), it is not necessary to check for availability of 2 CRD pumps again after branch 14 on TR-8.

EPU/SAMA PRA Model Comment: For the most part, the original disposition is still applicable. Additionally, all of the success criteria have been re-examined and re-developed using MAAP as described in the updated event tree notebook.

Element: AS Subelement: 22 Observation 1 INDEX: 31

Core Damage

The definition of core damage is critical to the quantification process and the understanding of the resulting risk measures. (As background, see Attachment AS-22A)

The PSA Applications Guide offers a core damage definition of the following:

> A state of "Uncovery and heatup of the reactor core to the point where prolonged clad oxidation and severe fuel damage is anticipated."

The ASME PRA Standard provides an example definition:

> Collapsed liquid level less than 1/3 core height or code-predicted peak core temperature >2,500^{O}F (BWR)

Finally, an alternative definition of severe core damage used in many BWR PRAs is:

> RPV water level below 1/3 core height
>
> AND
>
> Core nodal temperature (using a nodalization like MAAP) to be greater than 1800°F for more than 1 min.

To this could be added the criteria regarding excessive reactivity insertion to require it to be less than 280 cal/sec.

The Susquehanna PRA uses a core damage definition for ATWS events that:

NEDE-24222 demonstrates significant margin to 10 CFR 50.46 fuel limits for non-oscillation ATWS event and these are not considered core damage events in the Susquehanna PRA. However, due to the potential for fuel cladding dryout and clad melt, any ATWS which exhibits unstable core power oscillations is assumed to lead to gross clad failure in multiple fuel pins and is defined as a core damage event.

The above definitions are quite close and all are generally consistent. The Susquehanna definition is the most restrictive and results in the possibility of assigning “core damage” to states where there is large flow/power oscillations (“instabilities”) due to ATWS conditions.

Disposition:

A formal calculation was performed to document a revised ATWS core damage criterion for use in the PRA. This criterion is related to the amount of time before feedwater flow is reduced to suppress large power oscillations that can result in excessive cladding temperatures. PPL also defines core damage as core nodal temperature greater than 1800°F.

EPU/SAMA PRA Model Comment: The scenarios in question that result in unstable core power oscillations that are assumed to lead to gross clad failure in multiple fuel pins have been redefined as fuel damage events (rather than core damage events), and are not included in the reported core damage frequency. This is more consistent with standard BWR industry practice. These sequences are maintained, however, in the Level 2 model evaluation to determine their impact on the release characterization.

Element: DA Subelement: 15 Observation 2 INDEX: 130

Conditional LOOP

LOOP given a scram and LOOP given a LOCA event have not been included in the model.

Disposition:

The fault tree was revised to incorporate the conditional LOOP given LOCA and LOOP given a trip. The conditional probability for LOOP given LOCA is 2.4E-2 and for LOOP given plant trip is 2.4E-3. The referenced letters from the Office of Nuclear Regulatory Research provide the bases for these numbers. The Kuritzky letter (June 14, 2002) provides a basis for the LOOP given plant trip. The Thadani letter (July 31, 2002) establishes a factor of 10 difference between the two conditional probabilities with the LOOP given LOCA being 10 times higher than LOOP given plant trip. Therefore the conditional probability of a LOOP given a LOCA is 2.4E-2. Erin Engineering is also using these values in the risk models for the Exelon plants.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: DE Subelement: 8 Observation 1 INDEX: 45

2nd DC Bus Failure

The CCF of a 2nd DC Bus failing given failure of the first is considered underestimated. Consider use of NUREG-0666 or alternative to assess.

1. Common Hardware issues
2. Common Environment
3. Crew error is post initiator repair actions

Disposition:

The final analysis of the F&O concludes that the CCF value used in the model is adequate.

The CCF number used in the model is not directly comparable to the value listed in NUREG – 0666. The NUREG – 0666 value, 6E-5, for the CCF of two buses failing is a probability for two buses failing per reactor year and is considered the total probability of two buses failing. The total probability is the sum of the probability of A bus failing and the CCF probability for B bus failing plus the probability of B bus failing and the CCF for the A bus. The two bus CCF value used in the SSES model is 9.88E-9. This number is based on CCF multiplier from NUREG/CR-5485 adjusted for run time common cause

failure by dividing the Table 5-11 value by 2 and the independent failure rate of 1.166E-7, reference EC-RLIB-0504 p. 18.

To make a valid comparison, the model number will be adjusted for total probability and expressed in terms of a yearly frequency. Also NUREG – 0666 only addresses a CCF of two buses while the model has CCF for 2, 3, and 4 buses. The CCF for the 3 and 4 buses failing must be added to the CCF for the two buses failing since any failure mode that can fail 3 or 4 buses will also fail two buses.

Model Data

CCF for 2 of 4 buses 9.88E-9

CCF for 3 of 4 buses 4.67E-9

CCF for 4 of 4 buses 2.59E-8

CCF for 24 hours	Total CCF probability for 24 hours	Total CCF probability for one year
CCF probability for 2 of 4 buses * # of combinations of 2	9.88E-9*6 = 5.93E-8	
CCF probability for 3 of 4 buses* # of combinations of 3	4.67E-9*4 = 1.87E-8	
CCF probability for 4 of 4 buses* # of combinations of 4	2.59E-8*1 = 2.59E-8	
Total	1.04E-7	1.04E-7*365= 3.79E-5

Hence, the equivalent “model” CCF is 3.79E-5 and is somewhat lower than the NUREG – 0666 value of 6E-5. However, the NUREG number includes common cause due to closing a tiebreaker between DC buses, which is cited as causing most of the two bus failures. Since SSES does not have any tiebreaker between DC channels, this failure mode does not need to be considered. Recognizing that “most” dual failures were attributable to closing the bus tiebreaker it can be reasonably assumed that the other dual bus failures would have amounted to less than 3E-5 per year. Therefore it is concluded that the SSES dual DC bus failure CCF value of 3.79E-5 compares well with the value from NUREG – 0666, 3E-5, and does not need to change as a result of this F&O. Thus, no change to the model is required.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: HR Subelement: 10 Observation 1 INDEX: 53

MRI

The model takes significant credit for Manual Rod Insertion (MRI). SSES has made a plant modification to make this action more efficient and easier to perform. This is a very positive reflection of the active risk management program at PPL.

The MRI action has been reassessed with revised timing by PPL reflecting the power uprate condition and the latest T&H calculations. The HEP was readjusted using the IPE HRA methods to reflect the latest timings (time available). However, the following items are considered not to have been assessed as part of the analysis:

Confirmation of the feasibility of the assumed manipulation and diagnosis time by simulator observation.

Confirmation that sufficient manpower is available within the time frame.

Confirmation that the T&H case performed adequately models that situation. Specifically, for the events involving MSIV closure, does it include FW coastdown,

enhanced CRD injection, maximum HPCI and RCIC flows

Failure of CST refill

Finally, the success of MRI in overcoming the mechanical common cause failure is difficult to assess and has not been attempted by other BWR utilities. It involves an assessment of the conditional failure probability of MRI to insert control rods given a mechanical common cause failure to scram has occurred due to the following:

Core barrel tilted or loose and was the cause of the control rod and fuel movement that caused binding of the control rods.

Other mechanical failures that interfere with control rod movement.

Disposition:

1. Based on simulator data (seventeen data points) for MRI during an ATWS, MRI initiation times range from 5 minutes to 12.5 minutes with only one data point exceeding 12 minutes. In the PRA, Manual Rod Insertion must begin by 12 minutes or it is considered to be failed. The operator failure rate for initiation of MRI within 12 minutes is specified as 0.061 in the PRA (Susquehanna Human Reliability Analysis Notebook). This error rate shows excellent agreement with the available simulator data. Using a lognormal distribution, the error rate based on simulator data is 0.066.

2. Simulator exercises demonstrate that sufficient manpower would be available in the control room to initiate MRI during an ATWS event.

3. Thermal-hydraulic calculations for reactor shutdown via MRI account for continued feedwater injection after the MSIVs are closed. In a SABRE code analysis, feedwater continues to inject to the RPV for 100 seconds after the MSIVs are closed. At 100 seconds into the event, the SABRE model indicates that steam line pressure decays to the point where it can no longer power the feedwater turbines. As discussed in calculations supporting the Emergency Procedures, successful shutdown via MRI requires operator action to throttle HPCI injection by 20 minutes. Prior to 20 minutes, full HPCI and RCIC flow (5600 gpm) is assumed. CRD flow is not included in the SABRE Run; however, the CRD injection rate is very small (63 gpm) compared to full HPCI and RCIC flow (5600 gpm). Success of MRI also requires makeup to the CST within 18 minutes using demineralized water transfer pumps and a condensate pump.

4. The PRA has been revised to include failure of MRI due to control cell friction caused by channel bow. MRI failure due to channel-bow induced friction is deemed possible and its probability is specified as 0.5. The probability of MRI failure due to core barrel tilt is expected to be orders of magnitude smaller than that assigned for channel bow, and therefore, this effect is already included in the specified failure probability of 0.5.

EPU/SAMA PRA Model Comment: Based on MAAP calculations for both pre-EPU and EPU conditions and a revised success criteria requirement to maintain the pool temperature below 260^{O}F for early ATWS conditions, MRI is no longer credited for success at all in these scenarios. MRI is only credited for success if the condenser is maintained available.

Element: HR Subelement: Observation 3 INDEX: 56

MANUAL LOCAL RECOVERIES

There is extensive use of local manual recoveries in the assessment of RHR for suppression pool cooling and RHRSW for very late RPV injection. The following 6 items are of note:

1. The HEPs apply at long times

2. The HEPs are quite low (6E-4)

   <u>**Disposition**</u>: Both observations are correct. All non-ATWS sequences in the PRA model require local valve manipulation at a time period of greater than 5hrs. Applying Table 5-54 of the Human Reliability & Safety Analysis Handbook; Gertman

& Blackman; 1994, the data only goes out to 300 minutes. For HEP evaluation >300 minutes, as is the case in our PRA model, the reference instructs use of the 300 minutes human error probability of 6E-04. For ATWS sequences that would require valve manipulation <300 minutes, values are used from the same referenced table for the appropriate time. The ATWS valve recovery times are logically differentiated in the model as required per the sequence into HEP values corresponding to 2, 3.4, and 5 hours. No model changes required.

3. The HEPs need to be dependent on the HEP for suppression pool cooling initiation (i.e., applies to the use of HEPs for RHRSW injection initiation)

   <u>Disposition</u>: An extensive HEP dependency analysis was performed on the PRA model. All significant dependent HEP combinations (HEP combinations recurring in the top 1500 cutsets) have been analyzed and incorporated into the PRA model.

4. The access, cue, timing, training, manipulation time need to be addressed for each valve or group of valves under the assumed conditions.

   <u>Disposition</u>: The HEPs given to these groups of valves rely not only on the research conducted by Gertman and Blackman (Human Reliability & Safety Analysis Handbook; Gertman & Blackman; 1994), but also on the large time available to complete the local recovery based on thermal-hydraulic accident analyses performed. Manipulation time is assumed negligible when compared to available time. Operator qualification is assumed to be sufficient training (also based on available time).

   Valve use and access is described in parts 5 and 6 of this response.

5. Specifically, has the valve been physically manipulated locally to demonstrate that it is feasible to accomplish the assumed action.

   <u>Disposition</u>: The valves have been physically manipulated locally at least once during start-up testing.

6. A specific access related issue that should be addressed on an accident sequence specific basis is the following related to high radiation:

6a. For ATWS scenarios it should be assumed that noble gases are present in the containment causing both shine and leakage related radiation in the reactor building. Under such conditions, access to the SPC return valves and RHR HX valves may be compromised. (See HR-12-4)

6b. For core damage events, the HEPs for local action are even more in question because of the high radiation environment likely to exist.

   <u>Disposition</u>: High radiation considerations in questions 6, 6a, and 6b have been handled as follows: Manual valve recoveries have been logically updated in the

model as guaranteed failed in sequences where core damage occurs prior to valve recovery via local manipulation. The assumption in the PRA model is that operators will not operate the valves locally if core damage has occurred.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. Additionally, the HEPs and dependent HEPs have been updated for EPU conditions as described in the HRA notebook.

Element: HR Subelement: Observation 4 INDEX: 57

ATWS – RHR Recoveries-Local Manual Actions

For ATWS, we cannot preclude core fuel perforations and radiation in the containment. This plant state may preclude crew actions to effectively complete the local action because of health physics concerns i.e., high radiation to personnel.

Disposition:

The PRA model was changed such that no credit is given for manual recovery of Rx Bldg valves if core damage has occurred. Impact on U1 & U2 PRA models determined to be minimal upon implementation and sensitivity analysis. Manual recovery of Rx Bldg valves is credited if core damage has not occurred.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: HR Subelement: 16 Observation 1 INDEX: 58

CONTROL OF HPCI/RCIC

After 4 hours into an SBO with successful load shed, 250 VDC may be unavailable. This creates the need to control HPCI and RCIC flow such that they do not trip and require restart. The ability to perform such control actions does not appear to be included as an HEP.

This same issue may also be present prior to 4 hours in an SBO w/o successful 250V DC load shed.

Disposition:

An HEP for operator failure to control level was developed, analyzed, documented, and included in the PRA model. Nothing further required for this F&O.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: HR Subelement: 16 Observation 2 INDEX: 59

250 VDC LOAD SHED

One of the assumptions used in the model is that procedure EO-100-030 is implemented to shed 250VDC loads. There is currently not an explicit HEP in the model to represent the failure of this action and the consequential inability to achieve at least 4 hours of HPCI/RCIC operation.

The procedure directs this to be accomplished after 30 min and before 45 min.

Disposition:

Created new HEP - Operator fails to shed 250VDC loads. This 250VDC load shed only impacts Unit 1. Unit 2 does not require 250VDC load shed because Unit 2 has a separate non-1E battery bank. Incorporated new basic event into the PRA model and updated the HRA Notebook with all information relevant to this HEP. This F&O and resolution is a copy of F&O Index 2.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: HR Subelement: 17 Observation 1 INDEX: 60

Recovery

Manual manipulation of valves has been included in the model with very high reliability.

The valves and their manipulation need to be examined for:

1. Accessibility

2. Time Available
3. 3. Cue
4. 4. Time Required
5. 5. Environment

These performances shape factors are not currently documented in the HRA.

Disposition:

This F&O is covered by F&O Index 56. The analysis and actions performed to resolve the F&O Index 56 correspondingly resolve this F&O as well. See resolution to F&O Index 56.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: HR **Subelement:** 26 **Observation** 1 **INDEX:** 65

ATWS HEP DEPENDENCY (see HR-26-2)

The HEPs that model response to ATWS may have dependencies that are not yet explicitly addressed. These dependencies can be incorporated into the model by:

Making the actions dependent (conditional); “hardwire” the conditional probabilities

OR

Performing a second HEP dependent sensitivity case with RPS mechanical failure set higher than 2.1 E-6. This will allow the ATWS HEPs to be included in the top cutsets examined.

Disposition:

A full SSES PRA HEP dependency analysis was completed for all HEPs in the model (which includes ATWS HEP dependencies addressed/questioned in this F&O.) All updated HEP dependency analyses are documented in the HRA notebook and are included in the model.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. Additionally, the HEPs and dependent HEPs have been updated for EPU conditions as described in the HRA notebook.

Element: HR Subelement: 26 Observation 2 INDEX: 66

ATWS (see HR-26-1)

ADS inhibit and SLC Failure may need to be treated explicitly

They can show up together. Their combination may not have been captured in the dependent HEP assessment.

(There may be a need for a diagnosis error that applies to all ATWS HEP combinations.)

Disposition:

A full SSES PRA HEP dependency analysis was completed for <u>all</u> HEPs in model (which includes the specific HEP dependencies addressed/questioned in this F&O.) All updated HEP dependency analyses are documented in the HRA notebook and included in the model.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. Additionally, the HEPs and dependent HEPs have been updated for EPU conditions as described in the HRA notebook.

Element: IE Subelement: 5 Observation 3 INDEX: 73

Initiating event Loss of Drywell Cooling (LDWC) is not modeled because "The drywell chillers provide cooling to the drywell during normal operation. If they are lost, a manual SCRAM or, ultimately an automatic SCRAM, on high drywell pressure will occur. No safety systems are affected. Loss of the drywell chillers is considered to be bounded by the turbine trip initiating event."

But, HPCI initiation occurs from High Drywell Pressure Relays 95E211K5A/B and 95E211K6A/B. This initiating of HPCI would more likely cause a level 8 trip, which causes a feedwater trip.

Disposition:

Loss of drywell cooling leads directly to high drywell pressure resulting from the increased drywell temperature. The high drywell pressure condition causes the HPCI system to initiate and begin reactor vessel injection, an event that would be very similar to an inadvertent HPCI startup initiator. The inadvertent HPCI startup initiator is evaluated in Section 15.5 of the SSES FSAR. The reload licensing analysis evaluation of the inadvertent HPCI start event from rated conditions concludes that the level control system is expected to reduce feedwater flow in time to prevent reactor vessel level from reaching the level 8 trip setting.

The reload licensing analysis also concludes that the inadvertent HPCI start at normal power level is similar to the loss of feedwater heating (LFWH) event. This conclusion is based on the fact that the feedwater flow reduction resulting from decreased feedwater demand combined with the low injection enthalpy of the water injected by the HPCI system will cause an increase in core inlet subcooling. In the event that the Level 8 trip and subsequent scram does not occur (as the full power analysis shows), the reactor stays at power and the event is not considered an initiating event for the PRA. If the lower power HPCI initiator causes a Level 8 trip, the result is a turbine trip. The inadvertent HPCI initiation event initiator is already classified as a turbine trip with bypass initiator in the PRA (see Appendix A, Section 2.6 of the Initiating Event Notebook, EC-RISK-1121, revision 0), thus, no further action is warranted.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: IE Subelement: 6 Observation 2 INDEX: 75

Dual Unit Effects

Dual unit effects and insights with a single diesel operating should be included in the summary notebook discussion (as sensitivities if desired) to address:

Effects of switching RHR high AMP loads

On RHR Motors

On D/G

RWST adequacy to support

Loss of SW on Unit 1

Loss of Instrument Air on Unit 1, should also be discussed

Disposition:

A dual unit shutdown with less than 4 diesels would require cycling the RHR pumps on and off in each unit for suppression pool cooling due to the present electrical restrictions on the bus and DG. Only one RHR pump is presently allowed to be on any one channel for both units. This process is required per Susquehanna Operating Procedure. Thus, the dual unit shutdown will not change the generated cutsets (results). This discussion covers the dual unit effects on:

- Effects of switching RHR high AMP loads
- On RHR Motors
- On D/G

The dual unit effects of requiring makeup from the RWST have been addressed in the event tree notebook in the development of the success criteria. Therefore the dual unit effects on the RWST have been addressed.

The loss of service water and the loss of instrument air on Unit 1 really have no dual unit effects. There is outage capability to cross tie certain service water loads between units but this cross tie is normally closed and is not credited in the PRA. The instrument air system can be cross-tied between units but this is not normally done and again is not credited in the PRA. Therefore there are no dual unit effects on service water and instrument air.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: IE Subelement: 15 Observation 1 INDEX: 92

A grid reliability of GR1 was selected for Susquehanna. Do calculations and procedures exist that verify black start capability from off-site power within 30 minutes?

Disposition:

The Initiating Event Note Book only cites GR1 as one of two comparisons to the grid loss frequency used in the model. The main comparison was against actual PJM experience. As discussed in the response to F&O Index Number 88, the Susquehanna LOOP initiation frequencies and recovery times provide reasonable results compared to the results which would be obtained if INEEL/EXT-04-02326, "Evaluation of Loss of Offsite Power Events at Nuclear Power Plants: 1986-2003" were used as a basis for LOOP initiation frequency

EPU/SAMA PRA Model Comment: The updated pre-EPU and EPU models have been revised to utilize the information from INEEL/EXT-04-02326 directly for the LOOP initiating event frequency and failure to recover probability values.

Element: MU Subelement: 4 Observation 1 INDEX: 115

The monitoring and collection of new information for an update is not presently a fully implemented and controlled process. The update guidance procedure provides for sending a model update information package to designated site personnel but does not establish a process for interface with the operator training program to ensure that insights are reviewed with the plant operators and EOOS support personnel. This may provide additional feedback pertaining to the fidelity of the PRA model.

Disposition:

Subsequent to the peer review, the above mentioned PRA maintenance and update procedure (NDAP-QA-1002) was formally issued. The purpose of this procedure is to define the basic process used by PPL to develop, control, and update the Susquehanna Probabilistic Risk Assessment (PRA). The procedure provides criteria to determine when updates are needed plus requirements for the PRA group to review changes in plant procedures and plant modifications to ensure the PRA continues to be consistent with the as-built / as-operated plant. The procedure also provides requirements for communicating PRA results to the organization, including Training, Work Management, Operations, Nuclear Regulatory Affairs, the Maintenance Rule expert panel, and station management. A revision to the maintenance and update procedure made after the peer review requires that the Training group be informed of significant PRA changes (risk significant systems, risk significant operator actions, risk significant scenarios, etc.).

Training modules on risk concepts have been developed and presented to Engineering, Operators, and the STAs. Other training has been provided to Work Management and the STAs (users of EOOS). Significant changes to the model would be reflected in the training modules.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: MU Subelement: 6 Observation 1 INDEX: 117

No detailed process has been established for the configuration control of the PSA model files including backup, storage and retrieval from a secure controlled location. Also, no formal benchmark process has been established to validate that retrieved model files are satisfactory for use in performing an application.

Disposition:

Three procedures are currently in place for management of controlled model files. These controls will apply to the CAFTA developed model and it's associated files. PPL's SQA procedure is the primary procedure that addresses control of software and data products. This procedure requires that all controlled data sets (i.e. PRA models) be placed in a "QA" data directory. PPL has established a directory that will be used to store the controlled PRA models. The SQA procedure also requires that controlled files must be documented, reviewed, and approved prior to being released for use.

The documentation for the PRA models will be done in accordance with PPL's recorded calculation procedure. Once the controlled files are moved into the QA directory, access permissions are set to "Read Only", preventing unintentional changes and assuring that the files as documented will be the same files that will be used in application calculations.

Finally, the PPL SQA procedure requires that a data custodian be established for all controlled data files. The data custodian will be notified of system or environment changes that may impact the correct operation of the data file. The data custodian will be notified prior to changes to the PPLNet environment so that he or she can evaluate the impact of the change. This protocol will assure that the controlled files will continue to yield the expected results.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: MU Subelement: 11 Observation 1 INDEX: 119

A process for review of prior PRA applications has not been fully implemented.

Disposition:

A process for review of prior PRA applications has been implemented through procedure NDAP-QA-1002. NDAP-QA-1002 states that, following a PRA Model Update, an information package describing the changes, the new PRA Taxonomy (risk significant operator actions and systems, and most risk significant MOV's and AOV's, ISI inputs, etc.), and the review of previous applications shall be prepared. This information package shall be transmitted to the following individuals via a calculation package so that review by each is formally documented:

1. Manager – Nuclear Fuels & Analysis
2. Manager – Station Engineering
3. Manager – Work Management
4. Manager – Nuclear Operations
5. Manager – Nuclear Regulatory Affairs
6. Manager – Nuclear Design Engineering
7. Manager – Nuclear Training
8. Manager – Quality Assurance
9. General Manager – Nuclear Assurance
10. General Manager – Nuclear Engineering
11. VP-Nuclear Operations
12. Nuclear Records
13. PORC Secretary
14. Supervisor NDE - SSES

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: MU **Subelement:** **Observation 1** **INDEX:** **120**

Sufficient documentation reflecting the process used for configuration control of the current PRA model update and maintenance does not exist. This detailed documentation of the update process is important to the configuration control and traceability of the model changes and review process provided for on PRA model update.

Disposition:

Subsequent to the peer review, NDAP-QA-1002, was formally issued. The purpose of this procedure is to define the process used by Plant Analysis to develop, control and update the Susquehanna Probabilistic Risk Assessment (PRA). Details on the process used to develop the current SSES PRA are provided below.

The current PRA model is documented and controlled under PPL QA procedures. All documentation packages include an independent technical review and final approval by qualified PPL engineers. Extensive model documentation includes:

1. Individual System Notebooks for all key systems important to risk (e.g. HPCI, RCIC, ADS and MSIVs, RHR, Electrical Distribution system, etc.),

2. Event Tree Notebook which documents the accident or transient progression from an initiating event to a plant damage state,

3. Initiating Events Notebook which documents the initiating events which are considered in the Susquehanna PRA and their associated frequencies,

4. Human Reliability Notebook which identifies human actions and their associated failure probabilities,

5. Dependency Matrix Notebook which provides an overall summary of the inter-relationships of plant systems

6. Internal Flooding Notebook which identifies the impact of internal floods on key equipment and equipment or train availability, and

7. Summary Notebook which documents the final PSA model including all software files developed as part of the model and the sensitivities on key input parameters.

Changes to any of the above documentation packages is also done under PPL QA procedures. As with the initial preparation, all changes are prepared, independently reviewed and approved prior to releasing the revised model for general use by plant personnel.

Plant procedures are in-place which assure that the Plant Analysis group will be informed of any plant or procedure changes which may affect the current risk model. If changes are warranted, all affected documentation will be revised to assure the PRA reflects the current as-built, as-operated plant.

The fault tree model and associated databases, which are developed and documented in the packages discussed above, are controlled via applicable PPL QA procedures. These procedures provide requirements and guidance for configuration control. After these files have been developed and approved for use, the model files are stored in special directories to prevent inadvertent changes by users.

The software used for risk analysis is controlled and documented in accordance with PPL QA procedures. These procedures provide requirements that must be met for all quality-related software, including configuration control of the software and future updates. Documentation packages have been developed for all risk analysis software to document the procurement, installation, verification and validation and configuration control of this software. Changes to the software must be documented in revisions to these software packages and are thus subject to independent technical review and approval prior to their use in risk related analyses.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: QU Subelement: 9 Observation 1 INDEX: 33

Common Cause of 4 EDGs and D/G "E"

The CCF of the 5th D/G may be too conservative. This dependency should be assessed considering diverse features of the D/G "E."

- Location
- Environment
- Manufacturer

- Design
- Maintenance Practices

Disposition:

This F&O states that the Common Cause Failure (CCF) probability of the fifth diesel may be too conservative. The CCF probability for the diesel generators was developed from NUREG/CR-5497. The CCF probability for the E diesel generator (E DG) is a conditional probability of it failing given one or more of the A – D diesel generators fails. The CCF probability for the A – D diesel generators is based on a group of four while the CCF probability for the E diesel generator is based on a group of 5. There is not much of an argument to be made for maintaining that the E DG should have a different CCF probability because:

- The E DG is manufactured by Cooper Bessmer as are the A – D
- The E DG model type is KSV as is the model type of the other four, except that DG E has 20 cylinders and the A – D have 16.
- The same maintenance practices are used on all five DGs.

Therefore, the CCF currently being used is considered appropriate.

EPU/SAMA PRA Model Comment: For the most part, the original disposition is still applicable. However, the common cause failure probabilities have been updated to utilize the most recently available CCF alpha-factor information from INEEL.

Element: QU Subelement: 14 Observation 1 INDEX: 34

The Summary Document does not identify how circular logic is identified and resolved in the PRA model. A consistent means of highlighting circular logic paths in the model, such as a gate naming convention, is not being employed.

Disposition:

Circular logic breaks are discussed in the Summary Notebook, which has been prepared, reviewed and approved per PPL documentation procedures. However, the model is not completely consistent with regard to a gate naming convention for circular

logic. It should be noted that if circular logic exists in the model, the fault tree will not quantify. The naming convention does not affect the model results.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: QU Subelement: 19 Observation 1 INDEX: 35

Designed Documentation

Using the fault tree recovery method allows for sequence based recoveries. This portion of the quantification is the least documented. The tree is large enough to require a documentation section.

Disposition:

The Summary Notebook section discussing recoveries was expanded following the Peer Review to include more detailed discussions of the approaches used for using sequence based recoveries in the model.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: QU Subelement: 31 Observation 1 INDEX: 39

The PSA results summary should identify dominant contributors

A detailed description of the Top 10 accident cutsets should be provided because they are important in ensuring that the model results are well understood and that modeling assumption impacts are likewise well known.

Similarly, the dominant accident sequence groups or functional failure groups should also be discussed. These functional failure groups should be based on a scheme similar to that identified by NEI 91-04, Appendix B.

Disposition:

A discussion of the top 10 cutsets is included in the Summary Notebook. The "SCHEME SIMILAR TO THAT IDENTIFIED BY NEI IN NEI 91-04" would require revising the event trees for different plant damage states. The plant damage states as

defined for SSES are technically adequate and do not require revision to resolve this F&O.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. Additionally, the expanded Level 2 modeling utilizes release characterizations that are more in line with BWR industry standards.

Element: QU Subelement: 34 Observation 2 INDEX: 41

The PRA model update is still in progress and will require a comprehensive review once the model is finalized to ensure consistency between the model content and all supporting documentation, including the results presented in the Summary Document.

Disposition:

The Summary notebook was in draft form when the Peer Review Team evaluated it. It was since issued as a formal calculation (prepared, reviewed and approved per PPL documentation procedures) in April 2004. The model content, supporting documentation, and detailed model results were provided in the calculation.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. A detailed summary notebook is completed for each model revision.

Element: SY Subelement: 5 Observation 1 INDEX: 141

HPCI

For transient events with the flow rate for injection relatively low, HPCI minimum flow valve could remain open and increase the drain rate from the CST.

Disposition:

The relevant technical evaluation in the Event Tree Notebook has been revised to address the effect of HPCI min-flow valve operation on CST inventory. The model now includes logic representing the timing evaluations related to the CST drain rates.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: SY Subelement: 13 Observation 1 INDEX: 149

ADEQUATE INVENTORIES

The following "inventories" do not appear to address the demands that may be imposed under accident conditions:

250 VDC adequacy (i.e., required DC load shed which is not currently included in the model)

CST/RWST inventory is not explicitly addressed

Disposition:

The 250V DC load shed is applicable to Unit 1 only. Unit 2 does not require 250VDC load shed because Unit 2 has a separate non-1E battery bank. The system fault tree model was revised to include dependency on the 250V DC load shed by creating the new HEP where the operator fails to shed 250VDC loads. Incorporated new basic event into PRA model and updated the HRA Notebook with all information relevant to this HEP.

Event Tree Notebook has been revised to address CST/RWST inventory. Effect of HPCI min-flow valve operation on CST inventory is also addressed in the Event Tree Notebook. The model now includes logic related to CST/RWST inventory demands during accident conditions.

EPU/SAMA PRA Model Comment: The original disposition is still applicable. Additionally, the updated event tree notebooks for pre-EPU and EPU conditions have been updated using MAAP including revised timing for CST inventory depletion.

Element: TH Subelement: 4 Observation 1 INDEX: 162

Technical Support (See AS-5-3)

The technical support for some of the success criteria should be re-examined to consider the following issues:

DW/T when recirc pump seal leakage is induced during an SBO

Effect of min flow valve being opened

Effect of HCL on timing of sequence

In addition, the description of the procedure directions in an SBO appear to give directions different than those assumed in the T&H calculations used in support of the PRA sequence for SBO.

Disposition:

Technical evaluation in Event Tree Notebook has been revised to address the effect of recirculation pump seal leakage on Drywell temperature response during a SBO.

Effects of RCIC and HPCI min-flow valves failed open on CST inventory are addressed in the revised Event Tree Notebook.

The effect of the HCTL on operation of HPCI and RCIC is also addressed in the revised Event Tree Notebook.

Additional discussion has been provided in the Event Tree Notebook to show that the TH calculations are consistent with the expected response of the plant in a SBO event. The discussion pertains specifically to the situation where the HCTL is reached and RCIC is the only injection system available in the plant. Based on discussion in the SBO procedure, it is not expected that the operator would deliberately depressurize the RPV in this case because the action would lead directly to core melt and vessel failure.

EPU/SAMA PRA Model Comment: The original disposition is still applicable.

Element: TH Subelement: 8 Observation 3 INDEX: 166

Charger Room Cooling

No evidence of an evaluation of charger room cooling has been performed.

It is noted that the team walkdown of the plant on Wednesday of the visit identified that the chargers were likely not subject to thermal conditions that would induce failure within the PRA mission time despite loss of ventilation based on the size of the room and its normal temperature.

Disposition:

This F&O states that no evidence of an evaluation of charger room cooling was performed. However, a formal calculation had been prepared that addresses the charger room cooling requirements. This calculation concludes that no cooling is required to the charger rooms. The calculation does require that the battery charger room doors be open prior to 6 hours from the time of loss of Control Structure HVAC. A plant off-normal procedure addresses this requirement. Therefore, the charger rooms do not require cooling which is how they are modeled.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: DA **Subelement:** 4 **Observation** 2 **INDEX:** 124

A limited set of failure data was updated with plant specific data prior to 1999. The majority of the failure data is based on generic values.

Generic data tends to be more conservative than plant data. Using plant data would also help identify any potential plant outliers.

Develop program to periodically update failure data using accumulated plant data.

Disposition:

PPL intends to develop and implement, prior to a future PRA model update, a program to periodically update component failure data with plant specific data. The program will consider utilizing plant specific data to define failure rates for the most risk significant components. (HPCI, for example, will be considered as a potential candidate for update with plant specific data.)

The ‘generic’ values currently used in the plant PRA model are accepted industry values. Although utilizing overly conservative component failure data in the plant PRA model can theoretically distort quantification results, industry accepted component failure rates generally have the tendency (as stated in the F&0) of being somewhat conservative relative to plant data. The industry accepted data used in the plant PRA is not considered to be overly conservative (i.e., use of the generic data does not skew the results or the risk insights obtained from the PRA), and is thus deemed sufficient for risk informed applications.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: DA Subelement: 4 Observation 4 INDEX: 126

The plant specific components receiving a data update do not include the HPCI pump which has a relatively high Fussell-Vesely importance.

Include the HPCI pump in the component population for periodic plant specific data update. Consider whether any other components merit plant specific data update.

Disposition:

PPL intends to develop and implement, prior to a future PRA model update, a program to periodically update component failure data with plant specific data. The program will consider utilizing plant specific data to define failure rates for the most risk significant components. (HPCI, for example, will be considered as a potential candidate for update with plant specific data.)

The ‘generic’ values currently used in the plant PRA model are accepted industry values. Although utilizing overly conservative component failure data in the plant PRA model can theoretically distort quantification results, industry accepted component failure rates generally have the tendency (as stated in the F&O) of being somewhat conservative relative to plant data. The industry accepted data used in the plant PRA is not considered to be overly conservative (i.e., use of the generic data does not skew the results or the risk insights obtained from the PRA), and is thus deemed sufficient for risk informed applications.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: DE Subelement: 7 Observation 1 INDEX: 42

Missing Human Interactions (see also DE-7-3)

The human interactions that can cut across system trains and can cause failure of multiple trains due to pre-initiator should be identified and documented. (See Element HR-26)

Identify and document pre-initiator unavailabilities and ensure that it is consistently treated for all relevant systems.

Disposition:

Twenty-one pre-initiator human errors are currently documented in the HRA Notebook and are included in the plant PRA model. Pre-initiators have been evaluated for the diesel generators, LPCI, RCIC, HPCI, Core Spray, SLC, and CRD. In the model quantification, the pre-initiators contribute 3.66% of the Unit 1 CDF and 3.67% of the Unit 2 CDF with more than half of the contribution coming from the A and B diesel generators. In general, the pre-initiators are comparable to the 16 pre-initiators included in the Limerick PRA model.

With regard to this F&O, SSES HRA pre-initiators are currently deemed sufficient for risk informed applications. The pre-initiators will, however, be comprehensively reevaluated in a future model update. Adding more pre-initiators is not expected to affect the insights presently realized.

EPU/SAMA PRA Model Comment: The original disposition is still applicable although the percent contributions have changed slightly.

Element: HR Subelement: 4 Observation 1 INDEX: 50

Missing Pre-initiator Human Error probabilities.

Only a limited number of pre- initiator Human Errors are included in the fault trees.

The pre-initiators included in the model are considered to be adequate except for possible common cause events. However, further consideration of plant specific procedures could identify other pre-initiators for inclusion.

Disposition:

Twenty-one pre-initiator human errors are currently documented in the HRA Notebook and are included in the plant PRA model. Pre-initiators have been evaluated for the diesel generators, LPCI, RCIC, HPCI, Core Spray, SLC, and CRD. In the model quantification, the pre-initiators contribute 3.66% of the Unit 1 CDF and 3.67% of the Unit 2 CDF with more than half of the contribution coming from the A and B diesel

generators. In general, the pre-initiators are comparable to the 16 pre-initiators included in the Limerick PRA model.

With regard to this F&O, SSES HRA pre-initiators are currently deemed sufficient for risk informed applications. The pre-initiators will, however, be comprehensively reevaluated in a future model update. Adding more pre-initiators is not expected to affect the insights presently realized.

EPU/SAMA PRA Model Comment: The original disposition is still applicable although the percent contributions have changed slightly.

Element: IE Subelement: Observation 1 INDEX: 88

LOOP frequencies developed for Susquehanna are not based on NUREG 1032.

However, EPRI database was used as a source of LOOP data for the Susquehanna area. An attempt was made to sub-divide the LOOP events into grid related, severe weather and extremely severe weather related events. This approach differs from using NUREG-1032 to develop the LOOP frequency and recovery terms. Using NUREG 1032 a value for the plant-centered frequency would be obtained and then using the correlations provided estimates for the grid-related, severe weather and extremely severe weather contributions to LOOP would be computed. The LOOP contributions due to non-plant centered events would be added to the plant centered LOOP frequency to obtain the total LOOP frequency.

Susquehanna started with a total frequency, however, rather than using NUREG 1032 to obtain additional contributions due to rare weather events, NUREG 1032 and Regulatory Guide 1.155 were used to sub-divide the total frequency into plant centered, grid related, severe weather and extremely severe weather related contribution. Comparisons to NUREG 1032 were made to valid results.

Using the Susquehanna approach, if the plant-centered LOOP frequency is 3.0E-02 per year and the plant is susceptible to severe weather events (say once every 50 years) it is likely that a severe weather event would not be included in the prior data distribution, which typically would cover a time span of 10 to 20 years. A 1 in 50 years severe weather event, according to the Susquehanna approach would reduce the plant center LOOP frequency to about 1.0E-02 per year.

The result of the Susquehanna approach is that the plant-centered LOOP frequency is less for Susquehanna than the national average (1.58E-02/yr versus 1.86E-02/yr). The Susquehanna plant-centered LOOP frequency is also less than what would be obtained using the 4 of 5 PJM events and the 2.98E-02/yr updated mean LOOP frequency (i.e., a plant-centered LOOP of 2.38E-02/yr).

Since the rare events (grid related, severe weather and extremely severe weather events) may not be included in the database used for the prior distribution, these terms should be added to the mean LOOP frequency. Since LOOP is a significant contributor to CDF, LOOP frequency/recovery will have a significant impact on results.

Disposition:

The main issue in this F&O is the inconsistency in references for the development of the LOOP initiator frequency and LOOP recoveries. A future update of the model will consider using INEEL/EXT-04-02326, "Evaluation of Loss of Offsite Power Events at Nuclear Power Plants: 1986-2003" which includes the August 14, 2003 power outage. This source of data has a LOOP initiator frequency specific to SSES and recovery curves for five different causes of a LOOP. The use of this document will provide a consistent data source for the LOOP initiator frequency and recoveries.

An assessment of the impact of the proposed change was performed by running a sensitivity case with the Grid, Extreme Weather and Severe Weather frequencies set to the INEEL values for SSES. To account for the less optimistic recoveries, the least optimistic recovery curve, extreme weather, values were manually inserted for the highest worth LOOP cutsets caused by extreme weather. The result of this effort was an increase of 10% for CDF. It is concluded, from this sensitivity case, that changing to the INEEL data would not result in a substantial change to the model results.

EPU/SAMA PRA Model Comment: The updated pre-EPU and EPU models have been revised to utilize the information from INEEL/EXT-04-02326 directly for the LOOP initiating event frequency and failure to recover probability values.

Element: IE Subelement: 5 Observation 2 INDEX: 72

Missing or incomplete documentation for exclusion.

1. Loss of GSW is not included in the fault tree. It is assumed to be no worse than the Loss of RBCCW or TBCCW. This does not account for the impact on both RBCCW and TBCCW being lost at the same time. If this has been taken into account, then the basis should be documented.

2. Medium Steam LOCA, or SORV3 (3 or more SORVs).

3. Feedwater ramp-up initiator.

4. Reference Leg break initiator should be added to the model.

Disposition:

1. The loss of general service water (GSW), referred to as normal service water (NSW or SW) at SSES, is discussed in the Initiating Events Notebook. The Initiating Events Notebook discussion states that the 'loss of normal service water is subsumed by and conservatively reflected in the loss of offsite power initiator category.'

   The conclusion that the loss of normal service water is subsumed by the LOOP event is based on the fact that the loss of normal service water event has impacts similar to those of the LOOP event (MSIV closure). Loss of normal service water is; however, less severe because the emergency on-site AC power sources are not the only AC power sources required for mitigation. In addition, the event frequency for loss of normal service water is evaluated to be much smaller than the LOOP frequency. Therefore, the loss of normal service water event is assumed to be subsumed by the LOOP event and a separate initiating event is not included in the current model. Since this approach may be slightly conservative, consideration will be given to including the loss of service water event as a specific initiating event as part of a future PRA update.

2. The Event Tree Notebook discusses the LOCA sequences in detail. A determining factor for a steam break is whether or not the high pressure makeup systems (HPCI or RCIC) are sufficient to mitigate the event and prevent core damage. Small steam breaks are defined as those breaks for which the high pressure makeup systems are required for mitigation. Large steam breaks are defined as those for which the break depressurizes the reactor vessel in sufficient time so that the low pressure injection systems (LPCI and core spray) prevent core damage. Small break events will result in success by having 3 ADS valves (to effect depressurization) and injection via low pressure injection systems. Therefore, the break consisting of three or more open SRVs will depressurize the reactor vessel and is already analyzed and considered to be a large steam break event.

3. The feedwater ramp-up initiator is discussed in Section 15.1.2 of the SSES FSAR as feedwater controller failure – maximum demand. An increase in feedwater flow at

power would lead directly to feedwater pump trips on high reactor level. Therefore, the feedwater ramp-up event is already included as part of the loss of feedwater initiator. The loss of feedwater initiator frequency includes loss of feedwater events caused by the feedwater ramp-up.

4. The Initiating Events Notebook discusses the methodology for evaluating the LOCA event frequencies (instrument line breaks are considered small steam or liquid breaks, depending on location). The frequency of breaks in the reference leg piping is part of the total frequency calculation for small liquid breaks. Breaks in the reference leg would also cause false high level signals to be generated from the affected instruments. However, the resulting high pressure in the drywell will cause the reactor to scram and the high pressure systems required for level control following LOCA (HPCI and RCIC) have redundant level instrumentation. Therefore, the false high level signal generated by the affected instrumentation would have no effect on the resulting small break LOCA event mitigation, and including a reference leg break as a specific initiating event is not required.

EPU/SAMA PRA Model Comment: For the most part, the original disposition is still applicable. However, sensitivity studies for the loss of service water and loss of instrument air events are included as part of the EPU sensitivity study evaluations.

Element: IE Subelement: 6 Observation 1 INDEX: 74

LOIA

Loss of Instrument Air can result in the shutdown of both plants and have relatively significant impacts:

MSIV closure

Loss of TBCCW

Disposition:

The loss of instrument air (LOIA) event can cause a shutdown of both units (resulting from the loss of TBCCW and the subsequent MSIV closure) only if the instrument air systems are cross-tied between the units. Operating with the instrument air system cross-tied is not a normal mode of operation at SSES, therefore, should the instrument air systems need to be cross-tied for any reason, a specific risk assessment would be required prior to such operation.

The loss of instrument air (LOIA) event is considered to be subsumed by the loss of TBCCW initiating event, as discussed in the Initiating Event Notebook. However, consideration will be given to adding the LOIA event to the SSES PRA model as an initiating event as part of a future PRA update.

EPU/SAMA PRA Model Comment: For the most part, the original disposition is still applicable. However, sensitivity studies for the loss of service water and loss of instrument air events are included as part of the EPU sensitivity study evaluations.

Element: IE Subelement: 7 Observation 1 INDEX: 76

BOC

The BOC should be retained in the quantitative model and not prematurely screened.

The BOC could be a significant LERF contributor.

Disposition:

Breaks outside containment (BOC) have not been prematurely screened. BOC's have been evaluated in the Initiating Events Notebook. The frequency of BOC events has been evaluated to be a factor of at least 15 less than the frequency of interfacing system LOCA (ISLOCA) events. ISLOCA events are included as initiating events in the current PRA model and the highest frequency ISLOCA event contributes approximately 3.5% to the overall CDF and approximately 8.4% to LERF. Based on the evaluated initiating event frequency for BOC events, BOC would contribute approximately 0.2% to CDF and 0.5% to LERF. These frequencies were evaluated as insignificant for the current PRA model for SSES. However, since BOC events have been included in PRA's performed by other utilities, PPL will evaluate adding BOC events to the PRA model.

EPU/SAMA PRA Model Comment: Due to their potential importance as LERF contributors, the BOC sequences have been added to the event sequence modeling as described in the updated event tree notebook.

Element: IE Subelement: 7 Observation 2 INDEX: 77

Loss of Instrument Air and BOCs are not modeled because of their core damage frequency contribution. Although this may be true, they should be modeled for use in Maintenance Rule A4 calculations and SDP.

Disposition:

The loss of instrument air (LOIA) event is considered to be subsumed by the loss of TBCCW initiating event, as discussed in the Initiating Event Notebook. However, consideration will be given to adding the LOIA event to the SSES PRA model as an initiating event as part of a future PRA update.

Breaks outside Containment (BOC's) were evaluated for their frequency in the Initiating Events Notebook. It was demonstrated, following the frequency evaluation, that BOC's have 'an insignificant impact on both CDF (<1%) and LERF (<1%). As such, the Break outside of Containment Initiating Events are not explicitly included in the SSES model.'

Thus, results of the current model would not be significantly impacted by including the LOIA and BOC as initiating events.

EPU/SAMA PRA Model Comment: Due to their potential importance as LERF contributors, the BOC sequences have been added to the event sequence modeling as described in the updated event tree notebook. Additionally, sensitivity studies for the loss of service water and loss of instrument air events are included as part of the EPU sensitivity study evaluations.

Element: IE Subelement: 13 Observation 2 INDEX: 89

Missing from the analysis

The results of the initiating event analysis should be compared with generic data sources to provide a reasonableness check of the quantitative and qualitative results.

Disposition:

The data sources for the event frequencies generated in the Initiating Events Notebook incorporated both SSES specific and external industry sources. The results of the SSES PRA model for CDF and LERF appear to be consistent with other industry

analyses, therefore, the frequency of initiating events used in the model should not be significantly different from other analyses in the industry.

However, an examination of the SSES initiating event frequencies versus industry sources will be undertaken and documented as part of the SSES full Level 2 PRA, currently under development as part of the License Renewal and Extended Power Uprate Projects.

EPU/SAMA PRA Model Comment: This is not anticipated to impact the results of the analysis.

Element: L2 Subelement: 5 Observation 1 INDEX: 99

SUCCESS CRITERIA

If needed use RMIEP (LaSalle) NUREG/CR-5305 analysis to support success criteria decisions regarding phenomena for which no plant specific thermal hydraulic analysis is available. This includes:

- Containment overtemperature failure

Disposition:

The SSES success criteria for preventing Containment over-temperature failure are discussed in the Performance Criteria Notebook. These success criteria are considered acceptable for the current SSES PRA that evaluates CDF and LERF. Further definition of these success criteria will be considered as part of the SSES Level 2 PRA, currently under development as part of the License Renewal and Extended Power Uprate Projects.

EPU/SAMA PRA Model Comment: The timing of containment failure (including overtemperature failures) for pre-EPU and EPU conditions have been updated based on MAAP calculations as described in the updated event tree notebook.

Element: L2 Subelement: 8 Observation 2 INDEX: 101

CONTAINMENT ISOLATION

The placement of the CI node at the end of the event tree is workable. However, in certain cases (see LT2, BRANCH LT-2-3, LT-2-7, LT-2-10;TR-3 BRANCHES TR-3-1 TO TR-3-9) the event tree does not branch at CI. The end state is currently identified as core damage and a release, but it is not LERF. However, if the CI node was asked, the contribution due to LERF would be calculated.

Disposition:

The event tree package will be reexamined as part of the full SSES Level 2 PRA model development currently being undertaken as part of the License Renewal and Extended Power Uprate projects.

The LT2 branch, referenced above should reflect the LERF potential resulting from CI failure, because core damage exists on entry into LT2. Therefore, the failure of the containment isolation function would lead directly to radioactive material release and LERF.

Revising the LT2 branch to include the CI failure event as LERF will result in a minimal increase for the SSES LERF value. However, the LERF value, as evaluated by the present PRA model, is conservative. Therefore, the LERF increase resulting from the CI failure events is judged to be inconsequential to the overall result.

Adding the CI node to TR3 would have no effect on the LERF calculation. In the TR3 event, core damage does not occur until at least 6 hours following the General Emergency declaration.

EPU/SAMA PRA Model Comment: The CI node has been moved to early in the event trees for all scenarios as described in the updated event tree notebook. This allows for proper determination of the release characterization given CI fails.

Element: L2 Subelement: 10 Observation 1 INDEX: 105

CONTAINMENT OVERTEMPERATURE FAILURE(COTF)

The assumption that COTF occurs for RPV breach events without drywell sprays is considered to be too pessimistic. MAAP and MELCOR calculations for Mark II plants demonstrate substantial containment temperature and pressure capability for extended times (many hours) after RPV breach. This can occur both with LPCI/CS injection to the failed RPV or with no RPV injection. (See related comment on the definition of "early").

Disposition:

A Susquehanna specific calculation for RPV breach was added to the Event Tree Notebook (EC-RISK-1092, Appendix O, added in revision 5) concluded that the pressure generated by the water from the reactor vessel flashing to steam would result in immediate containment failure on overpressure (COPF). A MAAP input file for Susquehanna is being prepared as part of a full Level 2 PRA (being developed to support the License Extension and Extended Power Uprate (EPU) projects). The RPV breach event will be reconsidered during the development of the Level 2 PRA.

EPU/SAMA PRA Model Comment: The timing of containment failure (including overtemperature failures) for pre-EPU and EPU conditions have been updated based on MAAP calculations as described in the updated event tree notebook.

Element: L2 Subelement: 15 Observation 1 INDEX: 108

Class 4 Containment Failure

The definition of containment failure during an ATWS and its size and location should be identified. The attached discussion of ATWS-induced dynamic loads is included for your use in considering the plant specific evaluation. Attachment L2-15 provides some considerations regarding containment failure modes that may require consideration under ATWS conditions.

Disposition:

The current Susquehanna PRA evaluates Core Damage Frequency (CDF) and Large Early Release Frequency (LERF). As such, no specifics on containment failure modes

or quantification of release amounts or paths are documented in the current PRA. A full Level 2 PRA, with quantification of containment failure releases and locations, is under development in support of the License Renewal project. The impact of ATWS induced dynamic loads on containment failure size and location is being included as part of the full Level 2 PRA model development.

EPU/SAMA PRA Model Comment: The timing of containment failure (including ATWS induced dynamic loads) for pre-EPU and EPU conditions has been incorporated into the event sequence modeling based on MAAP calculations as described in the updated event tree notebook.

Element: L2 Subelement: 22 Observation 3 INDEX: 112

LERF

The magnitude of the release is not included as a determining factor in the LERF definition in the SSES simplified LERF model. Only the fact that a release occurs (greater than leakage) is included as the basis for the LERF determination. This would appear to be extremely conservative.

The timing definition for LERF used for the SSES PRA is within 12 hours after a General Emergency. This is atypical in the industry (usually 4-6 hours). The bad weather evacuation for SSES may indicate as much as 9 hours. This time estimate should be made to be more consistent (i.e., not overly conservative) relative the definition in Regulatory Guide 1.174.

Disposition:

For the current SSES PRA (which evaluates CDF and LERF), no quantification of magnitude of the radioactivity release rate is performed. A full Level 2 PRA, with quantification of containment failure releases and locations, is under development in support of the License Renewal project.

The 12-hour break point for LERF following the declaration of General Emergency was judged to be overly conservative. The current version of the Event Tree Notebook re-evaluated the LERF timing definition as within 6 hours of a General Emergency declaration. Thus, the current Susquehanna PRA defines LERF as a release within 6 hours of declaration of a General Emergency.

EPU/SAMA PRA Model Comment: The pre-EPU and EPU models defines LERF as a "high" release (i.e., > 10% CsI) within 6 hours of declaration of a General Emergency. Other release categories are also defined as described in the updated event tree notebook.

Element: MU Subelement: Observation 1 INDEX: 113

The update process is currently defined by only a high level Maintenance and Update guidance procedure. The procedure does not go into effect until December 31, 2003. As such, the Peer Review team was unable to review the implementation of the Maintenance and Update process. The intent of the program as specified in the procedure was evaluated. Grades recorded that reflect the lack of an active program. The overall process is deemed inadequate for configuration control of the details of the change process and does not allow review by affected plant programs consistent with current industry practice. A detailed procedure driven process should be implemented for PRA model updates to ensure consistency in work practices and to capture detailed information such as specific model modifications performed, the revised model assembly, the quantification plan, results evaluation, required reviews and approvals, and review of prior applications.

Disposition:

Subsequent to the peer review, the above mentioned PRA maintenance and update procedure (NDAP-QA-1002) was formally issued. The purpose of this procedure is to define the basic process used by PPL to develop, control, and update the Susquehanna Probabilistic Risk Assessment (PRA). The procedure provides: criteria to determine when updates are needed, requirements for the PRA group to review changes in plant procedures and plant modifications, and requirements for documentation. The procedure also provides requirements for communicating PRA results to the organization, including Training, Work Management, Operations, Nuclear Regulatory Affairs, the Maintenance Rule expert panel, and station management. Details on the process used to develop and control the current SSES PRA are provided below:

The current PRA model is documented and controlled under PPL QA procedures. All documentation packages include an independent technical review and final approval by qualified PPL engineers. Extensive model documentation includes:

1. System Notebooks for all key systems important to risk (e.g. HPCI, RCIC, ADS and MSIVs, RHR, Electrical Distribution system, etc.),
2. An Event Tree Notebook which documents the accident or transient progression from an initiating event to a plant damage state,
3. An Initiating Events Notebook which documents the initiating events considered in the Susquehanna PRA and their associated frequencies,
4. A Human Reliability Notebook which identifies human actions and their associated failure probabilities,
5. A Dependency Matrix Notebook which provides an overall summary of the inter-relationships of plant systems
6. An Internal Flooding Notebook which identifies the frequencies and the impact of internal floods on key equipment and equipment or train availability, and
7. A Summary Notebook which documents the final PSA model including all software files developed as part of the model and the sensitivities on key input parameters.

Changes to any of the above documentation packages is also done under PPL QA documentation procedures. As with the initial preparation, all changes are prepared, independently reviewed and approved prior to releasing the revised model for general use by plant personnel.

The fault tree model and associated databases, which are also developed and documented in the packages discussed above, are controlled via applicable PPL QA procedures. These procedures provide requirements and guidance for configuration control. After these files have been developed and approved for use, the model files are stored in special directories to prevent inadvertent changes by users.

The software used for risk analysis is controlled and documented in accordance with PPL Software QA procedures. These procedures provide requirements that must be met for all quality-related software, including configuration control of the software and future updates. Documentation packages have been developed for all risk analysis software to document the procurement, installation, V&V and configuration control of this software. Changes to the software must be documented in revisions to these software packages and are thus subject to independent technical review and approval prior to their use in risk related analyses.

A more detailed procedure for documenting the PRA model assembly process could help ensure consistent model development in the future. The absence of this procedure does not have any impact on the current model results. Any changes to the current model will still need to go through the calculation process, which provides for a review and approval of the revision.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: QU Subelement: Observation 1 INDEX: 32

A process for documenting PRA model assembly does not exist that describes how the different elements (functional top logic, event tree and fault tree development, system model integration, circular logic resolution, recovery fault tree development, mutually exclusive file development, and flag file development and model file use) of the PRA model are developed. Such documentation ensures consistency in model assembly and awareness of the process employed for future model and file updates.

Disposition:

The current PRA model and associated PRA elements are documented, reviewed and approved in calculation packages per PPL calculation procedure (with the exception of a few system notebooks for the less important systems).

A detailed written procedure for documenting the PRA model assembly would help provide consistent model development in the future. Lack of this procedure does not have any impact on the current model results. Any changes to the model will need to go through the calculation process, which provides for a review and approval of the revision. Therefore, it is not necessary to have this documentation in place to have a model that represents the “as-built/as-operated” plant.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: ST Subelement: 5 Observation 2 INDEX: 136

CONTAINMENT OVERTEMPERATURE FAILURE (COTF)

The mechanistic treatment of containment failure due to the combination of high temperatures and pressures is not included in the structural analysis. A default conservative assumption is used.

Disposition:

A PPL recorded calculation addresses the success criteria for maintaining an intact containment on the basis of both temperature and pressure. Containment over-pressure failure (COTF) is defined to occur at 140 psig, as discussed in the calculation. Containment over-temperature failure is defined to occur when RPV melt-through occurs with the drywell floor dry and with insufficient drywell spray available. Containment failure due to COPF or COTF is evaluated on these bases in the Event Tree Notebook. However, because the current PRA model is a modified Level 1 PRA (CDF and LERF are evaluated), no quantification of containment break location or radioactivity release rate has been performed. The evaluation of containment break location and radioactivity release rates will be undertaken as part of the full Level 2 PRA model for SSES, currently under development as part of the License Renewal and Extended Power Uprate projects.

EPU/SAMA PRA Model Comment: The containment failure timings (due to COPF or COTF) have been re-assessed using MAAP as described in the event tree notebook. Probabilities have also been assigned to the location of the failures as described in the updated event tree notebook.

Element: ST Subelement: 5 Observation 3 INDEX: 137

HYDRODYNAMIC LOADS

The structural analysis does not examine the possible effects associated with containment barrier unavailability due to ATWS events that include:

- Hydrodynamic loads
- Pool bypass above temperatures above 240F (Sonin experiments) Containment vent

Stuck open tailpipe vacuum breakers

- High pool water level (and hydrodynamic loading)

See discussion associated with L2-15.

Disposition:

In the current SSES PRA (which evaluates CDF and LERF), no quantification of containment breach location or radioactivity release rate is performed. A full Level 2 PRA, with quantification of containment failure releases and locations, is under development in support of the License Renewal project. The impact of ATWS induced dynamic loads on containment failure size and location is being included as part of the full Level 2 PRA model development.

EPU/SAMA PRA Model Comment: The timing of containment failure (including ATWS induced dynamic loads) for pre-EPU and EPU conditions has been incorporated into the event sequence modeling based on MAAP calculations as described in the updated event tree notebook.

Element: SY Subelement: 4 Observation 1 INDEX: 140

The quality and content of system notebooks are good. Several other system notebooks are in various stages of development. All modeled systems should have these books completed and reviewed.

Disposition:

It was planned to develop system notebooks for the 27 systems credited in the PRA model. Of the 27, notebooks were issued for 17 of the most risk significant systems. Of the 10 remaining, five notebooks have been drafted and five have not yet been prepared. PPL intends to complete and formally document the remaining 10 system notebooks. However, given that the most important systems have been addressed by specific system notebooks and that the remaining systems are relatively straightforward to model, no significant model impacts are foreseen once the 10 remaining system notebooks are issued.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable.

Element: SY Subelement: 8 Observation 2 INDEX: 144

Missing Pre- initiator Human Errors Probabilities (HEPs)

Selected Pre- initiator Human Errors are included in the system model. PPL should ensure that the pre-initiators are examined relative to plant design and procedures and are incorporated and quantified.

Disposition:

Twenty-one pre-initiator human errors are currently documented in the HRA Notebook and are included in the plant PRA model. Pre-initiators have been evaluated for the diesel generators, LPCI, RCIC, HPCI, Core Spray, SLC, and CRD. In the model quantification, the pre-initiators contribute 3.66% of the Unit 1 CDF and 3.67% of the Unit 2 CDF with more than half of the contribution coming from the A and B diesel generators. In general, the pre-initiators are comparable to the 16 pre-initiators included in the Limerick PRA model.

With regard to this F&O, SSES HRA pre-initiators are currently deemed sufficient for risk informed applications. The pre-initiators will, however, be comprehensively reevaluated in a future model update. Adding more pre-initiators is not expected to affect the insights presently realized.

EPU/SAMA PRA Model Comment: None. The original disposition is still applicable although the percent contributions have changed slightly.

E.3 LEVEL 3 PRA ANALYSIS

This section addresses the critical input parameters and analysis of the Level 3 portion of the probabilistic risk assessment. In addition, Section E.7.3 summarizes a series of sensitivity evaluations to potentially critical parameters.

E.3.1 Analysis

The MACCS2 code (NRC 1998a) was used to perform the Level 3 probabilistic risk assessment (PRA) for the Susquehanna Steam Electric Station. Susquehanna specific parameters are used for population distribution and economic parameters. Other input parameters given with the MACCS2 "Sample Problem A", formed the basis for the present analysis. Plant-specific release data included the time-dependent nuclide distribution of releases and release frequencies. The behavior of the population during a release (evacuation parameters) was based on plant and site-specific set points. These data were used in combination with site-specific meteorology to simulate the probability distribution of impact risks (both exposures and economic effects) to the surrounding 50-mile radius population as a result of the release accident sequences at Susquehanna.

E.3.2 Population

The population surrounding the Susquehanna site was estimated for the year 2044.

Population projections within 50 miles of Susquehanna were determined using SECPOP2000, (NRC 2003) utilizing a geographic information system (GIS), U.S Census block-group level population data allocated to each sector based on the area fraction of the census block-groups in each sector, and population growth rate estimates. U.S. Census data from 1990 and 2000 were used to determine an annual average population growth estimate for each of the 50-mile radius rings. The annual population growth estimate for each ring was applied uniformly to all sectors in the ring to calculate the year 2044 population distribution.

The distribution is given in terms of population at distances to 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 miles from the plant and in the direction of each of the 16 compass points (i.e., N, NNE, NE……NNW).

The total year 2044 population for the 160 sectors (10 distances × 16 directions) in the region is estimated as 2,025,499. The population multiplier (in parenthesis) and

distribution of the population is given for the 10-mile radius from Susquehanna and for the 50-mile radius from Susquehanna in Tables E.3-1 and E.3-2, respectively.

E.3.3 Economy

MACCS2 requires the spatial distribution of certain economic data (fraction of land devoted to farming, annual farm sales, fraction of farm sales resulting from dairy production, and property value of farm and non-farm land) in the same manner as the population. This was done by using the SECPOP2000 code (NRC 2003) for each of the counties surrounding the plant to a distance of 50 miles. SECPOP2000 utilizes economic data from the U.S. Department of Agriculture, "1997 Census of Agriculture" (USDA 1998) and from other 1998 and 1999 data sources. Economic values for up to 97 economic zones were calculated and allocated to each of the 160 sectors.

In addition, generic economic data that are applied to the region as a whole were revised from the MACCS2 sample problem input when better information was available. These revised parameters include per diem living expenses (applied to owners of interdicted properties and relocated populations), relocation costs (for owners of interdicted properties), and value of farm and non-farm wealth. These values were updated to the year 2000 value using the Consumer Price Index ratio.

Susquehanna MACCS2 economic parameters include the following:

Susquehanna MACCS2 Economic Parameters

Variable	Description	SSES Value
DPRATE[(1)]	Property depreciation rate (per yr)	0.2
DSRATE[(1)]	Investment rate of return (per yr)	0.12
EVACST[(2)]	Daily cost for a person who has been evacuated ($/person-day)	41.15
POPCST[(2)]	Population relocation cost ($/person)	7600.00
RELCST[(2)]	Daily cost for a person who is relocated ($/person-day)	41.15
CDFRM0[(2)]	Cost of farm decontamination for various levels of decontamination ($/hectare)	855.00 1900.00
CDNFRM[(2)]	Cost of non-farm decontamination per resident person for various levels of decontamination ($/person)	4560.00 12160.00
DLBCST[(2)]	Average cost of decontamination labor ($/man-year)	53200.00
VALWF0[(3)]	Value of farm wealth ($/hectare)	6139.00
VALWNF[(3)]	Value of non-farm wealth ($/person)	121627.00

(1) DPRATE and DSRATE are based on NUREG/CR-4551 value (NRC 1990).
(2) These parameters for Susquehanna use the NUREG/CR-4551 value and updates them to the 2000 CPI value (NRC 1990).
(3) VALWF0 and VALWNF are based on SECPOP2000 values for Susquehanna.

E.3.4 Food and Agriculture

Food ingestion was modeled using the COMIDA2 methodology consistent with Sample Problem A. The COMIDA2 model utilizes national based food production parameters derived from the annual food consumption of an average individual such that site specific food production values are not utilized. The fraction of population dose due to food ingestion is typically small compared to other population dose sources. For Susquehanna, approximately 5% of the total population dose is due to food ingestion. A sensitivity case was performed to determine the impact of using site specific food production data obtained from the counties surrounding the site (USDA 2004). The results are discussed in Section E.7.3.

E.3.5 Nuclide Release

The core inventory at the time of the accident is based on a plant specific ORIGEN 2.1 calculation performed in 2004. The core inventory corresponds to the best estimate, end-of-cycle values (i.e., 24 month fuel cycle) for the Susquehanna core.

Susquehanna nuclide release categories are related to the MACCS categories as shown in Table E.3-3. All releases are modeled as occurring at 60.0 meters (top of the Reactor Building). The thermal content of each of the releases are assumed to be 1.0E+07 watts based on values provided in Sample Problem A and NUREG/CR-4551 (NRC 1990).

Two nuclide release sensitivity cases were performed to determine the effect of release height and thermal content assumptions. One sensitivity case modeled the releases occurring at ground level (0.0 meters). The second sensitivity case modeled the thermal content of each release to be the same as ambient (i.e., buoyant plane rise is not modeled). The results are discussed in Section E.7.3.

E.3.6 Evacuation

Reactor scram signal begins each evaluated accident sequence. A General Emergency is declared when plant conditions degrade to the point where it is judged that there is a credible risk to the public. Therefore, the timing of the General Emergency declaration is sequence specific and ranges from 6 minutes to 18 hours for the release sequences evaluated.

The MACCS2 User's Guide input parameters of 95 percent of the population within 10 miles of the plant [Emergency Planning Zone (EPZ)] evacuating and 5 percent not evacuating were employed. These values have been used in similar studies (e.g., Hatch, Calvert Cliffs, (SNOC 2000) and (BGE 1998)) and are conservative relative to the NUREG-1150 study, which assumed evacuation of 99.5 percent of the population within the EPZ. The evacuees are assumed to begin evacuating 60 minutes after a General Emergency has been declared and are evacuated at an average radial speed of 2.2 miles per hour (0.97 m/sec). This speed is the time weighted value accounting for season, day of the week, time of day, weather conditions, and special events. The evacuation time weighted average of 338 minutes is for the full 0-10 mile EPZ, an assumed 15 minute notification time, 15 minutes for evacuation preparation, and 30 minutes average departure time. (HMM 1981)

Two evacuation sensitivity cases were also performed to determine the impact of evacuation assumptions. One sensitivity case reduced the evacuation speed by a factor of two (0.49 m/sec). The second sensitivity case assumed a 90 minute delay (in lieu of 60 minute delay) prior to the start of physical evacuation movement. The results are discussed in Section E.7.3.

E.3.7 Meteorology

Annual Susquehanna meteorology data from year 2001 was used in MACCS2 for the base case results. Year 2001 was the most complete and contained Susquehanna site specific precipitation data as well as mid tower data.(1) The 2001 Susquehanna meteorological data set contained two gaps of missing dates (57 total hours, representing 0.65% of the hourly readings). One of the gaps contained more than six consecutive hours of missing data and was filled by substituting data from previous hours or days. One of the gaps contained six or fewer consecutive hours of missing data and was filled by interpolation. The year 2001 meteorological data set was utilized for the Susquehanna base case MACCS2 analysis based on the fact that the year 2001 provided the highest population dose risk and offsite economic cost risk and is judged to be the most conservative.

The year 2001 meteorological data set consisted of 2 gaps of missing data (57 hours, 0.65%). Traditionally, up to 10% of missing data is considered acceptable. Of the

(1) Based on the meteorological sensitivity cases, year 2001 MET data was found to result in the highest population cost and highest dose and was therefore chosen for the Base Case.

missing gaps, one gap consisted of 6 hours or fewer and interpolation was used to fill in the missing meteorological data. One gap consisted of 52 hours of missing data. Missing meteorological data gaps of more than 6 hours were filled based on substituting data from the same time of day from the period just before or after the missing data in order to account for seasonal variations and the onset of severe weather. It is noted that MACCS results used in the SAMA analysis are the statistical mean of 406 weather sequences (each sequence contains 120 hours of data) chosen at random from pre-sorted weather bins. Due to the large number of samples analyzed, the adjustment of any particular weather sequence has negligible impact on the mean results.

Susquehanna MACCS2 analysis evaluated three meteorological data sets (Calendar years 2000, 2001, and 2003) to ensure that the meteorological data set used in the analysis is adequate. The use of the most conservative data set (year 2001) accounts for any weather sequences that may have been misrepresented by substitute data. Based on the multiple years analyzed, minimum data gaps in the year 2001 meteorological data, and the sampling methodology used, the reported mean results are judged acceptable and appropriate for use in averted cost risk calculations.

Meteorological data was prepared for MACCS2 input as follows:

1. Wind speed and direction from the 10-meter sensor of the site tower were combined with precipitation (hourly cumulative). If the lower wind direction was unavailable, mid and/or upper directions were used to estimate the lower wind direction. Onsite precipitation from Susquehanna Steam Electric Station was utilized.

2. If a brief period (i.e., few hours) of missing data existed for all tower sensors, interpolation was used between hours.

3. For larger data voids (i.e., days), tower data from the previous or following week was utilized to fill data gaps (for the same time of day).

4. Atmospheric stability was calculated according to the vertical temperature gradient of the tower temperature data.

5. Atmospheric mixing heights were specified for morning and afternoon. These values were taken from the document *Mixing Heights, Windspeeds, and Potential for Urban Air Pollution throughout the Contiguous United States* (EPA 1972).

   This source defined morning as being the four-hour period from 0200 to 0600 Local Standard Time and afternoon as being the four-hour period from 1200 to 1600 Local Standard Time.

The Code Manual for MACCS2: Volume 1 (from Appendix A, pages A-1 and A-2) states the following:

"The first of these two values corresponds to the morning mixing height and the second to the afternoon height. In the current implementation, the larger of these two values and the value of the boundary weather mixing height is used by the code."

"In its present form, that atmospheric model implemented in MACCS2 does not allow a change in the mixing layer to occur during transport of the plume. Mixing layer height is assumed to be constant and therefore only a single value is used by the code."

For the Susquehanna MACCS2 analyses, these conditions mean that, only the afternoon mixing height is used since it is larger than the morning mixing height. Note that the boundary weather mixing height, wind speed and stability category are only used when there is no meteorological data. These fixed boundary weather values are ignored by the code when an hourly meteorological data file is supplied by the user, as was the case in the MACCS2 runs for Susquehanna.

As noted above, site meteorological data for years 2002 and 2003 are also evaluated as sensitivity cases to ensure year 2001 data is an appropriate data set. The results are discussed in Section E.7.3.

E.3.8 MACCS2 Results

Tables E.3-4a and E.3-4b show the mean off-site doses and economic impacts to the region within 50 miles of Susquehanna for each of nine release categories calculated using MACCS2 for pre-EPU and post-EPU conditions, respectively. These impacts are multiplied by the annual frequency for each release category and then summed to obtain the dose-risk and offsite economic cost-risk (OECR).

E.4 BASELINE RISK MONETIZATION

This section explains how PPL calculated the monetized value of the status quo (i.e., accident consequences without SAMA implementation). PPL also used this analysis to establish the maximum benefit that could be achieved if all on-line SSES risk were eliminated, which is referred to as the Maximum Averted Cost-Risk (MACR).

The calculations below have been performed using the Unit 1, pre-EPU input. The same process used for the pre-EPU Unit 1 case is also used to establish the MACR for the following cases:

- Unit 2 pre-EPU
- Unit 1 post-EPU
- Unit 2 post-EPU

Section 4.6 summarizes the results for these cases.

E.4.1 Off-Site Exposure Cost

The baseline annual off-site exposure risk was converted to dollars using the NRC's conversion factor of $2,000 per person-rem, and discounted to present value using NRC standard formula (NRC 1997):

$$W_{pha} = C \times Z_{pha}$$

Where:

W_{pha} = monetary value of public health risk after discounting

C = $[1-\exp(-rt_f)]/r$

t_f = years remaining until end of facility life = 20 years

r = real discount rate (as fraction) = 0.03 per year

Z_{pha} = monetary value of public health (accident) risk per year before discounting ($ per year)

The Level 3 analysis showed an annual off-site population dose risk of 1.67 person-rem. The calculated value for C using 20 years and a 3 percent discount rate is approximately 15.04. Therefore, calculating the discounted monetary equivalent of accident dose-risk involves multiplying the dose (person-rem per year) by $2,000 and by the C value (15.04). The calculated off-site exposure cost is $50,232.

E.4.2 Off-Site Economic Cost Risk

The Level 3 analysis showed an annual off-site economic risk of $9,665. Calculated values for off-site economic costs caused by severe accidents must be discounted to present value as well. This is performed in the same manner as for public health risks and uses the same C value. The resulting value is $145,358.

E.4.3 On-Site Exposure Cost Risk

Occupational health was evaluated using the NRC methodology that involves separately evaluating immediate and long-term doses (NRC 1997).

For immediate dose, the NRC recommends using the following equation:

Equation 1:

$$W_{IO} = R\{(FD_{IO})_S - (FD_{IO})_A\}\{[1 - \exp(-rt_f)]/r\}$$

Where:

W_{IO} = monetary value of accident risk avoided due to immediate doses, after discounting

R = monetary equivalent of unit dose ($2,000 per person-rem)

F = accident frequency (events per year) (1.86E-06 (total CDF))

D_{IO} = immediate occupational dose [3,300 person-rem per accident (NRC estimate)]

$_S$ = subscript denoting status quo (current conditions)

$_A$ = subscript denoting after implementation of proposed action

r = real discount rate (0.03 per year)

t_f = years remaining until end of facility life (20 years).

Assuming F_A is zero, the best estimate of the immediate dose cost is:

W_{IO} = R $(FD_{IO})_S$ {[1 – exp(-rt$_f$)]/r}

= 2,000∗1.86E-06 ∗3,300∗{[1 – exp(-0.03∗20)]/0.03}

= $185

For long-term dose, the NRC recommends using the following equation:

Equation 2:

$$W_{LTO} = R\{(FD_{LTO})_S - (FD_{LTO})_A\}\,\{[1 - \exp(-rt_f)]/r\}\{[1 - \exp(-rm)]/rm\}$$

Where:

W_{LTO} = monetary value of accident risk avoided long-term doses, after discounting, $

D_{LTO} = long-term dose [20,000 person-rem per accident (NRC estimate)]

m = years over which long-term doses accrue (as long as 10 years)

Using values defined for immediate dose and assuming F_A is zero, the best estimate of the long-term dose is:

W_{LTO} = R $(FD_{LTO})_S$ {[1 – exp(-rt$_f$)]/r} {[1 – exp(-rm)]/rm}

= 2,000∗1.86E-06 ∗20,000∗{ [1 – exp(-0.03∗20)]/0.03} {[1 –exp(-0.03∗10)]/0.03∗10}

= $967

The total occupational exposure is then calculated by combining Equations 1 and 2 above. The total accident related on-site (occupational) exposure risk (W_O) is:

W_O = W_{IO} + W_{LTO} = ($185 + $967) = $1,152

E.4.4 On-Site Cleanup and Decontamination Cost

The total undiscounted cost of a single event in constant year dollars (C_{CD}) that NRC provides for cleanup and decontamination is $1.5 billion (NRC 1997). The net present value of a single event is calculated as follows. NRC uses the following equation to integrate the net present value over the average number of remaining service years:

$$PV_{CD} = [C_{CD}/mr][1-\exp(-rm)]$$

Where:

PV_{CD} = net present value of a single event

C_{CD} = total undiscounted cost for a single accident in constant dollar years

r = real discount rate (0.03)

m = years required to return site to a pre-accident state

The resulting net present value of a single event is $1.3E+09. The NRC uses the following equation to integrate the net present value over the average number of remaining service years:

$$U_{CD} = [PV_{CD}/r][1-\exp(-rt_f)]$$

Where:

PV_{CD} = net present value of a single event ($1.3E+09)

r = real discount rate (0.03)

t_f = 20 years (license renewal period)

The resulting net present value of cleanup integrated over the license renewal term, $1.65E+10, must be multiplied by the total CDF (1.86E-06) to determine the expected value of cleanup and decontamination costs. The resulting monetary equivalent is $30,771.

E.4.5 Replacement Power Cost

Long-term replacement power costs was determined following the NRC methodology in NRC, 1997. The net present value of replacement power for a single event, PV_{RP}, was determined using the following equation:

$$PV_{RP} = [\$1.2\times10^8/r] * [1 - \exp(-rt_f)]^2$$

Where:

PV_{RP} = net present value of replacement power for a single event, ($)

r = 0.03

t_f = 20 years (license renewal period)

To attain a summation of the single-event costs over the entire license renewal period, the following equation is used:

$$U_{RP} = [PV_{RP} /r] * [1 - \exp(-rt_f)]^2$$

Where:

U_{RP} = net present value of replacement power over life of facility ($-year)

After applying a correction factor to account for SSES's size relative to the "generic" reactor described in NUREG/BR-0184 (NRC 1997)(i.e., 1204 megawatt electric/910 megawatt electric, the replacement power costs are determined to be 7.31E+09 ($-year). Multiplying this value by the CDF (1.86E-06) results in a replacement power cost of $13,598.

E.4.6 Total Cost-Risk

The calculations presented in Sections E.4-1 through E.4-5 provide the on-line, internal events based MACR for a single unit. Given that the SSES SAMA analysis is performed on a site basis and must consider the external events contributions, further steps are required to obtain a site based maximum averted cost-risk estimate that accounts for external events. This estimate, which is referred to as the Modified Maximum Averted Cost-Risk (MMACR) is calculated according to the following steps:

1. For presentation purposes, round each unit's MACR to the next highest thousand,

2. Multiply each unit's rounded MACR from the previous step by a factor of 2 to account for External Events contributions (refer to Section E.5.1.8 for additional details related to the basis for this factor),

3. Add the Unit 1 and Unit 2 results from step 2 together to obtain the MMACR.

4. Repeat steps 1-3 using the post-EPU PRA results to obtain the post-EPU MMACR.

The following table summarizes the results of this process.

SSES MMACR DEVELOPMENT SUMMARY

Input	Pre-EPU		Post-EPU	
	Unit 1	**Unit 2**	**Unit 1**	**Unit 2**
CDF (per year)	1.86E-06	1.83E-06	1.97E-06	1.94E-06
Dose-Risk (person-REM, single year)	1.67	1.63	1.90	1.86
OECR ($/yr)	9,665	9,405	11,151	10,845
Plant Net MWe	1204	1209	1304	1306
Output				
Offsite Exposure Cost-Risk	$50,232	$49,029	$57,151	$55,947
Offsite Economic Cost-Risk	$145,358	$141,448	$167,707	$163,105
Onsite Exposure Cost-Risk	$1,152	$1,133	$1,220	$1,201
Onsite Cleanup Cost-Risk	$30,771	$30,275	$32,591	$32,095
Replacement Power Cost-Risk	$13,598	$13,434	$15,598	$15,384
Total Unit MACR	$241,111	$235,319	$274,267	$267,732
Rounded to Next Highest Thousand	$242,000	$236,000	$275,000	$269,000
Unit MMACR (Includes External Events (MACR x 2))	$484,000	$472,000	$550,000	$538,000
Site MMACR	$956,000		$1,088,0000	

E.5 PHASE 1 SAMA ANALYSIS

The Phase 1 SAMA analysis, as discussed in Section E.1, includes the development of the initial SAMA list and a coarse screening process. This screening process eliminated those candidates that are not applicable to the plant's design or are too expensive to be cost beneficial even if the risk of on-line operations were completely eliminated. The following subsections provide additional details of the Phase 1 process.

E.5.1 SAMA Identification

The initial list of SAMA candidates for SSES was developed from a combination of resources. These include the following:

- SSES PRA results and PRA Group Insights
- Industry Phase 2 SAMAs (review of the potentially cost effective Phase 2 SAMAs for selected plants)
- SSES Individual Plant Examination IPE (SSES IPE) (PPL 1991)
- SSES IPEEE (PPL 1994)

These resources are judged to provide a list of potential plant changes that are most likely to reduce risk in a cost-effective manner for SSES.

In addition to the "Industry Phase 2 SAMA" review identified above, an industry based SAMA list was used in a different way to aid in the development of the SSES plant specific SAMA list. While the industry SAMA review cited above was used to identify SAMAs that might have been overlooked in the development of the SSES SAMA list due to PRA modeling issues, a generic SAMA list was used as an idea source to identify the types of changes that could be used to address the areas of concern identified through the SSES importance list review. For example, if Instrument Air availability was determined to be an important issue for SSES, the industry list would be reviewed to determine if a plant enhancement had already been conceived that would address Susquehanna's needs. If an appropriate SAMA was found to exist, it would be used in the SSES list to address the Instrument Air issue; otherwise, a new SAMA would be developed that would meet the site's needs. This generic list was compiled as part of the development of several industry SAMA analyses and has been provided in Addendum 1 for reference purposes.

It should be noted that the process used to identify SSES SAMA candidates focuses on plant specific characteristics and is intended to address only those issues important to the site. In this case, the existing capabilities of the plant preclude the need to include many of the potential SAMAs that have been identified for other BWRs. As a result, the types of changes that might be cost effective for SSES are reduced and the SAMA list is relatively short. For example,

- A portable 480V AC generator is available to provide long term power to the 125V DC battery chargers in SBO conditions. The availability of 125V DC supports SRV operation to allow diesel fire pump (DFP) injection after HCTL requires emergency depressurization, which challenges HPCI/RCIC operability.

- Nitrogen bottles are available to support long term ADS valves. The nitrogen bottle supply is sized to be available for the entire PRA mission time of 24 hours.

- Local, manual containment vent capability exists. This provides for an alternate means of venting the containment in the event that the remote vent capability fails.

- 2 loops of RHRSW provide a low pressure injection source that is not dependent on the suppression pool or CST and can be aligned to either RHR loop. In addition, these pumps are located outside the reactor building and would potentially be available after containment venting/failure.

- The DFP can be aligned for injection in SBO conditions through either a hard piped connection or a fire hose (credit currently limited by flow considerations)

- RCIC can be operated without DC power (not credited in the PRA)

- Given HCTL violation, procedures allow for maintaining reactor pressure at a level capable of sustaining RCIC if the DFP is not available for injection.

- The “E” emergency diesel generator (EDG) is available to replace any of the four primary EDGs in the event of a failure.

- ADS not inhibited for non ATWS conditions, which reduces the importance of the manual depressurization action.

The fact that the SSES SAMA list is relatively small compared with previous SAMA submittals is considered to be driven by actual plant capability. The plant features identified above provide effective means of reducing important areas of plant risk.

E.5.1.1 Level 1 SSES Importance List Review

The SSES PRA was used to generate a list of events sorted according to their risk reduction worth (RRW) values. The top events in this list are those events that would provide the greatest reduction in the SSES CDF if the failure probability were set to zero. The events were reviewed down to the 1.02 level for both the pre-EPU and post-EPU models, which approximately corresponds to a 2 percent change in the CDF given 100 percent reliability of the event. If the dose-risk and offsite economic cost-risk were also assumed to be reduced by a factor of 1.02, the corresponding averted cost-risk would be $4,728 for Pre-EPU Unit 1. After applying a factor of 2 to estimate the potential impact of External Events (refer to Section E.5.1.8), the result is about $9,457. Similarly, the Pre-EPU Unit 2 result was determined to be $9,338, which yields a pre-EPU site total of $18,795 for both units. Similarly, for post-EPU conditions, the total is $21,304.

The lower end of implementation costs for SAMAs are expected to apply to procedural changes, which have previously been estimated to cost about $50,000 (CPL 2004). Given that the SSES important list was reviewed down to a level corresponding to a site-wide averted cost-risk of less than $21,304 (post-EPU), all events that are likely to yield cost beneficial improvements are believed to have been addressed by the review process. In fact, if the $50,000 lower end implementation cost were used to set the RRW threshold for SSES, the cut off RRW value would be about 1.05 rather than 1.02. Due to the relatively low CDF calculated for SSES, additional events were reviewed to develop a more robust SAMA list.

Table E.5-1a through E.5-1d document the disposition of each event in the pre-EPU and post-EPU Level 1 SSES RRW list for both Units 1 and 2. Note that no basic events were preemptively screened from the process even if they solely represent sequence flags. Whatever the event, the intent of the process is to determine if insights can be gleaned to reduce the risk of the accident evolutions represented by the events listed. However, unique SAMAs are not identified for all of the events in the RRW list. Previously identified SAMAs are suggested as mitigating enhancements when those SAMAs (or similarly related changes) would reduce the RRW importance of the identified event. It is recognized that in some cases, additional requirements may need to be imposed on the SAMA to get a reduction in the RRW value for the basic event listed. In these cases, if an existing SAMA can approximate such an impact, then it is considered to address the relevant event and provide a first order indication of the potential benefit. A more detailed PRA analysis may then be performed to better estimate the potential cost-benefit if it is determined to be warranted.

E.5.1.2 Level 2 SSES Importance List Review

A similar review was performed on the importance listings from the Level 2 results. In this case, a composite file based on the top 90 percent of all dose-risk (and over 96 percent of offsite economic cost-risk) was used to identify the largest contributors to Level 2 risk. This file was composed of the following release category results: High/Early, High/Intermediate, Moderate/Intermediate, and Moderate/Late. This method was chosen to prevent high frequency-low consequence events from dominating the importance listing.

The Level 2 RRW values were reviewed down to the 1.02 level. As described for the Level 1 RRW list, events below the 1.02 threshold value are estimated to yield an averted cost-risk less than $21,304 and are not considered to be likely candidates for identifying cost effective SAMAs. As such, the events with RRW values below 1.02 were not reviewed. Tables E.5-2a through E.5-2d document the disposition of each event in the pre-EPU and post-EPU Level 2 SSES RRW list for both Units 1 and 2. The same groundrules related to event disposition in the Level 1 importance tables were utilized in the Level 2 importance tables.

E.5.1.3 SSES PRA Group Insights

While the PRA model's importance lists identify the highest contributors to plant risk based on the latest available information, previous PRA models provided some insights that are considered to be potentially valuable even if they do not impact the largest contributors in the current risk profile. One potential plant enhancement that was identified based on previous PRA model insights has been added to the SAMA list for completeness:

- Install 100 Percent Capacity Battery Chargers (SAMA 4)

SAMA 4 is related to ensuring the plant's DC requirements can be met even when the batteries are unavailable. For scenarios in which the batteries have failed or are out of service for maintenance, the chargers could supply the DC loads if they were replaced with higher capacity units and procedures were developed to remove the failed batteries from the circuit. Currently, the chargers cannot support the full DC load requirements early in LOOP or LOCA sequences.

In this case, the importance list review has also identified this as a potential SAMA based on loss of DC scenarios caused by battery failure/unavailability.

E.5.1.4 Industry SAMA Analysis review

The SAMA identification process for SSES is primarily based on the PRA importance listings/insights, the IPE, and the IPEEE. In addition to these plant specific sources, selected industry SAMA analyses were reviewed to identify any Phase 2 SAMAs that were determined to be potentially cost beneficial at other plants. These SAMAs were further analyzed and included in the SSES SAMA list if they were considered to be potentially cost beneficial for SSES. The following subsections provide a more detailed description of the identification process.

While many of these SAMAs are ultimately shown not to be cost beneficial, some are close contenders and a small number have been shown to be cost beneficial at other plants. Use of the SSES importance ranking should identify the types of changes that would most likely be cost beneficial for SSES, but review of selected industry Phase 2 SAMAs may capture potentially important changes not identified for SSES due to PRA modeling differences. Given this potential, it was considered prudent to include a review of selected industry Phase 2 SAMAs in the SSES SAMA identification process.

The Phase 2 SAMAs from the following U.S. nuclear sites have been reviewed:

- V.C. Summer (SCE&GC 2002)
- H.B. Robinson (CPL 2002)
- Palisades (NMC 2005b)
- Dresden (Exelon 2003a)
- Quad Cities (Exelon 2003b)
- Brunswick (CPL 2004)
- Monticello (NMC 2005a)

Three pressurized water reactor (PWR) and four BWR sites were chosen from available documentation to serve as the Phase 2 SAMA sources. Most of the Phase 2 SAMAs from these sources are not included in the SSES SAMA list. The industry Phase 2 SAMAs that were considered to have the potential to be cost effective for SSES were independently identified through the SSES importance list review. The remaining industry Phase 2 SAMAs were judged not to provide any significant benefit to the plant, were determined to already in place at SSES, or were addressed by SAMAs more

suitable to SSES's needs. These SAMAs were not considered further and no SAMAs unique to the review of the industry Phase 2 SAMAs were included in the SSES SAMA list.

E.5.1.5 SSES IPE Plant Improvement Review

The SSES IPE generated a list of risk-based insights and potential plant improvements. Typically, changes identified in the IPE process are implemented and closed out; however, there are some items that are not completed due to high projected costs or other criteria. Because the criteria for implementation of a SAMA may be different than what was used in the post-IPE decision-making process, these recommended improvements are re-examined in this analysis. The following table summarizes the status of the potential plant enhancements resulting from the IPE process and their treatment in the SAMA analysis:

Description of Potential Enhancement	Status of Implementation	Disposition
Revision of the control strategy for HPCI suction transfer, and raising of the HPCI/RCIC backpressure trip setpoints in order to ensure timely availability and alignment of HPCI and RCIC for high pressure injection.	Implemented.	No further review required.
Revision of the control logic which would allow immediate operator control of LPCI and Core Spray injection and installation of a bypass switch on the Low Pressure Permissive.	Implemented on Core Spray.	The current PRA indicates these control issues are no longer an important issue. No further review required.
Provide an alternate, independent power supply for the Condensate Transfer Pumps.	Not Implemented. This improvement was designed to achieve two purposes: RHR keep fill following a LOOP and a source of low pressure water should the fire pump fail. A head tank has been installed for a passive ECCS keep fill.	The keep fill issue has been adequately addressed. Fire pump reliability is not an important issue for SSES and requires no further review.
Guidance for aligning the Control Rod Drive system for reactor vessel high pressure makeup.	Implemented.	No further review required.

Description of Potential Enhancement	Status of Implementation	Disposition
Revised guidance regarding primary containment control; e.g., use of RWCU for heat removal, water mass addition to the suppression pool as a means of slowing containment pressurization, redefinition of the HCTL, and priority on core integrity protection rather than containment integrity.	Implemented.	No further review required.
Revised guidance regarding RPV flooding actions to allow adequate core cooling to be verified even when reactor water level instrumentation is not available.	Implemented.	No further review required.
Revise guidance regarding reactor vessel level control to allow SRVs to cycle automatically rather than to be manually operated.	Not implemented.	Determined not to be required for safe operation of the plant. No further review required.
Revise guidance regarding reactor scram recovery actions to ensure that a plant cool down does not occur unless the reactor is shutdown with control rods.	Implemented.	No further review required.
Guidance to vent primary containment when fission products have not been released from the core and specific plant conditions exist.	Implemented. SSES procedures address containment venting with and without core damage.	No further review required.

E.5.1.6 SSES IPEEE Plant improvement review

Similar to the IPE, there may be a number of proposed plant changes that were previously rejected based on non-SAMA criteria that should be re-examined. In addition, there may be issues that are in the process of being resolved, which could be important to the disposition of some SAMAs. The IPEEE was used to identify these items.

The following table summarizes the status of the potential plant enhancements resulting from the IPEEE process and their treatment in the SAMA analysis:

Description of Potential Enhancement	Status of Implementation	Disposition
Address miscellaneous equipment issues that may impact the plant response during a seismic event (office furniture that may impact safety related equipment, transient items that are in close proximity to safety related equipment, equipment with missing screws or broken latches).	Implemented.	No further review required.
Improve housekeeping procedures and training on seismic issues (transient equipment control, performance of periodic walkdowns, and training to improve seismic awareness)	Implemented	No further review required.
Secure equipment with interaction concerns (electrical load centers, control and instrumentation panels and cabinets, CRTs in the MCR).	Implemented.	The issue with the CRTs in the main control room was thought to be that the CRTs were incorrectly fastened to the panel. A subsequent walkdown revealed that the fastenings were correct. No further review required.
Add a second restraining ring to the bottom of the H2/O2 bottles where they are only attached by a single ring.	Not implemented.	The subject H2/O2 bottles were spares and were removed. No further review required.
Investigate the need for drip shields for panels 1(2)Y115 and 1(2)Y125.	Not implemented	Determined not to be required. A redundant power source is available if the subject fails due to spray. No further review required.
Revise "natural Phenomena" procedures to discuss the potential impact a large seismic event could have on the fire protection system.	Implemented.	No further review required.

E.5.1.7 Use of External Events in the SSES SAMA Analysis

In addition to the incorporation of previous IPEEE insights, an effort was made to make further use of the IPEEE in the SAMA process. However, the SSES IPEEE was not maintained as a “living” analysis. This limits the capability of the models that make up the IPEEE as they do not include the latest PRA practices nor do they necessarily represent the current plant configuration or operating characteristics. The fact that the models are not currently in a quantifiable state presents further difficulty because the results are limited to what has been retained from the original analysis. These factors limit the qualitative insights and quantitative estimates that can be made with regard to external events contributors.

On a larger scale, given that the industry has generally not pursued external events modeling at a level consistent with internal events models, the technology for external events analysis is not as robust or refined. The result is that the CDF values yielded by the internal and external events models are not necessarily comparable.

The type of information available for these events is also dependent on the manner in which they were addressed in the IPEEE. For instance, the fire analysis was performed using the methodology prescribed in the PRA Procedures Guide (NRC 1983a), which produced results similar to those yielded by the internal events analysis. However, the Seismic Margins Analysis (SMA) does not produce a CDF and is predicated on the ability to evaluate the seismic durability of the equipment required to safely shut the plant down. The results of this kind of analysis do not directly lend themselves to the type of frequency-based analysis used in the SAMA evaluation.

The external events models are considered to be useful tools for identifying important accident sequences and mitigative equipment, but for the reasons stated above, the quantitative results can not be directly combined with those from the internal events models. Section E.5.1.8 provides a description of the method used to estimate the quantitative contribution of external events in the SAMA analysis.

Qualitatively, the IPEEE was used in the SSES SAMA analysis primarily to identify the highest risk external events based accident sequences and the potential means of reducing the risk posed by those sequences. The SSES IPEEE examined the risk due to the following types of initiators:

- Internal Fires
- Seismic Events

- High Winds
- External Flooding and Probable Maximum Precipitation
- Transportation and Nearby Facility Accidents

The IPEEE indicated that the other external hazards listed in Section 2 of NUREG-1407 were not included in the IPEEE because they were either not applicable to SSES or because they were included in other analyses (IPE or Station Blackout Analysis) (NRC 1991a). For the SAMA analysis, the same exclusions are considered to apply and only the five initiating event types addressed in the IPEEE are used in the SAMA identification process. The following subsections document this process and the results.

E.5.1.7.1 Fires

As discussed above, the techniques used to model external events vary according to the type of initiating event being analyzed. The SSES Fire model shared many of the same characteristics as its contemporary internal events model. However, limitations on the state of technology for Fire PRA, lack of an update program, and some divergences from what were typical fire modeling techniques produced results that are not comparable to the current internal events results.

While the ability to directly compare the results of the internal events and fire models is limited, information is available that may be used to identify potential fire related plant enhancements. For each Fire Zone contributing to the CDF, a description of the impacted equipment and corresponding CDF is available. This information is used to determine which Fire Zones are the most important to SSES and the type of equipment or function that could be used mitigate an accident resulting from a fire in that fire zone (i.e., a SAMA candidate). As details of the accident progression and component level results are not available, a more specific SAMA identification process is not readily available.

Given that the Fire Zone Results were updated in response to the NRC's audit of the IPEEE, the audit response results are used in this process. The results for all contributing Fire Zones are summarized below and are included in the SAMA review:

Fire Zone	Equipment Lost	CDF, Per cycle
1-2B	Division I and II emergency service water (ESW), HPCI	2.1E-9
0-28B-II	Battery Charger Area, Channels A and B DC	1.3E-9
0-27C	UCSR, Channels A and B DC Power	3.5E-10
0-25E	LCSR, HPCI and Div. I RHR	3.3E-9
Various	HPCI and RCIC	3.3E-8
0-26H	Panel 1C601 – Auto Initiation of ECCS	5.1E-9
Total		4.5E-8

Fire Zone 1-2B

The initial assessment of Fire Zone 1-2B in the IPEEE was performed assuming that fires did not spread between cabinets. The re-evaluation performed during the NRC audit resulted in the alteration of this assumption such that multiple cabinet fires were considered. At the time of the IPEEE assessment and in the initial stages of the IPEEE audit, a large fire in zone 1-2B was assumed to result in a LOOP for this Fire Zone. Given that this fire would also cause a loss of the four ESW pumps (taking no credit for raceway wrap), the consequence would be a Station Blackout. As the IPEEE audit calculations were prepared, the cable database was searched and it was determined that there are no cables in Fire Zone 1-2B that would affect off site power (OSP). The audit response does indicate, however, that a fire can cause the loss of the high pressure systems.

Loss of the high pressure systems is considered to be addressed by the installation of an engine driven HPI pump (SAMA 1).

Fire Zone 0-28B-II

This fire zone includes multiple permanent ignition sources, including 21 cabinets and 6 battery chargers that support both divisions of DC power. Given the wide range of equipment in this zone, a fire that consumed the entire zone would fail significant portions of both divisions of 125V DC power. However, based on COMPBRN IIIe calculations, cabinet fires were restricted to the cabinet of origin and no spreading was assumed to occur between cabinets. As a result, the importance of a fire in this zone depends on the equipment that is supported by the ignition source.

Based on a review of the IPEEE, the critical fires in zone 0-28B-II are those that impact Class 1E 125V DC channel A. These include fire events for:

- 1D612 – 125V DC class 1E load center
- 1D613 – 125V DC class 1E channel A charger (fails both the charger and battery and leads to loss of 1D612)
- 1D614 – 125V DC class 1E distribution panel (powered by 1D612)

Fires in these sources result in loss of an entire channel of emergency DC power, which impacts the following equipment:

- CIG (MSIV closure)
- RCIC
- Division I of ADS
- Division I of ESW
- Division I of CRD
- Division I of Core Spray
- Division I of RHRSW (by loss of breaker control)
- Division I of RHR

Given that loss of a single division of DC power alone leaves the remaining division's equipment available, additional failures are required in order for core damage to occur. However, random failure of the alternate division DC load center or bus is a critical failure that can eliminate most means of providing core cooling and/or heat removal.

In order to address this scenario, any mitigating effort would have to function without DC power support or include a means of bypassing the failed DC buses. Review of the internal events importance results revealed that DC bus failure is also an important internal events contributor and the SAMA developed to address non-fire related bus failures could also be used to reduce fire risk:

- Provide Direct Feeds to Required DC Loads (SAMA 9)

This SAMA provides a means of providing power to critical loads when the bus supplying the equipment is unavailable. Aligning direct leads from the Division II battery chargers or batteries to the critical Division I equipment could provide a means of cooling the core when a fire has damage the Division I DC distribution system and

random equipment failures prevent an adequate response from the Division II equipment.

Fire Zone 0-27C

Fire Zone 0-27C (Upper Cable Spreading Room) contains cables for both divisions of 125V DC power for both units (1/2D614 and 1/2D624). While the buses themselves are not impacted by this fire, the same SAMA that addresses the bus failures identified for Fire Zone 0-28B-II would be effective here:

- Provide Direct Feeds to Required DC Loads (SAMA 9)

Burn-up and failure of the power cable to required loads could be mitigated by running direct feeds from available DC sources to the equipment.

Fire Zone 0-25E

Fire Zone 0-25E (Lower Cable Spreading Room) contains conductors for HPCI and Division I of RHR. Loss of this equipment alone does not present a critical challenge to the plant given that RCIC is available for HPI, ADS is available, and at least one division of heat removal and low pressure injection are available. Some maintenance conditions could present a challenge to HPI capabilities, but heat removal is possible through venting even if RHR heat removal is lost through the fire event and a coincidental maintenance task.

Additional HPI capability could be added through the installation of a high pressure diesel driven injection pump (SAMA 1).

Fifteen Various Fire Zones

In the original IPEEE, fifty five Fire Zones were screened from further review based on a low combustible loading. The IPEEE audit resulted in further evaluation of these zones to determine if potentially important fire consequences were masked as a result of that screening assumption. A more detailed review performed during the audit demonstrated that thirty one of these zones met the SSES defense in depth criteria and did not require additional analysis. Of the fire zones that did not meet the defense in depth criteria, seven were evaluated in conjunction with Control Room fire calculation EC-013-0859 (PPL 2002) and it was determined that the control capability and procedural guidance for operating the plant outside of the Main Control Room was adequate. No SAMAs are considered to be required to address Main Control Room abandonment. The remaining seventeen were subjected to a CDF analysis. Two of the seventeen zones for which CDFs were calculated are zones 0-27C and 0-25E, which are addressed above.

The final fifteen zones could not demonstrate defense in depth since the availability of either HPCI or RCIC was not certain. The CDF calculations for these rooms were performed assuming that both HPCI and RCIC were failed. Given that HPI is the main function impacted by a fire in these zones, installation of a high pressure, drive diesel injection pump (SAMA 1) would reduce the risk for these fire zones.

Fire Zone 0-26H

This fire zone includes the Main Control Room cabinets for a single unit and the cabinets that are shared between units (common cabinets). The IPEEE identified three cabinets that were the most significant to Main Control Room fire risk at SSES: 1C614, 0C653, and 1C601.

Cabinet 1C614 contains two subsections that are divided by a full metal barrier to maintain divisional separation. It was determined in the IPEEE, however, that a fire in either division would disable both RCIC and HPCI. While loss of this equipment in not trivial, defense in depth was met given that a diverse body of equipment remained available, including CRD, both divisions of ADS, both divisions of Core Spray, and both divisions of RHR in LPCI mode. The installation of diesel driven HPI pump (SAMA 1) is considered to address the loss of HPI capability presented by a SAMA in this cabinet. In addition, the original IPEEE Fire analysis did not consider the need to evacuate the Main Control Room in the event of a fire. If required, the operators could use the electrically isolated RCIC controls on the Remote Shutdown panel to meet HPI requirements.

Cabinet 0C653 controls breakers for both sources of offsite power, as well as EDG power, to all four ESS buses for each unit. Based on the information provided in the IPEEE, the only significant impact of a fire in this cabinet is a consequential LOOP/SBO. In order for a LOOP to occur, a hot short trip would be required for each startup bus (0A103 and 0A104). Both hot shorts are required for a LOOP because a single hot short will only cause loss of a single division of power. After these events initiate a LOOP, there are two other hot short scenarios in this cabinet that could lead to an SBO. The first is a combination of four hot shorts to prevent closure of the EDG breaker to each emergency bus. The second is a combination of two hot shorts that would result in closure of the ESW spray pond bypass valves. Closure of these two valves would result in loss of ESW flow to the EDGs and subsequent over temperature failure. In the unlikely event that an SBO would occur due to such a combination of fire initiated hot shorts, HPCI, RCIC, and the fire suppression system would still be available for vessel injection. For long term SBOs, procedures exist to operate RCIC with the high backpressure trips bypassed and DC control power is available through the portable

station generator. Alternatively, the SRVs could be maintained open and injection could be provided by the DFP. No additional SAMAs are considered to be required to mitigate fires in this panel; however, the high pressure diesel driven pump (SAMA 1) would reduce the risk of this fire.

The original IPEEE Fire analysis assumed the fire barriers in cabinet 1C601 would prevent the spread of a fire to the other sections of the cabinet. The IPEEE audit response did not credit these barriers and assumed loss of the entire panel and that control room abandonment was required. In this case, the Remote Shutdown Panel (RSP) would be used to cool down the reactor. In addition to the option to operate the plant from the RSP, local control is available. For example, the ADS valves can be opened from the Upper and Lower Relay Rooms and two additional RHR pumps can be started locally per procedure OP-149-002. Given that multiple control options are available to the operators and that the only equipment disabled by the fire are the controls in the MCR, no SAMAs are considered to be required to address a fire in cabinet 1C610.

Fire SAMA Identification Summary

Based on the review of the SSES Fire Zone results, no SAMAs have been identified for inclusion on the SAMA list that are unique to the Fire analysis. However, two SAMAs were identified that could reduce the SSES fire risk that were also identified as a means of reducing the internal events risk. These SAMAs include:

- Diesel Driven HPI Pump (SAMA 1)
- Provide Direct Feeds to Required DC Loads (SAMA 9)

E.5.1.7.2 Seismic

The EPRI seismic margins methodology (EPRI 1991) is used to identify the minimal set of equipment required to safely shut the reactor down and to determine if that equipment is capable of surviving the Review Level Earthquake (RLE). Equipment that is not capable of withstanding the RLE is identified and required to be addressed. While methods exist for using this information to develop a seismically induced core damage frequency, this was not performed as part of the SSES IPEEE. It should also be noted that even in a seismic analysis developed to yield a CDF, the pedigree of information is not equivalent to what is used in the internal events models. Given that there is a limited amount of seismic response information available for nuclear power plants, analysis techniques developed to model the plant response often compensate by ingraining a conservative bias in their methodologies to prevent overestimating the

capabilities of the plants. While seismic risk evaluations are helpful in the identification of potential plant weaknesses, the methodologies have not evolved to a point where the results can be directly compared with the internal events models.

As indicated above, the SMA results are useful in the identification of potential plant weaknesses, but the foundations of the SMA should be acknowledged when considering the results. For example, the SSES IPEEE identifies multiple examples of the conservative biases that are present in the plant's SMA:

1. The design basis ground spectra were based on a conservative envelope of several natural earthquakes that occurred on soil and rock sites (SSES on primarily founded on bedrock).

2. A synthetic earthquake acceleration time history was derived based on the 1952 Taft Earthquake for use as input to generate floor response spectra. A response spectrum of the synthetic time history enveloped the original design basis ground response spectrum with a significant margin that varies in magnitude along the frequency range.

3. Frequency broadening of the in-structure response spectrum curves by ±15 percent introduces a substantial reserve margin in the seismic qualification of equipment and attached components.

4. With the exception of the ESSW pumphouse, the effects of structural embedments on increasing the lateral stiffness of the seismic models were not considered.

5. For the SSES design, the structural damping values used for structures and equipment are considered to be conservative. These conservative damping values result in unrealistic high seismic demand for seismic qualification of structures and equipment.

6. Seismic design of Category I structures was performed by using linear elastic techniques. However, experience tells us that past near failures and failures involve some degree of yielding, which results in nonlinear inelastic energy absorption. The original seismic design documents did not account for these inelastic energy absorption mechanisms and consequently substantial factors of safety were built in at various design states.

7. The design concrete compressive strength is 4000 psi for all seismic Category I structures. But, the increase in concrete strength as it ages was not accounted for in the development of the two dimensional lumpe-mass models. This increase will inevitably increase the stiffness of the primary lateral load carrying system and, hence, change the fundamental building frequencies creating a better structural safety margin.

8. Whenever dynamic analysis was performed for structures and equipment, the dynamic response was obtained by performing modal analysis in the frequency domain in lieu of the time domain. It is industry recognized that the results of the frequency domain analysis are generally 5 percent to 30 percent higher than the respective more-realistic time domain results.

9. For seismic equipment qualification by testing, the test response spectra usually envelop the required response spectra over the frequency range of interest with a reserve margin of 10 percent or higher.

10. For dynamic qualification of similar pieces of equipment, dynamic demand was usually calculated by conservatively enveloping demand at different floor locations. This usually results in unrealistic dynamic demand with more than one peak and broad frequency content.

11. The flexibility of floor slabs in the vertical direction was conservatively represented by adding uncoupled linear springs to the lumped mass models representing the primary lateral load carrying systems. This simple representation overlooks the structural continuity of the structure and consequently overestimates the in-structure response spectra.

With these limitations in mind, the SSES IPEEE seismic results and history were reviewed in order to determine if there were any unresolved issues that could impact SSES risk. The types of issues that were of interest included:

- Unfinished plant enhancements that were determined to be required to ensure the equipment on the Safe Shutdown List would be capable of withstanding the RLE,
- Additional plant enhancements that were identified as means of reducing seismic risk but were not implemented at the plant.

An effort was also made to use the results of the equipment and structural screening documentation to determine if any outlier issues that were screened in the IPEEE could impact seismic risk at SSES. The following subsections summarize this review.

Unimplemented Plant Enhancements

As documented in section E.5.1.6, all of the seismic based plant enhancements for SSES have been addressed. No further review is required.

Motor Control Centers

The High Confidence of Low Probability of Failure (HCLPF) value for motor control center (MCC) 2B237 was determined to be 0.26 in the IPEEE, which is below the 0.3 value required for equipment on the Safe Shutdown Equipment List (SSEL). The SSES

Seismic Review Team (SRT) reviewed this equipment and determined that no plant modification was required based on the following:

- The HCLPF value is more than twice higher than the design basis Safe Shutdown Earthquake's (SSE) peak ground acceleration.
- It is not certain that the potential impact between the MCC and the adjacent HVAC duct could lead to malfunction of internal components.
- There is some safety margin available between the required Seismic Margins Earthquake (SME) (which is the same as the RLE) loads and test loads for the internal components to compensate for some or all of the additional dynamic loads due to impact.
- MCC 2B237 is not required for core protection. It is only on the SSEL to provide depth for suppression pool cooling. MCC 2B237 controls valves for Div. 1 RHR and RHRSW associated with heat exchanger A and RHR flow to the suppression pool. Even if MCC 2B237 fails, time is available for local manual valve operation.

As indicated in the SRT's assessment, even if it is assumed that a seismic event disables MCC 2B237, the RHR heat removal valves can be operated locally without time stress as a meaningful factor. The internal events model has analyzed these operator actions and includes credit for local valve manipulations given the failure of remote operation for loss of DHR scenarios. In those cases, the failure probability of the local valve manipulation has been estimated to be 6E-4. Similar credit is likely available after a seismic event. Given that the RHR and RHRSW valves are located in a seismically sound structure, the environmental performance shaping factors due to building failures should not be an issue. If the Extreme Stress multiplier of 10 from NUREG/CR-1278 (NRC 1983b) is applied to this HEP to account for any psychological effects of the earthquake, the failure probability increases to only 6E-3, which is comparable to the mitigating equipment and alignment failures in previous SAMA submittals (NMC 2005a) (CPL 2004). Given that a reasonably reliable means of opening the RHR/RHRSW valves is available without motive power from MCC 2B237, that conservatism is built into the judgment that MCC 2B237 could fail under the RLE loads, and that an additional division of RHR is available to support the decay heat removal function, no SAMAs are considered to be required to address this outlier.

Low Voltage Switchgear and Distribution Panels

It was noted during the IPEEE Seismic walkdown that there were breaker hoists stored on top of low voltage switchgear and distribution panels. As indicated in Section

E.5.1.6, action was taken to change the storage location of the breaker hoists and this issue has been closed out. No SAMAs are required for these outliers.

Motor Operated Valves

The outliers for this category include valves HV-155-F006 (HPCI injection valve) and HV-251-F024B (SPC return valve). The HCLPF value for each of these valves was determined to be 0.21g in the IPEEE, which is below the value of 0.3g required for items on the SSEL. The SSES SRT considered these results in conjunction with the operational requirements of the valves during seismic events and determined that no plant changes were required to improve their HCLPF values for the following reasons, as stated in the IPEEE:

- The HCLPF values are more than twice the design basis SSE's peak ground acceleration,
- It is not certain that the potential impact between the operator of the valve and the adjacent item could lead to malfunction of the valve. In the case of HV-155-F006, the dynamic interaction between the valve's stem protector and PSV-15513 is the controlling item in the calculated HCLPF value. A gap of approximately 0.75 inches is provided between the stem and the stem protector and should impact occur, only slight bending of the protector would result.
- Past earthquake experience and generic testing results strongly indicate that the actual structural damping values for piping systems are higher than the recommended damping value in EPRI NP-6041-SL or the value used in calculating dynamic displacements.
- The calculated valve displacement values were obtained by performing modal piping analyses in the frequency domain in lieu of the time domain. It is industry recognized that the results of the frequency domain analysis are generally 5 percent to 30 percent higher than the respective more realistic time domain results.
- Similar to failure of MCC 2B237, the consequence of failing valve HV-251-F024B impacts the DHR function. In this case, there are at least two mitigating factors that marginalize the importance of this failure. The first is that failure of HV-251-F024B does not preclude the use of alternate SDC. Once the reactor is depressurized, the "B" loop of RHR can still be used to provide DHR by taking suction from the suppression pool, injecting through the RHR heat exchangers, and returning flow to the suppression pool through the SRVs. The second mitigating factor is that the seismically induced failure of HV-251-F024B is only expected to fail the valve operator such that local, manual operation of the valve is still possible.

Given the existence of an alternate means of using the “B” RHR loop for DHR when valve HV-251-F024B has failed, the capability to open the valve locally for the expected failure mode, and the margin present in the methodologies used to assess the HCLPF value of 0.21g, no SAMAs are considered to be required to address the seismically induced failure of this valve. Also, as noted in the discussion for failure of MCC 2B237 above, an analysis of local valve manipulations for DHR recovery has been performed for the internal events analysis. The estimated reliability of this action is comparable to what has been estimated for other SAMAs even when potential stress factors related to a seismic event are considered and local manipulation of the valve is considered to be a viable recovery path.

The circumstances related to the potential failure of the HPCI injection valve (HV-155-F006) are similar to those for valve HV-251-F024B in that the assessment of the 0.21g HCLPF value is considered to be conservative and that another means of providing the affected function is available. In this case, the alternate HPI source is another system on the SSEL (RCIC) rather than an alternate use of the same train of the same system. In both cases, the affected function is still available. In the event that RCIC fails in conjunction with HV-155-F006, the ADS valves and low pressure injection/DHR would still be available to provide core cooling. No SAMAs are considered to be required to address the seismically induced failure of this valve.

Control and Instrumentation Panels and Cabinets

Two types of outliers were identified during the review of the plant control and instrumentation panels and cabinets. The first was that multiple close proximity panels In the Main Control Room and Relay Rooms were not fastened together. As indicated in Section E.5.1.6, these panels have been fastened together and the issue has been closed out.

The second outlier that was identified was the means used to secure the CRTs to the panels in the MCR. This issues was investigated and it was subsequently determined that the supports for the CRTs were adequate (PPL 1998). No SAMAs are required.

Automatic Transfer Switches

Walkdown of the “A” through “E” Diesel Generator Buildings revealed that the gap between an HVAC support and the top of automatic transfer switch #OATS556 (about ½ inch) in Diesel Generator Building “E” is inadequate for SME loads. The HCLPF value estimated for OATS556 in the IPEEE was 0.25g, which is less than the 0.3g value required for items on the SSEL. However, the SRT did not consider this condition to warrant a plant change for the following reasons:

- The HCLPF value is equal to 2.5 times the design basis SSE's peak ground acceleration.
- There is still available safety margin between the required SME loads and the test loads for the internal components to compensate for some or all of the additional dynamic loads due to impact.
- It is not certain that the potential impact between the switch panel and HVAC support could lead to malfunction of the internal components.
- SSES has redundant safety systems. For this condition, the availability of Diesel Generator Building "A" through "D" will provide the Class 1E power in the event that OATS556 does not survive an SME.
- It is conservatively assumed in calculating the HCLPF value of 0.25g that the zero period acceleration (ZPA) at the basement floor of Diesel Generator Building "E" is 0.3g for SME loading. However, a more accurate representation of the soil/structure interaction model will likely show a de-amplification of ground motion at basement level due to inertial and kinematic effects.

The insights provided by the SRT present an argument that indicates the failure of the "E" diesel generator automatic transfer switch is unlikely in an SME. Review of the internal events model shows that the unavailability of the "E" diesel generator would have a relatively large impact on CDF given a LOOP, which is likely during a Review Level Earthquake. However, further review of the OATS556 automatic transfer switch revealed that it has no impact on EDG availability and would likely serve no purpose in a seismic event.

The function of the OATS556 automatic transfer switch is to transfer the power supply for Class-1E MCC 0B565 to transformer 0X556 given loss of power on transformer 0X555. Given loss of power to both of these transformers, the breakers between OATS556 and MCC 0B565 automatically open and the MCC is powered from transformer 0X565, which is backed by emergency power. If the seismic event fails OATS556, the result is minimal because MCC 0B565 would receive power from transformer 0X565. No SAMA is required to address this issue.

Other Items

As part of the seismic analysis performed in the IPEEE, several other issues were reviewed in order to determine the plant's ability to respond to an RLE, including the following:

- Masonry walls

- Control Room ceiling
- Spray pond risers
- Low ruggedness relays
- Piping systems
- Electrical raceways
- Electrical conduit
- HVAC systems
- Soils (building foundations)

No areas of concern were identified during the review of these items and no additional SAMAs are required.

E.5.1.7.3 High Winds

The approach taken to analyze the high wind, flood, and “other” external event risk in the SSES IPEEE was to implement a progressive screening approach. The first three steps included 1) a review of SSES specific hazard data and licensing basis, 2) identification of significant changes since Operating License issuance, and 3) verification that the SSES design met the 1975 Standard Review Plan (SRP) criteria. The next three steps consisted of determining the hazard frequency and consequences. These steps were optional and could be bypassed provided that the first three steps were satisfied and any identified vulnerabilities were demonstrated to be insignificant. The last step was to document the process. An additional aspect of the process was to ensure that it was coordinated with any other ongoing external events programs so that the IPEEE considered all available information.

For the SAMA analysis, this process is considered adequate for screening events that do not pose a credible threat to plant operations. However, any issues that could impact plant safety are reconsidered to determine if the development of a SAMA is appropriate to address the vulnerability.

The SSES licensing bases were reviewed as part of the High Wind analysis and the new structures on the site were examined for potential wind related vulnerabilities. Most, but not all, of the site changes were designed to resist high wind loads and were

not susceptible to high wind events. Those that did not meet the high wind design requirements of the SSES licensing bases did not serve any safety related function. It was determined that the failures of these plant additions/changes could be a source of tornado generated missiles; however, it was judged that any such missiles were enveloped by the existing postulated missiles considered in the design of the safety related facilities/structures. The SSES design bases were then compared to the 1975 SRP and found to be almost identical. This strict conformance to the 1975 SRP was believed to provide a reasonably high level of assurance that the SSES design basis, with respect to high winds, was sufficient. The conclusion of the IPEEE High Wind analysis was that there are no high wind vulnerabilities.

Given the low potential for identifying cost beneficial SAMAs to mitigate risk posed by high winds, no further efforts were made in the SAMA analysis to develop high wind related SAMAs.

E.5.1.7.4 External Flooding and Probable Maximum Precipitation

As indicated in Section E.5.1.7.3, the IPEEE employed a progressive screening method to examine external flooding. For the SAMA analysis, this process is considered adequate for screening events that do not pose a credible threat to plant operations. However, any issues that could impact plant safety are reconsidered to determine if the development of a SAMA is appropriate to address the vulnerability.

The review of the licensing bases, the first step in the screening process, showed that SSES was classified as a “dry” site with regard to external flooding and that the plant is secure from these threats. The dispositions of the flooding sources considered are summarized below:

- Probable Maximum Flood (PMF): The PMF water elevation, coincident with wind generated waves for the Susquehanna River, is defined as 548 feet mean sea level (MSL). This elevation is 120 feet below the site grade elevation of 670.0 feet MSL. As the Susquehanna River is the only water system adjacent to SSES that could have an impact on site flooding other than local storm runoff, it is excluded as a flooding threat. Site walkdowns were performed to examine the potential impact of storm runoff and it was confirmed that this was not an issue for SSES.

- Seismically Induced Dam Failures: Both singular and multiple upstream dam failures were investigated and determined not to be a threat to plant operations.

- Seiche Flooding: Considerations for seiche flooding are deemed inappropriate and not applicable to the SSES flood design basis.

- Storm Surge: The potential for an open coast surge upstream to the plant was not considered a credible occurrence and it was eliminated from the SSES flood design basis (not a threat).

- Tsunami Flooding: Not applicable to the Susquehanna site.

- Ice Jam Related Flooding: The elevation of the flood waters due to ice jam related issues were determined to be less than the PMF. Given that the PMF elevation was 120 feel below site grade, ice jam floods are also excluded as a flooding threat.

- Spray Pond Flooding: The design basis flood level for the spray pond was determined by superimposing the effects of coincident wind generated wave activity on various flood levels. This type of flood activity was determined not to pose a threat to any safety related features of SSES.

- River Diversion: The Susquehanna river, in the vicinity of SSES, was determined not to be subject to major realignment or diversion due to natural causes and was eliminated from the SSES flood design basis.

Review of the plant changes/additions since issuance of the operating license, step two of the screening methodology, has shown that none of them would directly affect or increase the potential vulnerabilities due to the external flood design basis.

The third require step of the screening process requires comparison of the SSES design bases to the 1975 SRP. This comparison demonstrated that the acceptance criteria of the 1975 SRP was essentially identical to the design basis in the SSES FSAR, which was considered to provide adequate assurance that the SSES design basis was sufficient. As a result, it was determined that no flood related vulnerabilities existed at SSES. A confirmatory walkdown of the site was performed to identify any potential vulnerabilities that were not included in the original design basis analysis. No other vulnerabilities were identified. A further review of the potential impacts of storm runoff and spray pond flooding was performed, but no safety related equipment was determined to be threatened by these events.

Given the low potential for identifying cost beneficial SAMAs to mitigate risk posed by external flooding, no further efforts were made in the SAMA analysis to develop SAMAs related to external flooding events.

E.5.1.7.5 Transportation and Nearby Facility Accidents

Transportation and nearby facility accidents were included in the SSES IPEEE to account for human errors or equipment failures that may occur in events not directly

related to the power generation process at the plant. The types of hazards typically considered in this category include:

- Transportation Accidents due to Aircraft Activity
- Transportation Accidents due to Marine Activity
- Transportation Accidents due to Pipeline Activity
- Transportation Accidents due to Railroad Activity
- Transportation Accidents due to Truck Activity
- Nearby Industrial Facilities
- Nearby Military Facilities
- Hazardous Material Releases from Onsite Storage
- Other Onsite Hazards

At the time the IPEEE was performed, available information related to military, commercial, and general aviation traffic was used to determine that this type of traffic did not pose a threat to plant safety. It is recognized that the types of credible threats to nuclear facilities by aircraft have changed since the time the IPEEE was published. While this is true, efforts are underway within the industry to address this issue in conjunction with other forms of sabotage. Based on the fact that this topic is currently being analyzed in another forum and due to the complexity of the issue, aircraft impact events are considered to be out of the scope of the SAMA analysis.

For the remaining Transportation and Nearby Facility related events, the progressive screening approach described in Section E.5.1.7.3 was used to eliminate them from further consideration. For the SAMA analysis, this process is considered adequate for screening events that do not pose a credible threat to plant operations. However, any issues that could impact plant safety are reconsidered to determine if the development of a SAMA is appropriate to address the vulnerability.

For part 1 of the IPEEE screening process, the licensing basis was reviewed related to Nearby Industrial, Military and Transportation Facilities. The information reviewed included:

- Transportation routes within five miles of the plant, including highways and rail lines,

- Locations and routes of oil and natural gas pipelines,
- Locations of industrial and military facilities,
- Locations of airports and control areas.
- Descriptions of the nature and operations of the facilities, pipelines, waterways, and airports as well as their possible impact on SSES.

The second stage of the screening process revealed that there had been no changes to the transportation routes since issuance of the operating license; however, a new natural gas pipeline was installed. This pipeline was addressed in the SSES FSAR (PPL 2005a) and determined not to be a threat to the safe operation of the plant.

The third step of the screening process required that the SSES design criteria could be shown to satisfy the 1975 SRP criteria. It was determined in the IPEEE that SRP acceptance criteria were met and that Transportation and Nearby Facility accidents did not pose a threat to safe operation of the plant.

SSES has also performed a Control Room habitability analysis (PPL 2004) to assess the potential of a chemical release to impact the ability of the operators to control the plant. This analysis included the review of chemicals that were stored on-site at SSES, those stored off-site in fixed facilities within 5 miles of the plant, and chemicals being transported within 5 miles of the site. The results of the study indicated that none of the chemicals in these areas posed a threat to the Control Room operators. In addition, SSES staff has indicated that the chemical load review performed as part of the Control Room habitability study revealed that no new chemical explosion hazards have been introduced to the SSES area that were not addressed by the IPEEE (ERIN 2005).

Given the low potential for identifying cost beneficial SAMAs to mitigate risk posed by Transportation and Nearby Facility Accidents, no further efforts were made in the SAMA analysis to develop SAMAs related to these hazards.

E.5.1.8 Quantitative Strategy for External Events

The quantitative methods available to evaluate external events risk at SSES are limited, as discussed above. In order to account for the external events contributions in the SAMA analysis, a multi-staged process has been implemented to provide gross estimates of the averted cost-risk based on external events accidents.

The first part of this process is used in the Phase 1 analysis and is based on the assumption that the risk posed by external and internal events is approximately equal. While no CDF estimates are available for seismic, high wind, external flooding, or other external events, the final internal fire CDF estimate of 4.5E-8 per 15 month cycle (PPL 1998) was more than a factor of 2 lower than the internal events CDF from the IPE of the same time period. As the fire CDF is often the greatest of the external events considered in the IPEEE, the assumption that the SSES external events CDF is approximately equivalent to the internal events CDF does not appear to be non-conservative.

Continuing on with the assumption that the internal and external events risks are assumed to be equal, the MACR calculated for the internal events model has been doubled to account for external events contributions. As identified in Section E.4.6, this total is referred to as the MMACR. The MMACR is used in the Phase 1 screening process to represent the maximum achievable benefit if all risk related to on-line power operations was eliminated. Therefore, those SAMAs with costs of implementation that are greater than the MMACR were eliminated from further review.

The second stage of this strategy is to also apply the doubling factor to the Phase 2 analysis. Any averted cost-risk calculated for a SAMA was multiplied by two to account for the corresponding reduction in external events risk.

The final stage of the process is used for SAMAs that were identified based on IPEEE insights. For these cases, IPEEE insights and the Internal Events PRA are used, as appropriate, to develop an averted cost-risk for the SAMA that accounts for the external and internal events risk reductions. For instance, the IPEEE typically provides information that can be used to estimate bounding changes in risk that would be realized if the SAMAs were implemented. These risk changes are used to approximate averted cost-risks based on external events contributions. Then, if it can be determined that the SAMA would impact the internal events model, the PRA is used to quantify the averted cost-risk based on its internal events contributions. The cost-risks from the external and internal events results are then added to yield the total for the SAMA. In some cases, the SAMAs do not impact the internal events models and the calculations do not require the use of the PRA model.

E.5.2 Phase 1 Screening Process

The initial list of SAMA candidates is presented in Table E.5-3. The process used to develop the initial list is described in Section E.5.1.

The purpose of the Phase 1 analysis is to use high-level knowledge of the plant and SAMAs to preclude the need to perform detailed cost-benefit analyses on them. The following screening criteria were used:

- Applicability to the Plant: If a proposed SAMA does not apply to the SSES design, it is not retained.
- Implementation Cost Greater than Screening Cost: If the estimated cost of implementation is greater than the Modified Maximum Averted Cost-Risk, the SAMA cannot be cost beneficial and is screened from further analysis.

Table E.5-3 provides a description of how each SAMA was dispositioned in Phase 1. Those SAMAs that required a more detailed cost-benefit analysis are evaluated in Section E.6.

E.6 PHASE 2 SAMA ANALYSIS

Not all of the Phase 2 SAMA candidates require detailed analysis. The Phase 2 process allows for the screening of SAMAs known to be related to non-risk significant systems or to components/functions with low importance rankings. Due to the nature of the PRA based process used to develop the SSES SAMA list, there are limited avenues for SAMAs of this type to be included in the list. However, potential pathways do exist:

- Inclusion of unresolved proposed plant changes from previous SSES risk analyses,
- Inclusion of SAMAs based on the results of conservative modeling methods.

While no calculations are required for eliminating a SAMA that is linked to a non-risk significant system or components, some quantitative efforts are usually required to screen SAMAs that were developed to address risk contributors based on conservative modeling techniques. These cases are identified in Table E.6-1 and discussed in detail in the SAMA specific subsections of E.6.

For the SAMAs requiring detailed analysis, a more detailed conceptual design was prepared along with a more detailed estimated cost. This information was then used to evaluate the effect of the candidates' changes upon the plant safety model.

The final cost-risk based screening method is defined by the following equation:

Net Value = (baseline cost-risk of site operation (MMACR) – cost-risk of site operation with SAMA implemented) – cost of implementation

If the net value of the SAMA is negative, the cost of implementation is larger than the benefit associated with the SAMA and the SAMA is not considered beneficial. The baseline cost-risk of plant operation was derived using the methodology presented in Section E.4. The cost-risk of plant operation with the SAMA implemented is determined in the same manner with the exception that the revised PRA results reflect implementation of the SAMA.

The implementation costs used in the Phase 2 analysis include both SSES specific estimates developed by plant personnel and estimates taken from other SAMA submittals for those SAMAs that were determined to be highly similar. It should be noted that the SSES specific implementation costs do include contingency costs for unforeseen difficulties, but they do not account for any replacement power costs that may be incurred due to consequential shutdown time.

Sections E.6.1 – E.6.11 describe the detailed cost-benefit analysis that was used for each of the remaining candidates. It should be noted that the release category results provided for each SAMA do not include contributions from the negligible release category. The results for both pre-EPU and post-EPU conditions are provided.

E.6.1 SAMA Number 1: Diesel Driven High Pressure Injection Pump

The estimated cost of implementation for this SAMA was assessed by plant personnel and determined to be $2,798,000 for the site (PPL 2006c). While this cost estimate exceeds even the Post-EPU MMACR by more than a factor of 2.5, a detailed analysis of the SAMA was performed to demonstrate the large potential risk reduction that is available through implementation of a SAMA of this type.

This SAMA represents the use of a diesel-driven high pressure injection pump (DDHPIP) to provide makeup to the RPV. The DDHPIP has the potential of reducing the risk of SBO scenarios by providing an injection source that does not require the station's DC power to support SRV operation, valve manipulations, or pump control. Proceduralizing the use of decay heat curves to makeup with boiloff as a function of time is a means of ensuring core coverage after the loss of DC powered instrumentation in long term SBO scenarios. Use of the hotwell as the primary source of water and the circulating water as the secondary source is required to address the need of a large, cool suction source in these scenarios.

This injection system would also provide benefit in non-SBO LOOP cases in which power and injection equipment failures result in the loss makeup to the RPV.

In order to represent this SAMA, the model was modified by adding a DDHPIP gate (199DDP) to the following gates:

- 1HPM : FAILURE OF HPM SYSTEMS TO FEED THE VESSEL (FW AVAIL)
- 1EXTHPM_E: FAILURE OF EXTENDED HIGH PRESSURE MAKEUP
- 155-N-N-1PP_E: FAILURE OF ONE CRD PUMP WITH E DG BACKUP

The 199DP gate includes start and run failures for the DDHPIP:

- 199DGRNEWDDP: 1.6E-02
- 199DGSNEWDDP: 2.4E-02

These are the only failures modeled for the DDHPIP. For simplicity, other failures such as operator alignment errors, and injection valve failures are assumed to be non-contributors. In addition, no power dependencies are assumed and the injection source is always assumed to be available.

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	3.05E-07	0.43	$2,371	7.65E-07	0.67	$2,954
Unit 1 Percent Change	83.6%	74.3%	75.5%	61.2%	64.7%	73.5%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	3.05E-7	0.43	$2,363	7.66E-07	0.67	$2,947
Unit 2 Percent Change	83.3%	73.6%	$2,363	60.5%	64.0%	72.8%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 1, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.45E-07	4.45E-09	5.96E-12	0.00E+00	1.78E-08	5.53E-09	7.43E-08	9.69E-09	1.78E-09	0.00E+00	9.13E-09	**2.68E-07**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.38	0.01	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	**0.43**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,117	$53	$0	$0	$153	$31	$10	$6	$1	$0	$0	**$2,371**

SAMA 1, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.45E-07	3.76E-09	5.96E-12	0.00E+00	1.79E-08	5.33E-09	7.43E-08	9.88E-09	7.05E-10	0.00E+00	8.24E-09	**2.65E-07**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.38	0.01	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	**0.43**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,117	$45	$0	$0	$154	$30	$10	$6	$1	$0	$0	**$2,363**

SAMA 1, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.47E-07	5.62E-09	1.27E-11	0.00E+00	2.60E-08	5.83E-09	1.86E-07	4.60E-07	2.26E-10	0.00E+00	9.13E-09	**8.40E-07**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.43	0.01	0.00	0.00	0.04	0.01	0.03	0.15	0.00	0.00	0.00	**0.67**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,249	$74	$0	$0	$244	$38	$31	$318	$0	$0	$0	**$2,954**

SAMA 1, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.47E-07	4.82E-09	1.27E-11	0.00E+00	2.62E-08	5.61E-09	1.86E-07	4.63E-07	5.92E-11	0.00E+00	8.24E-09	**8.41E-07**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.43	0.01	0.00	0.00	0.04	0.01	0.03	0.15	0.00	0.00	0.00	**0.67**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,249	$64	$0	$0	$246	$37	$31	$320	$0	$0	$0	**$2,947**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 1 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$113,893	$370,107	$550,000	$168,999	$381,001
Unit 2	$472,000	$113,255	$358,745	$538,000	$169,928	$368,072
Total	$956,000	$227,148	$728,852	$1,088,000	$338,927	$749,073

Based on the $2,798,000 cost of implementation, the Pre-EPU net value for this SAMA is -$2,069,148 ($728,852 - $2,798,000 = -$2,069,149), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$2,048,927 ($749,073 - $2,798,000 = -$2,048,927), which implies that this SAMA is not cost beneficial.

While this SAMA was shown not to be a cost effective change for SSES, the results appear to indicate that a large risk reduction is available through the implementation of a SAMA of this type.

E.6.2 SAMA Number 2a: Improve Cross-tie Capability between 4kv AC Emergency Buses (A-D, B-C)

Failure of an EDG combined with the failure of the "E" diesel in conjunction with non-diesel equipment in an alternate train results in the unavailability of equipment that could be used if power were aligned to it. SSES currently relies on the presence of the spare diesel (the "E" EDG) to mitigate EDG failures. While the "E" EDG is a valuable plant asset, emergency 4kV AC cross-tie capability would further reduce plant risk.

The intent of this SAMA is to provide SSES with cross-tie capability through procedure changes and minimal hardware modifications. The proposed changes include providing a mechanism to easily bypass the emergency 4kV AC feeder breaker interlocks such that new procedures would allow the operators to cross-tie buses which share a common emergency safeguards transformer. The inter-train cross-ties that would be supported by this SAMA include the "A" to "D" connection and the "B" to "C" connection. While this does not provide the full cross-tie capability that is available at some plants, the availability of these additional AC alignments still yields a significant risk reduction for SSES.

The impact of implementing this SAMA has been estimated through the following changes:

- Adding the "D" EDG as a potential means of power to the "A" emergency 4kV AC buses (1A201 and 2A201),
- Adding the "C" EDG as a potential means of power to the "B" emergency 4kV AC buses (1A202 and 2A202),
- Adding the "B" EDG as a potential means of power to the "C" emergency 4kV AC buses (1A203 and 2A203),
- Adding the "A" EDG as a potential means of power to the "D" emergency 4kV AC buses (1A204 and 2A204).

To provide a bounding cost-benefit estimate, the cross-tie action for this SAMA was conservatively assumed to be 100 percent reliable.

The cost of implementation for this SAMA was estimated to be $656,000 by PPL (PPL 2005g).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	8.25E-07	0.67	$3,446	8.86E-07	0.75	$3,833
Unit 1 Percent Change	55.6%	59.9%	64.3%	55.0%	60.5%	65.6%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	7.92E-07	0.61	$3,064	8.53E-07	0.68	$3,361
Unit 2 Percent Change	56.7%	62.6%	67.4%	56.0%	63.4%	69.0%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 2a, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.51E-07	5.11E-08	1.18E-10	0.00E+00	8.10E-09	5.88E-08	7.43E-08	2.76E-07	5.58E-08	0.00E+00	2.37E-08	**6.99E-07**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.40	0.08	0.00	0.00	0.01	0.07	0.01	0.08	0.02	0.00	0.00	**0.67**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,205	$613	$3	$0	$70	$335	$10	$166	$44	$0	$0	**$3,446**

SAMA 2a, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.51E-07	3.12E-08	1.04E-10	0.00E+00	7.64E-09	3.81E-08	7.43E-08	2.85E-07	2.27E-08	0.00E+00	2.18E-08	**6.32E-07**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.40	0.05	0.00	0.00	0.01	0.04	0.01	0.09	0.01	0.00	0.00	**0.61**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,205	$374	$3	$0	$66	$217	$10	$171	$18	$0	$0	**$3,064**

SAMA 2a, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.51E-07	5.66E-08	1.25E-10	0.00E+00	9.07E-09	6.46E-08	1.07E-07	3.38E-07	9.45E-09	1.56E-09	2.22E-08	**7.60E-07**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.44	0.09	0.00	0.00	0.01	0.08	0.02	0.11	0.00	0.00	0.00	**0.75**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,310	$747	$4	$0	$85	$426	$18	$234	$9	$0	$0	**$3,833**

SAMA 2a, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.51E-07	3.37E-08	1.11E-10	0.00E+00	8.62E-09	4.24E-08	1.07E-07	3.21E-07	3.40E-09	6.87E-10	2.11E-08	**6.89E-07**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.44	0.05	0.00	0.00	0.01	0.05	0.02	0.11	0.00	0.00	0.00	**0.68**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,310	$445	$3	$0	$81	$279	$18	$222	$3	$0	$0	**$3,361**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 2a Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$186,118	$297,882	$550,000	$206,321	$343,679
Unit 2	$472,000	$169,036	$302,964	$538,000	$187,348	$350,652
Total	$956,000	$355,154	$600,846	$1,088,0000	$393,669	$694,331

Based on the $656,000 cost of implementation, the Pre-EPU net value for this SAMA is -$55,154 ($600,846 - $656,000 = -$55,154), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is $38,331 ($694,331 - $656,000 = $38,331), which implies that this SAMA is cost beneficial.

E.6.3 SAMA Number 3: Proceduralize Staggered RPV Depressurization When Fire Protection System Injection is the Only Available Makeup Source

Currently, the Fire Protection System can be aligned to the RPV for makeup, but in the cases where it is the only available injection source, only 50 percent of the system flow is credited for makeup to a given unit. This is due to the assumption that if one unit requires Fire Protection makeup, the opposite unit will also require use of the Fire Protection System for injection, thus splitting flow. SSES MAAP calculations indicate

that 50 percent flow from the Fire Protection System is not enough to maintain core coverage when RPV depressurization occurs just prior to Fire Protection System injection. The flashing of RPV inventory reduces level to below 2/3 core height and level cannot be recovered prior to core damage. If the SSES procedures are modified to stagger RPV depressurization such that full Fire Protection System flow can be used to restore level to “normal” in a given unit before depressurization is performed on the opposite unit, core damage could be prevented. This procedure change would require valving out makeup flow to the initially depressurized unit while the second unit is depressurized and refilled to avoid splitting flow.

Model changes that were made to the PRA to represent the implementation of this SAMA at SSES include the addition of logic representing Fire Main injection to injection nodes used to prevent late core damage. Specific model changes are shown in the table below for the pre-EPU Unit 1 model. Unit 2 changes and those for the Post-EPU models are similar.

SAMA Number 3 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
116-I-N-INJ_E: LATE INJECTION FROM DIV 1 OF RHRSW	Deleted “AND” gate 016-I-N-DIV_E Added “AND” gate 100-I-N-16&13PP_E, which includes credit for Fire Main injection.
116-II-N-INJ_E: LATE INJECTION FROM DIV 2 OF RHRSW	Deleted “AND” gate 016-II-N-DIV_E Added “AND” gate 100-II-N-16&13PP_E, which includes credit for Fire Main injection.
1LOWPPS3_E: LOW PRESSURE INJECTION WITH RHR CORE SPRAY AND CONDENATE	Added “AND” gate “1LATE_INJ_E”, which is an “AND” gate of the following: 100-I-N-LATEINJ_E (FAILURE OF LATE INJECTION FROM DIV I - FROM RHRSW AND FM) 100-II-N-LATEINJ_E (FAILURE OF LATE INJECTION FROM DIV II)

The cost of procedure changes varies depending on the scope of the changes; however, the $50,000 value used in the Brunswick SAMA analysis (CPL 2004) is used here as a rough estimate of the cost for SSES. In addition to the cost of the procedure changes, flow analysis is required to confirm that the proposed changes would be

effective. The cost of this analysis is estimated to be $100,000. The total cost of implementation for this SAMA is, therefore, $150,000. This estimate does not account for any changes that would be required for operator training.

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	**Dose-Risk**	**OECR**	**CDF**	**Dose-Risk**	**OECR**
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.48E-06	1.44	$8,781	1.56E-06	1.63	$10,011
Unit 1 Percent Change	20.4%	13.8%	9.1%	20.8%	14.2%	10.2%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.48E-06	1.42	$8,620	1.56E-06	1.59	$9,803
Unit 2 Percent Change	19.1%	12.9%	8.3%	19.6%	14.5%	9.6%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 3, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	4.99E-07	2.17E-08	7.43E-08	8.96E-08	5.58E-08	0.00E+00	2.37E-08	**1.08E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.45	0.22	0.00	0.00	0.68	0.03	0.01	0.03	0.02	0.00	0.00	**1.44**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,497	$1,764	$3	$0	$4,286	$123	$10	$54	$44	$0	$0	**$8,781**

SAMA 3, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.09E-07	1.86E-08	7.43E-08	8.92E-08	2.28E-08	0.00E+00	2.18E-08	**1.04E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.45	0.20	0.00	0.00	0.70	0.02	0.01	0.03	0.01	0.00	0.00	**1.42**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,497	$1,560	$3	$0	$4,372	$106	$10	$54	$18	$0	$0	**$8,620**

SAMA 3, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.32E-07	2.28E-08	1.08E-07	1.41E-07	9.46E-09	1.56E-09	2.22E-08	**1.17E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.50	0.25	0.00	0.00	0.78	0.03	0.02	0.05	0.00	0.00	0.00	**1.63**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,632	$2,099	$4	$0	$5,001	$150	$18	$98	$9	$0	$0	**$10,011**

SAMA 3, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.43E-07	1.95E-08	1.08E-07	1.14E-07	3.42E-09	6.87E-10	2.11E-08	**1.12E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.50	0.22	0.00	0.00	0.79	0.02	0.02	0.04	0.00	0.00	0.00	**1.59**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,632	$1,835	$3	$0	$5,104	$129	$18	$79	$3	$0	$0	**$9,803**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 3 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$424,973	$59,027	$550,000	$478,898	$71,102
Unit 2	$472,000	$418,601	$53,399	$538,000	$471,344	$66,656
Total	$956,000	$843,574	$112,426	$1,088,000	$950,242	$137,758

Based on the $150,000 cost of implementation, the Pre-EPU net value for this SAMA is -$37,574 ($112,426 - $150,000 = -$37,574), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$12,242 ($137,758 - $150,000 = -$12,242), which implies that this SAMA is not cost beneficial.

E.6.4 SAMA Number 5: Automatic alignment of the portable station diesel generator

The operator action to align the portable station diesel generator is an important contributor to scenarios in which AC power is unavailable to the battery chargers. Typically, these are scenarios in which the “A” and “B” EDGs are unable to power their respective 4kV AC emergency buses, and the “E” diesel also fails to provide power to the “A” or “B” buses. These scenarios result in core damage due to the failure of high pressure injection after battery depletion and the inability to depressurize the RPV with the SRVs. Given that the alignment of the “E” diesel and the portable station diesel generator both currently depend on human actions, credit for further operator actions to align additional AC sources or alternate AC alignments would be difficult to justify.

The impact of automating the alignment of the portable station diesel generator has been estimated by modifying the failure probabilities of the portable station diesel generator alignment actions in the cutsets. Specifically, the following actions were set to false:

- 002-N-N-BMS-O (OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR)
- Z-BMS-IACIG-O (JHEP OPERATOR FAILS TO ALIGN BLUE MAX AND CROSSTIE IA TO CIG)
- Z-BMAX-EDG-O (DEPENDENT HEP FOR BLUE MAX AND E DG)

These events capture the dependent and independent failures to align the portable station diesel generator. In this case, the events have been set to “false” to eliminate all cutsets in which the action to align the portable generators has failed, which implies that the automated function is 100 percent reliable.

The cost of enhancing the portable station 480V AC generator so that it is capable of automatically starting and powering the 125V DC battery chargers has been estimated to be approximately $398,000 (PPL 2005b).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.38E-06	1.15	$6,164	1.48E-06	1.30	$7,077
Unit 1 Percent Change	25.8%	31.1%	36.2%	24.9%	31.6%	36.5%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.35E-06	1.10	$5,865	1.45E-06	1.25	$6,726
Unit 2 Percent Change	26.2%	32.5%	37.6%	25.3%	32.8%	38.0%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 5, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.59E-07	7.66E-08	1.21E-10	0.00E+00	2.18E-07	1.31E-07	7.43E-08	4.15E-07	5.58E-08	0.00E+00	2.37E-08	**1.15E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.42	0.12	0.00	0.00	0.30	0.15	0.01	0.13	0.02	0.00	0.00	**1.15**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,321	$919	$3	$0	$1,873	$745	$10	$249	$44	$0	$0	**$6,164**

SAMA 5, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.58E-07	5.88E-08	1.07E-10	0.00E+00	2.25E-07	1.11E-07	7.43E-08	4.26E-07	2.28E-08	0.00E+00	2.18E-08	**1.10E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.42	0.09	0.00	0.00	0.31	0.13	0.01	0.13	0.01	0.00	0.00	**1.10**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,307	$706	$3	$0	$1,933	$632	$10	$256	$18	$0	$0	**$5,865**

SAMA 5, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.59E-07	8.39E-08	1.31E-10	0.00E+00	2.33E-07	1.49E-07	1.08E-07	4.82E-07	9.46E-09	1.56E-09	2.22E-08	**1.25E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.47	0.13	0.00	0.00	0.34	0.18	0.02	0.16	0.00	0.00	0.00	**1.30**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,433	$1,107	$4	$0	$2,190	$982	$18	$334	$9	$0	$0	**$7,077**

SAMA 5, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.59E-07	6.34E-08	1.17E-10	0.00E+00	2.41E-07	1.28E-07	1.08E-07	4.67E-07	3.42E-09	6.87E-10	2.11E-08	**1.19E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.47	0.10	0.00	0.00	0.35	0.15	0.02	0.16	0.00	0.00	0.00	**1.25**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,433	$837	$3	$0	$2,265	$844	$18	$323	$3	$0	$0	**$6,726**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 5 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$323,915	$160,085	$550,000	$366,781	$183,219
Unit 2	$472,000	$310,111	$161,889	$538,000	$352,816	$185,184
Total	$956,000	$634,026	$321,974	$1,088,000	$719,597	$368,403

Based on the $398,000 cost of implementation, the Pre-EPU net value for this SAMA is -$76,026 ($321,974 - $398,000 = -$76,026), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$29,597 ($368,403 - $398,000 = -$29,597), which implies that this SAMA is not cost beneficial.

E.6.5 SAMA Number 6: Spare 480v AC Generator

The mechanical failure of the portable station diesel generator is an important contributor to scenarios in which AC power is unavailable to the battery chargers. Typically, these are scenarios in which the "A" and "B" EDGs are unable to power their respective 4kV AC emergency buses, and the "E" diesel also fails to provide power to the "A" or "B" buses. These scenarios result in core damage due to the failure of high pressure injection after battery depletion and the inability to depressurize the RPV with

the SRVs. While local, manual containment venting is possible at SSES, core damage will ensue without an injection source. Given that the portable station diesel generator has failed due to mechanical issues, alignment of a spare generator could be credited due to the fact that operators have successfully completed the alignment actions for the portable generator.

The impact of procuring an additional portable station diesel generator has been estimated by "AND"ing the existing start and run failure events under gate 002-N-N-0G503 with new events representing a second portable station diesel generator. The original events were renamed to 002DGS0G503-1 (start failure) and 002DGR0G503-1 (run failure). The new events were assigned the same failure probabilities as the original events and named 002DGS0G503-2 (start failure) and 002DGR0G503-2 (run failure). No common cause failure was assumed to exist between the portable station diesel generators

The cost of procuring an additional portable station 480V AC generator has been estimated to be approximately $203,000 (PPL 2005c).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.51E-06	1.29	$7,109	1.61E-06	1.46	$8,181
Unit 1 Percent Change	18.8%	22.8%	26.4%	18.3%	23.2%	26.6%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.49E-06	1.25	$6,853	1.59E-06	1.43	$7,874
Unit 2 Percent Change	18.6%	23.3%	27.1%	18.0%	23.1%	27.4%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 6, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.62E-07	9.46E-08	1.21E-10	0.00E+00	2.96E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.26E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.43	0.14	0.00	0.00	0.41	0.15	0.01	0.13	0.02	0.00	0.00	**1.29**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,365	$1,135	$3	$0	$2,543	$757	$10	$252	$44	$0	$0	**$7,109**

SAMA 6, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.62E-07	7.72E-08	1.07E-10	0.00E+00	3.06E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.21E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.43	0.12	0.00	0.00	0.42	0.13	0.01	0.13	0.01	0.00	0.00	**1.25**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,365	$926	$3	$0	$2,629	$643	$10	$259	$18	$0	$0	**$6,853**

SAMA 6, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.63E-07	1.03E-07	1.31E-10	0.00E+00	3.16E-07	1.50E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.36E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.48	0.16	0.00	0.00	0.46	0.18	0.02	0.16	0.00	0.00	0.00	**1.46**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,494	$1,360	$4	$0	$2,970	$989	$18	$337	$9	$0	$0	**$8,181**

SAMA 6, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.63E-07	8.30E-08	1.17E-10	0.00E+00	3.28E-07	1.29E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.31E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.48	0.13	0.00	0.00	0.48	0.16	0.02	0.16	0.00	0.00	0.00	**1.43**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,494	$1,096	$3	$0	$3,083	$850	$18	$327	$3	$0	$0	**$7,874**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 6 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$367,125	$116,875	$550,000	$416,134	$133,866
Unit 2	$472,000	$355,714	$116,286	$538,000	$405,201	$132,799
Total	$956,000	$722,839	$233,161	$1,088,000	$821,335	$266,665

Based on the $203,000 cost of implementation, the Pre-EPU net value for this SAMA is $30,161 ($233,161 - $203,000 = $30,161), which implies that this SAMA is cost beneficial.

For Post-EPU conditions, the net value for this SAMA is $63,665 ($266,665 - $203,000 = $63,665), which implies that this SAMA is cost beneficial.

E.6.6 SAMA Number 7: Re-Divisionalize ESW Cooling to RHR

An insight based on a previous plant configuration prompted SSES to change the RHR cooling alignment for the “C” and “D” RHR pumps and room coolers. To address the issue, ESW trains “A” and “C” were aligned to RHR trains “A” and “D” and ESW trains “B” and “D” were aligned to RHR trains “B” and “C”. While the plant configuration that instigated this change is no longer in place, a large portion of the current risk profile is related to the previous RHR cooling changes. Typically, these are scenarios in which

the “A”, “B”, and “E” EDGs are unable to power any 4kV AC emergency buses when either the “C” or “D” EDG has also failed. The station portable generator is available to support HPCI operation and depressurization, but SPC is not available to maintain the suppression pool as a suction source given the unavailability of RHR pump and room cooling. RCIC and Core Spray fail due to equipment/operator failures.

Changing the ESW cooling alignment so that a given ESW train cools the corresponding RHR train would provide a means of maintaining HPCI as a high pressure injection source and an RHR pump for low pressure makeup in the event of HPCI failure.

The impact of re-divisionalizing ESW cooling to RHR has been estimated by changing the RHR cooling support logic so that it references the same division as the pump. Specific model changes are shown in the table below for the pre-EPU Unit 1 model. Unit 2 changes and those for the Post-EPU models are similar.

SAMA Number 7 Model Changes

Gate and / or Basic Event ID and Description	Description of Change
149-I-C-SUPPORT: RESIDUAL HEAT REMOVAL CHANNEL C EQUIPMENT (BLOCK C)	Deleted gate 154-II-N-PPVLV Added gate 154-I-N-PPVLV
154-II-C-ESWFP[1]: FAILURE OF DIVISION II ESW OR FLOW PATH	Deleted gate 154-II-N-PPVLV Added gate 154-I-N-PPVLV
149-I-C-SUPPORT_E: RESIDUAL HEAT REMOVAL CHANNEL C EQUIPMENT (BLOCK C)	Deleted gate 154-II-N-PPVLV Added gate 154-I-N-PPVLV
149-II-D-SUPPORT: RESIDUAL HEAT REMOVAL CHANNEL D EQUIPMENT (BLOCK D)	Deleted gate 154-I-N-PPVLV Added gate 154-II-N-PPVLV
154-I-D-ESWFP[1]: FAILURE OR DIVISION I ESW OR FLOW PATH	Deleted gate 154-I-N-PPVLV Added gate 154-II-N-PPVLV
149-II-D-SUPPORT_E: RESIDUAL HEAT REMOVAL CHANNEL D EQUIPMENT WITH E DG BACKUP	Deleted gate 154-I-N-PPVLV Added gate 154-II-N-PPVLV

[1] This gate name was used in the model to identify that the cooling flowpath failures included under the gate were Division II failures. This gate includes only Division I powered valves and the cooling water flow path such that including the Division I flow path under the gate is appropriate even though the gate name “154-II-C-ESWFP” appears to be a Division II gate.

The cost of this SAMA has been estimated to be approximately $970,000 (PPL 2006a, PPL 2006b).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.67E-06	1.57	$9,153	1.76E-06	1.78	$10,465
Unit 1 Percent Change	10.2%	6.0%	5.3%	10.7%	6.3%	6.2%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.65E-06	1.54	$8,928	1.74E-06	1.73	$10,192
Unit 2 Percent Change	9.8%	5.5%	5.1%	10.3%	7.0%	6.0%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 7, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.71E-07	1.47E-07	1.13E-10	0.00E+00	5.05E-07	4.36E-08	7.43E-08	4.15E-07	5.50E-08	0.00E+00	2.37E-08	**1.43E-06**
Dose-$Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
Dose-$Risk_{SAMA}$	0.45	0.22	0.00	0.00	0.69	0.05	0.01	0.13	0.02	0.00	0.00	**1.57**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,497	$1,764	$3	$0	$4,338	$248	$10	$249	$44	$0	$0	**$9,153**

SAMA 7, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.71E-07	1.30E-07	9.92E-11	0.00E+00	5.14E-07	3.02E-08	7.43E-08	4.22E-07	2.19E-08	0.00E+00	2.18E-08	**1.39E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.45	0.20	0.00	0.00	0.70	0.04	0.01	0.13	0.01	0.00	0.00	**1.54**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,497	$1,560	$3	$0	$4,415	$172	$10	$254	$17	$0	$0	**$8,928**

SAMA 7, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.72E-07	1.59E-07	1.15E-10	0.00E+00	5.38E-07	4.78E-08	1.11E-07	4.80E-07	8.39E-09	1.56E-09	2.22E-08	**1.54E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.50	0.25	0.00	0.00	0.79	0.06	0.02	0.16	0.00	0.00	0.00	**1.78**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,632	$2,099	$3	$0	$5,057	$315	$19	$332	$8	$0	$0	**$10,465**

SAMA 7, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.72E-07	1.39E-07	1.01E-10	0.00E+00	5.49E-07	3.35E-08	1.07E-07	4.63E-07	2.34E-09	6.87E-10	2.11E-08	**1.49E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.50	0.22	0.00	0.00	0.80	0.04	0.02	0.15	0.00	0.00	0.00	**1.73**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,632	$1,835	$3	$0	$5,161	$221	$18	$320	$2	$0	$0	**$10,192**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 7 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$453,282	$30,718	$550,000	$511,610	$38,390
Unit 2	$472,000	$443,416	$28,584	$538,000	$500,500	$37,500
Total	$956,000	$896,698	$59,302	$1,088,0000	$1,012,110	$75,890

Based on the $970,000 cost of implementation, the Pre-EPU net value for this SAMA is -$910,698 ($59,302 - $970,000 = -$910,698), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$894,110 ($75,890 - $970,000 = -$894,110), which implies that this SAMA is not cost beneficial.

E.6.7 SAMA Number 8: Automatic Feedwater runback

The operator action to reduce Feedwater flow (feedwater runback) is an important component of ATWS mitigation for non-isolation ATWS cases. Success of level control using Feedwater in conjunction with either SLC injection or MRI results in a successful endstate (power level controlled and core cooling available). Without successful feedwater runback, core damage can still be avoided with SLC injection (no MRI credit), but some degree of fuel damage is assumed to occur. Given that any additional power/level control action devised to mitigate an ATWS would share a high dependence with the Feedwater runback action, any SAMAs requiring operator actions are considered to be of little benefit. A potentially effective means of reducing the risk of ATWS scenarios for SSES is believed to be the automation of the Feedwater runback action.

The impact of installing automatic Feedwater runback logic at SSES has been estimated by modifying the Feedwater runback failure flag in the Level 1 and Level 2 cutsets (145-N-N-REDFWO-FLAG for unit 1 and 245-N-N-REDFWO-FLAG for unit 2). Manipulation of this flag captures both the dependent and independent operator failures related to the Feedwater runback action. In this case, the flag has been set to 0.0 to

eliminate all cutsets in which the Feedwater runback action has failed, which implies that the automated function is 100 percent reliable.

The cost of installing logic to automate feedwater runback is considered to be similar in scope to the advanced boiling water reactor (ABWR) severe accident mitigation design alternative (SAMDA) to install computer aided instrumentation. This enhancement was estimated to cost approximately $600,000 for a single unit in the reactor's design phase (GE 1994). While this estimate would likely be larger for SSES to account for installation at both units, the need to retrofit an existing plant, and for inflation from the time the ABWR study was performed in 1994, $600,000 is used as a lower bound cost of implementation for this SAMA.

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.80E-06	1.67	$9,659	1.89E-06	1.89	$11,140
Unit 1 Percent Change	3.2%	0.0%	0.1%	4.1%	0.5%	0.1%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.78E-06	1.63	$9,399	1.86E-06	1.85	$10,834
Unit 2 Percent Change	2.7%	0.0%	0.1%	4.1%	0.5%	0.1%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 8, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	3.47E-08	4.18E-07	5.58E-08	0.00E+00	2.37E-08	**1.49E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,497	$1,764	$3	$0	$4,338	$757	$5	$251	$44	$0	$0	**$9,659**

SAMA 8, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	3.48E-08	4.30E-07	2.28E-08	0.00E+00	2.18E-08	**1.44E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,497	$1,560	$3	$0	$4,415	$643	$5	$258	$18	$0	$0	**$9,399**

SAMA 8, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	4.83E-08	4.86E-07	9.46E-09	1.56E-09	2.22E-08	**1.59E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.50	0.25	0.00	0.00	0.79	0.18	0.01	0.16	0.00	0.00	0.00	**1.89**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,632	$2,099	$4	$0	$5,057	$995	$8	$336	$9	$0	$0	**$11,140**

SAMA 8, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	4.81E-08	4.71E-07	3.42E-09	6.87E-10	2.11E-08	**1.54E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.50	0.22	0.00	0.00	0.80	0.16	0.01	0.16	0.00	0.00	0.00	**1.85**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,632	$1,835	$3	$0	$5,170	$857	$8	$326	$3	$0	$0	**$10,834**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 8 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$480,881	$3,119	$550,000	$545,052	$4,948
Unit 2	$472,000	$469,368	$2,632	$538,000	$533,052	$4,948
Total	$956,000	$950,249	$5,751	$1,088,0000	$1,078,104	$9,896

Based on the $600,000 cost of implementation, the Pre-EPU net value for this SAMA is -$594,249 ($5,751 - $600,000 = -$594,249), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$590,104 ($9,896 - $600,000 = -$590,104), which implies that this SAMA is not cost beneficial.

E.6.8 SAMA Number 9: Direct Feeds from the 125V DC Battery Chargers to Critical Loads

The failure of a 125V DC bus can result in loss of a wide range of equipment and is currently treated as an unrecoverable failure in the PRA. Repair, replacement, or bypass of a failed bus are actions that are currently possible given sufficient time; however, it is difficult to justify credit for these types of actions when procedures are not available to provide guidance on how to address bus failures in accident conditions.

Proceduralizing the use of pre-staged, temporary cables to bypass a failed DC bus would allow the operators to provide power to critical DC loads in a timely fashion during an accident assuming that the equipment on the failed bus is not damaged. The cost-benefit of this SAMA is developed assuming that the relevant equipment remains operable, but it is possible that fire damage or the consequences of a bus failure could render the equipment normally aligned to the bus inoperable.

This SAMA has been developed to address two cases that have been identified as important contributors to risk at SSES:

1. Failure of a 125V DC bus combined with the failure/unavailability of the 125V DC battery charger in the opposite division, and

2. A fire in fire zone 0-28B-II that impacts any of the following equipment: a) 1D612 – 125V DC class 1E load center, b) 1D613 – 125V DC class 1E channel A charger (fails both the charger and battery and leads to loss of 1D612), or c) 1D614 – 125V DC class 1E distribution panel (powered by 1D612).

In order for this SAMA to effectively mitigate these failures, it is believed that direct feeds to critical DC loads would have to be permanently pre-wired to reduce alignment time. Temporary jumper connections between the battery chargers and critical load wires would be made at the battery charger in the event that they are needed. The ability to power the critical loads from either division would improve the capability of this SAMA and is assumed to be available in this assessment.

The impact of implementing this SAMA has been estimated by setting the DC bus failure initiating events, independent failure events, and common cause failure events to zero in the PRA model. The events that were modified for Unit 1 are as follows: 102BUR1D612, %1LODCBUS_612, CCFBB2BUR_12, CCFBB2BUR_13, CCFBB2BUR_14, CCFBB3BUR_123, CCFBB3BUR_124, CCFBB3BUR_134, CCFBB4BUR_ALL, 102BUR1D622, %1LODCBUS_622, CCFBB2BUR_23, CCFBB2BUR_24, CCFBB3BUR_234.

Similarly, the following Unit 2 events were set to zero: 202BUR2D622, %2LODCBUS_622, CCFBB2BUR_23-UNIT2, CCFBB2BUR_12-UNIT2, CCFBB2BUR_24-UNIT2, CCFBB3BUR_123-UNIT2, CCFBB3BUR_124-UNIT2, CCFBB3BUR_234-UNIT2, CCFBB4BUR_ALL-UNIT2, 202BUR2D612, %2LODCBUS_612, CCFBB2BUR_13-UNIT2, CCFBB2BUR_14-UNIT2, CCFBB3BUR_134-UNIT2.

In addition to the changes identified above, a separate contribution is included to specifically address the fire contributions from zone 0-28B-II. Starting with the assumption that internal and external events contribute an equal portion site risk, a rough estimate of the averted cost-risk associated with eliminating the zone 0-28B-II risk can be made by further assuming that all External Events risk corresponds to Fire risk. As zone 0-28B-II accounts for about 3 percent of the total Fire frequency (1.3E-9/cycle / 4.5E-8/cycle = 0.0288), 3 percent of the external events risk can be assigned to zone 0-28B-II. Finally, if it is assumed that all zone 0-28B-II risk is eliminated by implementing this SAMA, the corresponding averted cost-risk for pre-EPU and post-EPU conditions can be calculated:

	Pre-EPU			Post-EPU		
	Total Unit MMACR	Unit Fire Contribution	Zone 0-28B-II Contribution	Total Unit MMACR	Unit Fire Contribution	Zone 0-28B-II Contribution
Unit 1_{Base}	$484,000	$242,000	$7,260	$550,000	$275,000	$8,250
Unit 2_{Base}	$472,000	$236,000	$7,080	$538,000	$269,000	$8,070
Total Averted Cost-Risk			$14,340			$16,320

These averted cost-risk estimates are added to those calculated from the general internal and external events models. This method captures the specific risk reduction associated with zone 0-28B-II fires and the non-zone 0-28B-II risk reduction resulting from the SAMA for other external events initiators.

Overall, this treatment provides an upper bound estimate of the benefit of this SAMA given that it does not account for operator alignment error, it assumes that the alignment does not require any manipulation time, and it eliminates DC bus failures that would prevent EDG operation in a LOOP or contingent LOOP.

The cost of providing the capability to provide direct feeds to the critical 125V DC loads been estimated to be approximately $346,000 (PPL 2005e).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.73E-06	1.64	$9,584	1.84E-06	1.89	$11,072
Unit 1 Percent Change	7.0%	1.8%	0.8%	6.6%	0.5%	0.7%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.71E-06	1.61	$9,345	1.82E-06	1.85	$10,776
Unit 2 Percent Change	6.6%	1.2%	0.6%	6.2%	0.5%	0.6%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 9, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.68E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.41E-08	4.20E-07	8.50E-09	0.00E+00	2.22E-08	**1.48E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
$Dose\text{-}Risk_{SAMA}$	0.44	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.00	0.00	0.00	**1.64**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,453	$1,764	$3	$0	$4,338	$757	$10	$252	$7	$0	$0	**$9,584**

SAMA 9, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.68E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.42E-08	4.31E-07	2.71E-09	0.00E+00	2.11E-08	**1.45E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.44	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.00	0.00	0.00	**1.61**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,453	$1,560	$3	$0	$4,415	$643	$10	$259	$2	$0	$0	**$9,345**

SAMA 9, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.69E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.41E-07	8.57E-09	0.00E+00	2.22E-08	**1.60E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.15	0.00	0.00	0.00	**1.89**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,586	$2,099	$4	$0	$5,057	$995	$18	$305	$8	$0	$0	**$11,072**

SAMA 9, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.69E-07	1.39E-07	1.17E-10	0.00E+00	5.49E-07	1.30E-07	1.08E-07	4.53E-07	2.89E-09	0.00E+00	2.11E-08	**1.57E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.15	0.00	0.00	0.00	**1.85**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,586	$1,835	$3	$0	$5,161	$857	$18	$313	$3	$0	$0	**$10,776**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 9 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$473,394	$10,606	$550,000	$540,499	$9,501
Unit 2	$472,000	$463,110	$8,890	$538,000	$529,300	$8,700
Non-Fire Specific Total	$956,000	$936,504	$19,496	$1,088,000	$1,069,799	$18,201
Fire Zone 0-28B-II Contribution			$14,340			$16,320
Total			$33,836			$34,521

The total averted cost-risk for this SAMA is the sum of the averted cost-risk from internal events PRA results (e.g., $19,496 for the Pre-EPU model) and the fire zone specific averted cost-risk estimated above (e.g. $14,340 for the Pre-EPU model). The net value is then calculated in the same way as for the other SAMAs: Net Value = Total Averted Cost Risk – Cost of Implementation. It should be noted that the PRA based averted cost-risk estimate still includes the doubling factor to account for the general external events contributions even though explicit fire contributions are addressed separately.

Based on the $346,000 cost of implementation, the Pre-EPU net value for this SAMA is -$312,164 ($33,836 - $346,000 = -$312,164), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$311,479 ($34,521 - $346,000 = -$311,479), which implies that this SAMA is not cost beneficial.

E.6.9 SAMA Number 10: Install a Pressure Control Valve Between the IA and CIG Systems

The importance of the IA to CIG cross-tie is primarily to avoid a plant transient that closes the MSIVs. Closing the MSIVs fails the Feedwater system as a source of high pressure makeup. This failure and loss of DC power fails HPI and extended depressurization capability through power and air dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action.

Other means of mitigating these sequences are possible, but they would require recovery/bypass of the failed bus, the addition of an alternate source of HPI, or the addition of a means to depressurize the RPV without DC power. Some of these enhancements are investigated for SSES based on the importance of other contributors, including SAMA 9, which addresses DC bus failures, and SAMA 1, which investigates an alternate HPI method. While these other SAMAs address the sequences in which the IA to CIG cross-tie action is important, this SAMA focuses specifically on the cross-tie issue and a relatively low cost enhancement.

The impact of automating the alignment of the IA to CIG cross-tie has been estimated by modifying the failure probabilities of the dependent and independent operator actions related to the IA to CIG cross-tie. Specifically, the following actions were set to false:

- Z-IACIG-RXLC-O (JHEP OPERATOR FAILS TO XTIE IA & CIG AND CONTROL RX WATER LEVEL)
- Z-IACIG-CVLOC-O (JHEP OPERATOR FAILS TO XTIE IA & CIG AND VENT CONTAINMENT LOCALLY)
- Z-VENT-IACIG-O (JHEP OPERATOR FAILS TO VENTILATE RHRSW AND XTIE IA TO CIG)
- Z-BMS-IACIG-O (JHEP OPERATOR FAILS TO ALIGN BLUE MAX AND CROSSTIE IA TO CIG)
- Z-IACIG-RWST-O (JHEP OPERATOR FAILS TO XTIE IA & CIG AND FAILS TO XTIE RWST)
- 1(2)25-N-N-FXTIACIG-O (OPERATOR FAILS TO OPEN IA-CIG CROSSTIE VALVES)

Setting the events to “false” eliminates all cutsets in which the action to align the cross-tie has failed. This implies that the automated function is 100 percent reliable.

The cost of installing a pressure control valve between the IA and CIG systems has been estimated to be approximately $386,000 (PPL 2005d). While installation of an additional air compressor is a potential means of addressing this SAMA, installation of the pressure control valve is considered to be a more cost effective means of addressing the issue at Susquehanna.

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.86E-06	1.67	$9,665	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.74E-06	1.65	$9,562	1.85E-06	1.88	$11,056
Unit 1 Percent Change	6.5%	1.2%	1.1%	6.1%	1.1%	0.9%
Unit 2_{Base}	1.83E-06	1.63	$9,405	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.72E-6	1.61	$9,343	1.83E-06	1.85	$10,765
Unit 2 Percent Change	6.0%	1.2%	0.7%	5.7%	0.5%	0.7%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 10, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.47E-07	1.21E-10	0.00E+00	5.05E-07	1.33E-07	7.43E-08	4.20E-07	5.58E-08	0.00E+00	2.37E-08	**1.53E-06**
$Frequency_{SAMA}$	1.68E-07	1.47E-07	1.21E-10	0.00E+00	5.03E-07	1.31E-07	7.41E-08	4.18E-07	1.94E-08	0.00E+00	2.25E-08	**1.48E-06**
Dose-$Risk_{BASE}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.02	0.00	0.00	**1.67**
Dose-$Risk_{SAMA}$	0.44	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.01	0.00	0.00	**1.65**
$OECR_{BASE}$	$2,497	$1,764	$3	$0	$4,338	$757	$10	$252	$44	$0	$0	**$9,665**
$OECR_{SAMA}$	$2,453	$1,764	$3	$0	$4,321	$745	$10	$251	$15	$0	$0	**$9,562**

SAMA 10, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.71E-07	1.30E-07	1.07E-10	0.00E+00	5.14E-07	1.13E-07	7.43E-08	4.31E-07	2.28E-08	0.00E+00	2.18E-08	**1.48E-06**
$Frequency_{SAMA}$	1.68E-07	1.30E-07	1.07E-10	0.00E+00	5.13E-07	1.13E-07	7.42E-08	4.31E-07	9.90E-09	0.00E+00	2.13E-08	**1.46E-06**
$Dose\text{-}Risk_{BASE}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.01	0.00	0.00	**1.63**
$Dose\text{-}Risk_{SAMA}$	0.44	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.00	0.00	0.00	**1.61**
$OECR_{BASE}$	$2,497	$1,560	$3	$0	$4,415	$643	$10	$259	$18	$0	$0	**$9,405**
$OECR_{SAMA}$	$2,453	$1,560	$3	$0	$4,407	$643	$10	$259	$8	$0	$0	**$9,343**

SAMA 10, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.69E-07	1.59E-07	1.31E-10	0.00E+00	5.37E-07	1.49E-07	1.07E-07	4.50E-07	8.83E-09	3.40E-10	2.22E-08	**1.60E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.50	0.25	0.00	0.00	0.78	0.18	0.02	0.15	0.00	0.00	0.00	**1.88**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,586	$2,099	$4	$0	$5,048	$982	$18	$311	$8	$0	$0	**$11,056**

SAMA 10, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.69E-07	1.39E-07	1.17E-10	0.00E+00	5.48E-07	1.29E-07	1.08E-07	4.61E-07	3.08E-09	2.34E-10	2.11E-08	**1.58E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.15	0.00	0.00	0.00	**1.85**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,586	$1,835	$3	$0	$5,151	$850	$18	$319	$3	$0	$0	**$10,765**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 10 Net Value

Unit	Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$484,000	$473,824	$10,176	$550,000	$539,917	$10,083
Unit 2	$472,000	$463,540	$8,460	$538,000	$529,471	$8,529
Total	$956,000	$937,364	$18,636	$1,088,000	$1,069,388	$18,612

Based on the $386,000 cost of implementation, the Pre-EPU net value for this SAMA is -$367,364 ($18,636 - $386,000 = -$367,364), which implies that this SAMA is not cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$367,388 ($18,612 - $386,000 = -$367,388), which implies that this SAMA is not cost beneficial.

E.6.10 SAMA Number 12: Containment Venting After Core Damage When Containment Failure is Imminent

The SSES procedure governing primary containment venting recommends that the primary containment not be vented when “large” source terms are expected to be incurred by the on-site or off-site population. Given that a core damage event would result in a “large” source term, the current PRA model conservatively precludes primary containment venting after a core damage event. For unrecovered loss of DHR scenarios, this evolution is assumed to eventually result in a drywell failure and a subsequent “unscrubbed” release of the primary containment contents to the atmosphere.

Discussions with plant operations staff indicate that procedures exist to direct containment venting irrespective of the dose, that the operators are aware of the procedures, and that the Technical Support Center would direct containment venting in the relevant circumstances to prevent containment failure. As a result, the importance rankings of the sequences in which containment venting is precluded due to high radiation levels are artificially inflated. If the existing plant capabilities are credited in the PRA, the importance of containment venting after core damage will be reduced and no plant enhancements to improve venting after core damage would be cost-beneficial.

To demonstrate this case, the baseline PRA results have been manipulated to show that the averted cost-risk associated with further improving SSES containment venting capabilities is less that the minimum expected cost of a SAMA. In this case, the minimum expected cost for a SAMA is considered to be a procedure change, which has been estimated in other SAMA submittals to be about $50,000 (CPL 2004).

In order to quantify the potential averted cost-risk for this SAMA, it was first necessary to develop a revised baseline model that credits the existing vent capabilities described by the operators. This was done by reviewing the PRA model to identify all sequences in which venting was not credited after core damage. These sequence frequencies were then modified to reflect the current SSES vent capability. For this analysis, the failure probability for venting after core damage was assumed to be 1E-1, which is relatively high given the long time that is typically available to prepare for containment venting. As a result, the contributions to the original release categories were reduced by a factor of 10. Because wetwell venting also results in a release, 90 percent of the original release category frequency was added to the release category characterizing a scrubbed release for the sequence in order to account for the impact of a successful containment vent.

The tables below summarize the changes that were made to the Unit 1 and Unit 2 sequences to obtain the revised baseline release category frequencies. Each contributing sequence impacted by changes to the venting assumptions is identified along with information about the frequency redistribution. For some sequences, venting did not impact the magnitude of the release. These sequences are included for completeness.

Unit 1 Sequence Changes (Pre-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Contribution to Original Release Category After Crediting Venting (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ1LT-2-012	LLL	1.97E-10	1.97E-11	LLL	1.77E-10
RCVSEQ1LT-2-016	LL	6.65E-09	6.65E-10	LLL	5.99E-09
RCVSEQ1LT-3-017	ML	6.54E-12	6.54E-13	LLL	5.89E-12
RCVSEQ1LT-3-030	LLL	1.72E-13	1.72E-14	LLL	1.55E-13
RCVSEQ1LT-3-032	LLL	5.31E-14	5.31E-15	LLL	4.78E-14
RCVSEQ1LT-3-034	LL	1.85E-11	1.85E-12	LLL	1.67E-11
RCVSEQ1LT-3-035	HL	8.93E-12	8.93E-13	LLL	8.04E-12
RCVSEQ1LT-3-040	LLL	1.27E-11	1.27E-12	LLL	1.14E-11
RCVSEQ1LT-3-042	LLL	7.29E-10	7.29E-11	LLL	6.56E-10
RCVSEQ1LT-3-046	LLL	2.12E-08	2.12E-09	LLL	1.91E-08
RCVSEQ1LT-6-014	LE	2.85E-09	2.85E-10	LE	2.57E-09
RCVSEQ1LT-6-033	LE	1.04E-10	1.04E-11	LE	9.36E-11
RCVSEQ1LT-6-040	LE	9.14E-10	9.14E-11	LE	8.23E-10
RCVSEQ1LT-6-047	LE	1.03E-09	1.03E-10	LE	9.27E-10
RCVSEQ1TR-2-017	LLL	1.56E-09	1.56E-10	LLL	1.40E-09
RCVSEQ1TR-2-021	LL	4.66E-08	4.66E-09	LLL	4.19E-08
RCVSEQ1TR-2-022	ML	1.53E-10	1.53E-11	LLL	1.38E-10
RCVSEQ1TR-3-040	LLL	8.25E-14	8.25E-15	LLL	7.43E-14
RCVSEQ1TR-3-042	LL	1.67E-09	1.67E-10	LLL	1.50E-09
RCVSEQ1TR-5-087	ML	6.92E-10	6.92E-11	LL	6.23E-10
RCVSEQ1TR-5-101	LL	4.00E-11	4.00E-12	LLL	3.60E-11
RCVSEQ1TR-6AH-001	HE	9.02E-11	9.02E-12	LE	8.12E-11
RCVSEQ1TR-6AL-001	LE	6.46E-09	6.46E-10	LE	5.81E-09
RCVSEQ1TR-6AL-003	LE	6.20E-08	6.20E-09	LE	5.58E-08
RCVSEQ1TR-6AL-005	LE	4.48E-10	4.48E-11	LE	4.03E-10
RCVSEQ1TR-6AL-007	LE	5.03E-10	5.03E-11	LE	4.53E-10
RCVSEQ1TR-8-027	LI	3.04E-10	3.04E-11	LLI	2.74E-10
RCVSEQ1TR-8-031	MI	4.69E-11	4.69E-12	LLI	4.22E-11

Unit 2 Sequence Changes (Pre-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Contribution to Original Release Category After Crediting Venting (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ2LT-2-012	LLL	2.46E-11	2.46E-12	LLL	2.21E-11
RCVSEQ2LT-2-016	LL	9.57E-10	9.57E-11	LLL	8.61E-10
RCVSEQ2LT-3-017	ML	6.54E-12	6.54E-13	LLL	5.89E-12
RCVSEQ2LT-3-030	LLL	1.72E-13	1.72E-14	LLL	1.55E-13
RCVSEQ2LT-3-032	LLL	5.31E-14	5.31E-15	LLL	4.78E-14
RCVSEQ2LT-3-034	LL	1.83E-11	1.83E-12	LLL	1.65E-11
RCVSEQ2LT-3-035	HL	8.93E-12	8.93E-13	LLL	8.04E-12
RCVSEQ2LT-3-040	LLL	1.27E-11	1.27E-12	LLL	1.14E-11
RCVSEQ2LT-3-042	LLL	7.17E-10	7.17E-11	LLL	6.45E-10
RCVSEQ2LT-3-046	LLL	2.03E-08	2.03E-09	LLL	1.83E-08
RCVSEQ2LT-6-014	LE	2.85E-09	2.85E-10	LE	2.57E-09
RCVSEQ2LT-6-033	LE	1.04E-10	1.04E-11	LE	9.36E-11
RCVSEQ2LT-6-040	LE	9.14E-10	9.14E-11	LE	8.23E-10
RCVSEQ2LT-6-047	LE	1.03E-09	1.03E-10	LE	9.27E-10
RCVSEQ2TR-2-017	LLL	6.87E-10	6.87E-11	LLL	6.18E-10
RCVSEQ2TR-2-021	LL	1.95E-08	1.95E-09	LLL	1.76E-08
RCVSEQ2TR-2-022	ML	1.53E-10	1.53E-11	LLL	1.38E-10
RCVSEQ2TR-3-040	LLL	8.25E-14	8.25E-15	LLL	7.43E-14
RCVSEQ2TR-3-042	LL	1.67E-09	1.67E-10	LLL	1.50E-09
RCVSEQ2TR-5-087	LL	4.00E-10	4.00E-11	LL	3.60E-10
RCVSEQ2TR-5-091	ML	4.00E-15	4.00E-16	LL	3.60E-15
RCVSEQ2TR-5-101	LL	4.00E-11	4.00E-12	LLL	3.60E-11
RCVSEQ2TR-6AH-001	HE	9.02E-11	9.02E-12	LE	8.12E-11
RCVSEQ2TR-6AL-001	LE	6.46E-09	6.46E-10	LE	5.81E-09
RCVSEQ2TR-6AL-003	LE	6.20E-08	6.20E-09	LE	5.58E-08
RCVSEQ2TR-6AL-005	LE	4.48E-10	4.48E-11	LE	4.03E-10
RCVSEQ2TR-6AL-007	LE	5.03E-10	5.03E-11	LE	4.53E-10
RCVSEQ2TR-7-008	LI	4.11E-13	4.11E-14	LLI	3.70E-13
RCVSEQ2TR-8-027	LI	2.69E-10	2.69E-11	LLI	2.42E-10
RCVSEQ2TR-8-031	MI	4.64E-11	4.64E-12	LLI	4.18E-11

Unit 1 Sequence Changes (Post-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Contribution to Original Release Category After Crediting Venting (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ1LT-2-012	LLL	1.97E-10	1.97E-11	LLL	1.77E-10
RCVSEQ1LT-2-016	LL	6.65E-09	6.65E-10	LLL	5.99E-09
RCVSEQ1LT-3-017	ML	1.40E-11	1.40E-12	LLL	1.26E-11
RCVSEQ1LT-3-030	LLL	3.67E-13	3.67E-14	LLL	3.30E-13
RCVSEQ1LT-3-032	LLL	1.13E-13	1.13E-14	LLL	1.02E-13
RCVSEQ1LT-3-034	LL	3.95E-11	3.95E-12	LLL	3.56E-11
RCVSEQ1LT-3-035	HL	1.91E-11	1.91E-12	LLL	1.72E-11
RCVSEQ1LT-3-040	LLL	1.27E-11	1.27E-12	LLL	1.14E-11
RCVSEQ1LT-3-042	LLL	7.29E-10	7.29E-11	LLL	6.56E-10
RCVSEQ1LT-3-046	LLL	2.12E-08	2.12E-09	LLL	1.91E-08
RCVSEQ1LT-6-014	LE	3.01E-09	3.01E-10	LE	2.71E-09
RCVSEQ1LT-6-033	LE	1.23E-10	1.23E-11	LE	1.11E-10
RCVSEQ1LT-6-040	LE	1.15E-09	1.15E-10	LE	1.04E-09
RCVSEQ1LT-6-047	LE	1.03E-09	1.03E-10	LE	9.27E-10
RCVSEQ1TR-2-017	LLI	1.56E-09	1.56E-10	LLI	1.40E-09
RCVSEQ1TR-2-021	LI	4.66E-08	4.66E-09	LLI	4.19E-08
RCVSEQ1TR-2-022	MI	1.53E-10	1.53E-11	LLI	1.38E-10
RCVSEQ1TR-3-040	LLL	4.15E-13	4.15E-14	LLL	3.74E-13
RCVSEQ1TR-3-042	LL	1.85E-09	1.85E-10	LLL	1.67E-09
RCVSEQ1TR-5-087	LL	7.30E-10	7.30E-11	LL	6.57E-10
RCVSEQ1TR-5-101	LL	4.00E-11	4.00E-12	LLL	3.60E-11
RCVSEQ1TR-6AH-001	HE	1.61E-10	1.61E-11	LE	1.45E-10
RCVSEQ1TR-6AL-001	LE	9.53E-09	9.53E-10	LE	8.58E-09
RCVSEQ1TR-6AL-003	LE	9.01E-08	9.01E-09	LE	8.11E-08
RCVSEQ1TR-6AL-005	LE	6.69E-10	6.69E-11	LE	6.02E-10
RCVSEQ1TR-6AL-007	LE	7.51E-10	7.51E-11	LE	6.76E-10
RCVSEQ1TR-8-027	LI	3.20E-10	3.20E-11	LLI	2.88E-10
RCVSEQ1TR-8-031	MI	4.75E-11	4.75E-12	LLI	4.28E-11

Unit 2 Sequence Changes (Post-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Contribution to Original Release Category After Crediting Venting (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ2LT-2-012	LLL	2.46E-11	2.46E-12	LLL	2.21E-11
RCVSEQ2LT-2-016	LL	9.57E-10	9.57E-11	LLL	8.61E-10
RCVSEQ2LT-3-017	ML	1.40E-11	1.40E-12	LLL	1.26E-11
RCVSEQ2LT-3-030	LLL	3.67E-13	3.67E-14	LLL	3.30E-13
RCVSEQ2LT-3-032	LLL	1.13E-13	1.13E-14	LLL	1.02E-13
RCVSEQ2LT-3-034	LL	3.90E-11	3.90E-12	LLL	3.51E-11
RCVSEQ2LT-3-035	HL	1.91E-11	1.91E-12	LLL	1.72E-11
RCVSEQ2LT-3-040	LLL	1.27E-11	1.27E-12	LLL	1.14E-11
RCVSEQ2LT-3-042	LLL	7.17E-10	7.17E-11	LLL	6.45E-10
RCVSEQ2LT-3-046	LLL	2.03E-08	2.03E-09	LLL	1.83E-08
RCVSEQ2LT-6-014	LE	3.01E-09	3.01E-10	LE	2.71E-09
RCVSEQ2LT-6-033	LE	1.23E-10	1.23E-11	LE	1.11E-10
RCVSEQ2LT-6-040	LE	1.15E-09	1.15E-10	LE	1.04E-09
RCVSEQ2LT-6-047	LE	1.03E-09	1.03E-10	LE	9.27E-10
RCVSEQ2TR-2-017	LLI	6.87E-10	6.87E-11	LLI	6.18E-10
RCVSEQ2TR-2-021	LI	1.95E-08	1.95E-09	LLI	1.76E-08
RCVSEQ2TR-2-022	MI	1.53E-10	1.53E-11	LLI	1.38E-10
RCVSEQ2TR-3-040	LLL	4.15E-13	4.15E-14	LLL	3.74E-13
RCVSEQ2TR-3-042	LL	1.84E-09	1.84E-10	LLL	1.66E-09
RCVSEQ2TR-5-087	LL	4.14E-10	4.14E-11	LL	3.73E-10
RCVSEQ2TR-5-091	ML	1.18E-14	1.18E-15	LLL	1.06E-14
RCVSEQ2TR-5-101	LL	4.00E-11	4.00E-12	LLL	3.60E-11
RCVSEQ2TR-6AH-001	HE	1.61E-10	1.61E-11	LE	1.45E-10
RCVSEQ2TR-6AL-001	LE	9.53E-09	9.53E-10	LE	8.58E-09
RCVSEQ2TR-6AL-003	LE	9.02E-08	9.02E-09	LE	8.12E-08
RCVSEQ2TR-6AL-005	LE	6.69E-10	6.69E-11	LE	6.02E-10
RCVSEQ2TR-6AL-007	LE	7.51E-10	7.51E-11	LE	6.76E-10
RCVSEQ2TR-7-008	LI	6.74E-13	6.74E-14	LLI	6.07E-13

Unit 2 Sequence Changes (Post-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Contribution to Original Release Category After Crediting Venting (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ2TR-8-027	LI	2.81E-10	2.81E-11	LLI	2.53E-10
RCVSEQ2TR-8-031	MI	4.67E-11	4.67E-12	LLI	4.20E-11

The following tables provide the release category frequencies along with the corresponding dose-risk and offsite economic cost-risk resulting from the changes identified above.

PRE-EPU UNIT 1

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Freq_{S12\ Base}$	1.71E-07	1.47E-07	1.13E-10	0.00E+00	5.05E-07	1.32E-07	7.44E-08	4.20E-07	6.94E-09	3.16E-10	7.33E-08	**1.53E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.00	0.00	0.01	**1.66**
$OECR_{S12\ Base}$	$2,495	$1,764	$3	$0	$4,338	$752	$10	$252	$6	$0	$1	**$9,621**

PRE-EPU UNIT 2

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Freq_{S12\ Base}$	1.72E-07	1.30E-07	9.90E-11	0.00E+00	5.14E-07	1.13E-07	7.47E-08	4.31E-07	2.73E-09	2.84E-10	4.19E-08	**1.48E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.00	0.00	0.00	**1.62**
$OECR_{S12\ Base}$	$2,510	$1,560	$3	$0	$4,415	$642	$10	$259	$2	$0	$1	**$9,402**

POST-EPU UNIT 1

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Freq_{S12\ Base}$	1.73E-07	1.59E-07	1.14E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.45E-07	1.74E-09	4.40E-08	3.00E-08	**1.65E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.51	0.25	0.00	0.00	0.79	0.18	0.02	0.15	0.00	0.01	0.00	**1.91**
$OECR_{S12\ Base}$	$2,645	$2,099	$3	$0	$5,056	$995	$18	$308	$2	$2	$1	**$11,129**

POST-EPU UNIT 2

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Freq_{S12\ Base}$	1.73E-07	1.39E-07	9.98E-11	0.00E+00	5.49E-07	1.30E-07	1.08E-07	4.55E-07	8.32E-10	1.84E-08	2.37E-08	**1.60E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.51	0.22	0.00	0.00	0.80	0.16	0.02	0.15	0.00	0.00	0.00	**1.86**
$OECR_{S12\ Base}$	$2,645	$1,835	$3	$0	$5,159	$857	$18	$315	$1	$1	$0	**$10,834**

The impact of this SAMA's suggested improvement to existing SSES procedures for venting after core damage is quantified by assuming that the failure probability of venting is 0.0 rather than 1.0. The changes to the release category frequencies were calculated in a manner similar to what was used to obtain the revised baseline frequencies above. The difference is that the entire sequence frequency is reclassified as a scrubbed release instead of 90 percent of the release, as shown in the following tables.

Unit 1 Sequence Changes (Pre-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ1LT-2-012	LLL	1.97E-10	LLL	1.97E-10
RCVSEQ1LT-2-016	LL	6.65E-09	LLL	6.65E-09
RCVSEQ1LT-3-017	ML	6.54E-12	LLL	6.54E-12
RCVSEQ1LT-3-030	LLL	1.72E-13	LLL	1.72E-13
RCVSEQ1LT-3-032	LLL	5.31E-14	LLL	5.31E-14
RCVSEQ1LT-3-034	LL	1.85E-11	LLL	1.85E-11
RCVSEQ1LT-3-035	HL	8.93E-12	LLL	8.93E-12
RCVSEQ1LT-3-040	LLL	1.27E-11	LLL	1.27E-11
RCVSEQ1LT-3-042	LLL	7.29E-10	LLL	7.29E-10
RCVSEQ1LT-3-046	LLL	2.12E-08	LLL	2.12E-08
RCVSEQ1LT-6-014	LE	2.85E-09	LE	2.85E-09
RCVSEQ1LT-6-033	LE	1.04E-10	LE	1.04E-10
RCVSEQ1LT-6-040	LE	9.14E-10	LE	9.14E-10
RCVSEQ1LT-6-047	LE	1.03E-09	LE	1.03E-09
RCVSEQ1TR-2-017	LLL	1.56E-09	LLL	1.56E-09
RCVSEQ1TR-2-021	LL	4.66E-08	LLL	4.66E-08
RCVSEQ1TR-2-022	ML	1.53E-10	LLL	1.53E-10
RCVSEQ1TR-3-040	LLL	8.25E-14	LLL	8.25E-14
RCVSEQ1TR-3-042	LL	1.67E-09	LLL	1.67E-09
RCVSEQ1TR-5-087	ML	6.92E-10	LL	6.92E-10
RCVSEQ1TR-5-101	LL	4.00E-11	LLL	4.00E-11
RCVSEQ1TR-6AH-001	HE	9.02E-11	LE	9.02E-11
RCVSEQ1TR-6AL-001	LE	6.46E-09	LE	6.46E-09
RCVSEQ1TR-6AL-003	LE	6.20E-08	LE	6.20E-08
RCVSEQ1TR-6AL-005	LE	4.48E-10	LE	4.48E-10
RCVSEQ1TR-6AL-007	LE	5.03E-10	LE	5.03E-10
RCVSEQ1TR-8-027	LI	3.04E-10	LLI	3.04E-10
RCVSEQ1TR-8-031	MI	4.69E-11	LLI	4.69E-11

Unit 2 Sequence Changes (Pre-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ2LT-2-012	LLL	2.46E-11	LLL	2.21E-11
RCVSEQ2LT-2-016	LL	9.57E-10	LLL	8.61E-10
RCVSEQ2LT-3-017	ML	6.54E-12	LLL	5.89E-12
RCVSEQ2LT-3-030	LLL	1.72E-13	LLL	1.55E-13
RCVSEQ2LT-3-032	LLL	5.31E-14	LLL	4.78E-14
RCVSEQ2LT-3-034	LL	1.83E-11	LLL	1.65E-11
RCVSEQ2LT-3-035	HL	8.93E-12	LLL	8.04E-12
RCVSEQ2LT-3-040	LLL	1.27E-11	LLL	1.14E-11
RCVSEQ2LT-3-042	LLL	7.17E-10	LLL	6.45E-10
RCVSEQ2LT-3-046	LLL	2.03E-08	LLL	1.83E-08
RCVSEQ2LT-6-014	LE	2.85E-09	LE	2.57E-09
RCVSEQ2LT-6-033	LE	1.04E-10	LE	9.36E-11
RCVSEQ2LT-6-040	LE	9.14E-10	LE	8.23E-10
RCVSEQ2LT-6-047	LE	1.03E-09	LE	9.27E-10
RCVSEQ2TR-2-017	LLL	6.87E-10	LLL	6.18E-10
RCVSEQ2TR-2-021	LL	1.95E-08	LLL	1.76E-08
RCVSEQ2TR-2-022	ML	1.53E-10	LLL	1.38E-10
RCVSEQ2TR-3-040	LLL	8.25E-14	LLL	7.43E-14
RCVSEQ2TR-3-042	LL	1.67E-09	LLL	1.50E-09
RCVSEQ2TR-5-087	LL	4.00E-10	LL	3.60E-10
RCVSEQ2TR-5-091	ML	4.00E-15	LL	3.60E-15
RCVSEQ2TR-5-101	LL	4.00E-11	LLL	3.60E-11
RCVSEQ2TR-6AH-001	HE	9.02E-11	LE	8.12E-11
RCVSEQ2TR-6AL-001	LE	6.46E-09	LE	5.81E-09
RCVSEQ2TR-6AL-003	LE	6.20E-08	LE	5.58E-08
RCVSEQ2TR-6AL-005	LE	4.48E-10	LE	4.03E-10
RCVSEQ2TR-6AL-007	LE	5.03E-10	LE	4.53E-10
RCVSEQ2TR-7-008	LI	4.11E-13	LLI	3.70E-13
RCVSEQ2TR-8-027	LI	2.69E-10	LLI	2.42E-10
RCVSEQ2TR-8-031	MI	4.64E-11	LLI	4.18E-11

Unit 1 Sequence Changes (Post-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ1LT-2-012	LLL	1.97E-10	LLL	1.77E-10
RCVSEQ1LT-2-016	LL	6.65E-09	LLL	5.99E-09
RCVSEQ1LT-3-017	ML	1.40E-11	LLL	1.26E-11
RCVSEQ1LT-3-030	LLL	3.67E-13	LLL	3.30E-13
RCVSEQ1LT-3-032	LLL	1.13E-13	LLL	1.02E-13
RCVSEQ1LT-3-034	LL	3.95E-11	LLL	3.56E-11
RCVSEQ1LT-3-035	HL	1.91E-11	LLL	1.72E-11
RCVSEQ1LT-3-040	LLL	1.27E-11	LLL	1.14E-11
RCVSEQ1LT-3-042	LLL	7.29E-10	LLL	6.56E-10
RCVSEQ1LT-3-046	LLL	2.12E-08	LLL	1.91E-08
RCVSEQ1LT-6-014	LE	3.01E-09	LE	2.71E-09
RCVSEQ1LT-6-033	LE	1.23E-10	LE	1.11E-10
RCVSEQ1LT-6-040	LE	1.15E-09	LE	1.04E-09
RCVSEQ1LT-6-047	LE	1.03E-09	LE	9.27E-10
RCVSEQ1TR-2-017	LLI	1.56E-09	LLI	1.40E-09
RCVSEQ1TR-2-021	LI	4.66E-08	LLI	4.19E-08
RCVSEQ1TR-2-022	MI	1.53E-10	LLI	1.38E-10
RCVSEQ1TR-3-040	LLL	4.15E-13	LLL	3.74E-13
RCVSEQ1TR-3-042	LL	1.85E-09	LLL	1.67E-09
RCVSEQ1TR-5-087	LL	7.30E-10	LL	6.57E-10
RCVSEQ1TR-5-101	LL	4.00E-11	LLL	3.60E-11
RCVSEQ1TR-6AH-001	HE	1.61E-10	LE	1.45E-10
RCVSEQ1TR-6AL-001	LE	9.53E-09	LE	8.58E-09
RCVSEQ1TR-6AL-003	LE	9.01E-08	LE	8.11E-08
RCVSEQ1TR-6AL-005	LE	6.69E-10	LE	6.02E-10
RCVSEQ1TR-6AL-007	LE	7.51E-10	LE	6.76E-10
RCVSEQ1TR-8-027	LI	3.20E-10	LLI	2.88E-10
RCVSEQ1TR-8-031	MI	4.75E-11	LLI	4.28E-11

Unit 2 Sequence Changes (Post-EPU)

Sequence Name	Original Release Category	Original Sequence Frequency (/yr)	Release Category with WW Vent	Contribution to Release Category With Wetwell Vent (/yr)
RCVSEQ2LT-2-012	LLL	2.46E-11	LLL	2.21E-11
RCVSEQ2LT-2-016	LL	9.57E-10	LLL	8.61E-10
RCVSEQ2LT-3-017	ML	1.40E-11	LLL	1.26E-11
RCVSEQ2LT-3-030	LLL	3.67E-13	LLL	3.30E-13
RCVSEQ2LT-3-032	LLL	1.13E-13	LLL	1.02E-13
RCVSEQ2LT-3-034	LL	3.90E-11	LLL	3.51E-11
RCVSEQ2LT-3-035	HL	1.91E-11	LLL	1.72E-11
RCVSEQ2LT-3-040	LLL	1.27E-11	LLL	1.14E-11
RCVSEQ2LT-3-042	LLL	7.17E-10	LLL	6.45E-10
RCVSEQ2LT-3-046	LLL	2.03E-08	LLL	1.83E-08
RCVSEQ2LT-6-014	LE	3.01E-09	LE	2.71E-09
RCVSEQ2LT-6-033	LE	1.23E-10	LE	1.11E-10
RCVSEQ2LT-6-040	LE	1.15E-09	LE	1.04E-09
RCVSEQ2LT-6-047	LE	1.03E-09	LE	9.27E-10
RCVSEQ2TR-2-017	LLI	6.87E-10	LLI	6.18E-10
RCVSEQ2TR-2-021	LI	1.95E-08	LLI	1.76E-08
RCVSEQ2TR-2-022	MI	1.53E-10	LLI	1.38E-10
RCVSEQ2TR-3-040	LLL	4.15E-13	LLL	3.74E-13
RCVSEQ2TR-3-042	LL	1.84E-09	LLL	1.66E-09
RCVSEQ2TR-5-087	LL	4.14E-10	LL	3.73E-10
RCVSEQ2TR-5-091	ML	1.18E-14	LLL	1.06E-14
RCVSEQ2TR-5-101	LL	4.00E-11	LLL	3.60E-11
RCVSEQ2TR-6AH-001	HE	1.61E-10	LE	1.45E-10
RCVSEQ2TR-6AL-001	LE	9.53E-09	LE	8.58E-09
RCVSEQ2TR-6AL-003	LE	9.02E-08	LE	8.12E-08
RCVSEQ2TR-6AL-005	LE	6.69E-10	LE	6.02E-10
RCVSEQ2TR-6AL-007	LE	7.51E-10	LE	6.76E-10
RCVSEQ2TR-7-008	LI	6.74E-13	LLI	6.07E-13
RCVSEQ2TR-8-027	LI	2.81E-10	LLI	2.53E-10
RCVSEQ2TR-8-031	MI	4.67E-11	LLI	4.20E-11

The changes in the release category frequencies are summarized in the "Results" section below. The cost benefit for this SAMA is performed according to the methodology presented in Sections E.4 and E.6 using the revised base model described above in place of the baseline SAMA model.

Results

Implementation of this SAMA yields a reduction in the Dose-risk and Offsite Economic cost-risk (no CDF impact). The results are summarized in the following table for Units 1 and 2 for both pre-EPU and post-EPU conditions:

	Pre-EPU			Post-EPU		
	CDF	Dose-Risk	OECR	CDF	Dose-Risk	OECR
Unit $1_{S12\ Base}$	1.86E-06	1.66	$9,621	1.97E-06	1.91	$11,129
Unit 1_{SAMA}	1.86E-06	1.66	$9,616	1.97E-06	1.91	$11,124
Unit 1 Percent Change	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Unit $2_{S12\ Base}$	1.83E-06	1.62	$9,402	1.94E-06	1.86	$10,834
Unit 2_{SAMA}	1.83E-06	1.62	$9,400	1.94E-06	1.86	$10,831
Unit 2 Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 12, Unit 1 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{S12\ Base}$	1.71E-07	1.47E-07	1.13E-10	0.00E+00	5.05E-07	1.32E-07	7.44E-08	4.20E-07	6.94E-09	3.16E-10	7.33E-08	**1.53E-06**
$Frequency_{SAMA}$	1.71E-07	1.47E-07	1.12E-10	0.00E+00	5.05E-07	1.32E-07	7.44E-08	4.20E-07	1.51E-09	3.51E-10	7.88E-08	**1.53E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.00	0.00	0.01	**1.66**
$Dose\text{-}Risk_{SAMA}$	0.45	0.22	0.00	0.00	0.69	0.15	0.01	0.13	0.00	0.00	0.01	**1.66**
$OECR_{S12\ Base}$	$2,495	$1,764	$3	$0	$4,338	$752	$10	$252	$6	$0	$1	**$9,621**
$OECR_{SAMA}$	$2,495	$1,764	$3	$0	$4,338	$752	$10	$252	$1	$0	$1	**$9,616**

SAMA 12, Unit 2 Results By Release Category (Pre-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{S12\ Base}$	1.72E-07	1.30E-07	9.90E-11	0.00E+00	5.14E-07	1.13E-07	7.47E-08	4.31E-07	2.73E-09	2.84E-10	4.19E-08	**1.48E-06**
$Frequency_{SAMA}$	1.72E-07	1.30E-07	9.81E-11	0.00E+00	5.14E-07	1.13E-07	7.47E-08	4.31E-07	5.15E-10	3.16E-10	4.42E-08	**1.48E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.00	0.00	0.00	**1.62**
$Dose\text{-}Risk_{SAMA}$	0.45	0.20	0.00	0.00	0.70	0.13	0.01	0.13	0.00	0.00	0.00	**1.62**
$OECR_{S12\ Base}$	$2,510	$1,560	$3	$0	$4,415	$642	$10	$259	$2	$0	$1	**$9,402**
$OECR_{SAMA}$	$2,510	$1,560	$3	$0	$4,415	$642	$10	$259	$0	$0	$1	**$9,400**

SAMA 12, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{S12\ Base}$	1.73E-07	1.59E-07	1.14E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.45E-07	1.74E-09	4.40E-08	3.00E-08	**1.65E-06**
$Frequency_{SAMA}$	1.73E-07	1.59E-07	1.12E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.40E-07	8.80E-10	4.87E-08	3.08E-08	**1.65E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.51	0.25	0.00	0.00	0.79	0.18	0.02	0.15	0.00	0.01	0.00	**1.91**
$Dose\text{-}Risk_{SAMA}$	0.51	0.25	0.00	0.00	0.79	0.18	0.02	0.15	0.00	0.01	0.00	**1.91**
$OECR_{S12\ Base}$	$2,645	$2,099	$3	$0	$5,056	$995	$18	$308	$2	$2	$1	**$11,129**
$OECR_{SAMA}$	$2,644	$2,099	$3	$0	$5,055	$995	$18	$305	$1	$3	$1	**$11,124**

SAMA 12, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{S12\ Base}$	1.73E-07	1.39E-07	9.98E-11	0.00E+00	5.49E-07	1.30E-07	1.08E-07	4.55E-07	8.32E-10	1.84E-08	2.37E-08	**1.60E-06**
$Frequency_{SAMA}$	1.73E-07	1.39E-07	9.79E-11	0.00E+00	5.49E-07	1.30E-07	1.08E-07	4.53E-07	5.44E-10	2.07E-08	2.40E-08	**1.60E-06**
$Dose\text{-}Risk_{S12\ Base}$	0.51	0.22	0.00	0.00	0.80	0.16	0.02	0.15	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.51	0.22	0.00	0.00	0.80	0.16	0.02	0.15	0.00	0.00	0.00	**1.86**
$OECR_{S12\ Base}$	$2,645	$1,835	$3	$0	$5,159	$857	$18	$315	$1	$1	$0	**$10,834**
$OECR_{SAMA}$	$2,644	$1,835	$3	$0	$5,159	$857	$18	$314	$0	$1	$0	**$10,831**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 12 Net Value

Unit	SAMA 12 Base Case Cost-Risk (Pre-EPU)	Revised Cost-Risk (Pre-EPU)	Averted Cost-Risk (Pre-EPU)	SAMA 12 Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$480,296	$480,145	$151	$548,471	$548,321	$150
Unit 2	$469,945	$469,884	$61	$535,132	$535,042	$90
Total	$950,241	$950,029	$212	$1,083,603	$1,083,363	$240

Based on the assumed minimum cost of implementation for a SAMA of $50,000 (procedure change), the Pre-EPU net value for this SAMA is -$49,788 ($212 - $50,000 = -$49,788), which implies that this SAMA could not be cost beneficial.

For Post-EPU conditions, the net value for this SAMA is -$49,760 ($240 - $50,000 = -$49,760), which implies that this SAMA could not be cost beneficial.

E.6.11 SAMA Number 14: Enhance Fire Main Connection to RHR

SAMA 14 was identified based on the Level 2 importance of the event “013-N-N-EARLY-O”, which represents alignment of the fire protection (FP) or RHRSW system to RHR for injection to the RPV or to containment through the RPV. Review of this HEP reveals that the action’s failure probability is driven by the more limiting conditions associated with FP alignment. This conservative approach prevents undue credit from being taken for FP injection under certain conditions, but it also prevents appropriate credit from being taken for RHRSW injection under other conditions.

The initial strategy conceived to reduce the risk of sequences including these cross-tie failures was to improve the reliability of the cross-tie alignment by simplifying the nature of the cross-tie through the installation of a hard pipe connection. Other methods of addressing the importance of this action through the addition of alternate AC power sources could have been suggested; however, common cause failure and human dependence issues would likely limit the credit that could be taken for these types of enhancements unless costly measures were taken to procure automated, diverse equipment. Ultimately, it was concluded that the existing SSES configuration is adequate to mitigate the sequences highlighted by the importance of the “013-N-N-

EARLY-O" event and that modeling assumptions have artificially inflated the importance of the cross-tie alignment action.

Review of the pre-EPU and post-EPU Level 2 cutsets that were used to generate the importance list revealed that over 88 percent of the cutsets that include the event "013-N-N-EARLY-O" are late injection sequences. There are two main reasons that no SAMAs are required to address the late sequences at SSES:

1. For the relevant late injection scenarios, the 60 minute alignment time of the FP cross-tie is not a limiting issue given that injection is not required until 20 hours (post-EPU conditions) after the initiating event (and many hours after any relevant action cue). Given that the HEP for "013-N-N-EARLY-O" is based on early injection requirements, the most important application of the action does not take credit for the long time that is available to align the FP cross-tie.

2. Discussions with SSES staff revealed that a proceduralized, low flow, hard pipe connection already exists at SSES that is not credited in the PRA model. This connection is capable of providing an injection flow rate of approximately 200 gpm and can be aligned by simple valve manipulations in about 10 minutes. While the low flow rate of the existing hard pipe connection precludes its use early in accident sequences, the connection could be used for makeup late in transient sequences when the decay heat levels are lower. Implementation of a SAMA to install another hard pipe connection between the RHR and FP systems would not reduce the risk of the late sequences further as a functional hard pipe connection already exists.

The remaining 10 to 12 percent of the cases involving the failure of the "013-N-N-EARLY-O" action are early injection scenarios with makeup requirements that exceed the capability of the existing FP to RHR hard pipe connection. While this precludes crediting that connection, the RHRSW to RHR cross-tie connection can be used as this alignment requires only about 2 minutes (based on discussions with Ops personnel). As indicated above, the HEP used to model the alignment of the RHRSW system for early injection is based on the characteristics of the FP system. If a revised HEP were developed to specifically address the alignment of RHRSW for early injection, the importance of the cross-tie action would be reduced below the review cutoff and no SAMAs would be required to address this issue.

Rather than develop a new HEP to demonstrate the impact of crediting the RHRSW cross-tie application, a bounding calculation has been performed using the early injection sequences with the existing cross-tie HEP. This was done by manipulating the composite Level 2 results that were used to generate the original importance list:

1. All cutsets from the Level 2 composite file containing the action “013-N-N-EARLY-O” were extracted and saved in a unique file.

2. The early injection contribution was estimated by eliminating all cutsets from the unique “013-N-N-EARLY-O” file containing the sequence tag for the important late injection sequence (RCVSEQ1TR-7-010B). The frequency of remaining cutsets is the “early injection” frequency for “013-N-N-EARLY-O”.

3. The RRW value for the early injection component of “013-N-N-EARLY-O” is the factor by which the composite Level 2 frequency is reduced by eliminating the early injection frequency for “013-N-N-EARLY-O”. For Unit 1 pre-EPU, the result is 1.005 (9.56E-7 / [9.56E-7 – 4.51E-9] = 1.005) and for Unit 2 the result is 1.004 (9.28E-7 / [9.28E-7 – 4.07E-9] = 1.004). For post-EPU conditions, the result for Unit 1 is 1.004 (1.02E-6 / [1.02E-6 – 4.56E-9] = 1.004) and for Unit 2 the result is 1.004 (9.91E-7 / [9.91E-7 – 4.19E-9] = 1.004).

Based on this calculation, the segment of the Level 2 results related to early injection through the RHRSW cross-tie is small. Even if it was determined that the existing RHRSW cross-tie was in some way inadequate, no SAMAs would be suggested given that the RRW of the cross-tie action for early injection is only 1.005, which is well below the 1.02 cutoff that is used to identify potentially cost beneficial SAMAs.

In summary, no SAMAs are considered to be required to address the importance of the “013-N-N-EARLY-O” action for the following reasons:

1. The CDF based RRW of “013-N-N-EARLY-O” is below the review cutoff limit of 1.02.

2. Over 88 percent of the Level 2 contribution from “013-N-N-EARLY-O” is based on long term scenarios while the HEP used to represent the alignment is based on early injection requirements.

3. An easily aligned hard pipe connection already exists between the FP system and RHR that can be used for 88 percent of the “013-N-N-EARLY-O” cases.

4. For the early injection component of the Level 2 results, the RHRSW alignment is assigned the HEP based on the characteristics of the FP system cross-tie requirements.

5. The Level 2 based RRW for the early injection component of “013-N-N-EARLY-O” is only 1.005, which falls below the review cutoff limit of 1.02. No further analysis is considered to be required.

E.7 UNCERTAINTY ANALYSIS

The following three uncertainties were further investigated as to their impact on the overall SAMA evaluation:

- Use a discount rate of 7 percent, instead of 3 percent used in the base case analysis.
- Use the 95th percentile PRA results in place of the mean PRA results.
- Selected MACCS2 input variables.

While results could be provided for both pre-EPU and post-EPU conditions, the post EPU results are more limiting and are used throughout the sensitivity analyses.

E.7.1 Real Discount Rate

A sensitivity study has been performed in order to identify how the conclusions of the SAMA analysis might change based on the value assigned to the real discount rate (RDR). The original RDR of 3 percent, which could be viewed as conservative, has been changed to 7 percent and the modified maximum averted cost-risk was re-calculated using the methodology outlined in Section E.4. The Phase 1 screening against the MMACR was re-examined using the revised MMACR to identify any SAMA candidates that could be screened from further analysis based on the premise that their costs of implementation exceeded all possible benefit. In addition, the Phase 2 analysis was re-performed using the 7 percent RDR.

Implementation of the 7 percent RDR reduced the MMACR by 24.4 percent compared with the case where a 3 percent RDR was used. This corresponds to a decrease in the MMACR from $1,088,000 to $822,000. The Phase 1 SAMA list was reviewed to determine if such a decrease in the MMACR would impact the disposition of any SAMAs. It was determined that SAMA 7 could have been screened in the Phase 1 analysis based on this reduction in the MMACR. While this is true, it should be noted that a detailed analysis would still have been performed for SAMA 7 in the 95th percentile sensitivity study.

The Phase 2 SAMAs are dispositioned based on PRA insights or detailed analysis. All of the PRA insights used to screen the SAMAs are still applicable given the use of the 7 percent real discount rate as the change only strengthens the factors used to screen

them. The SAMA candidates screened based on these insights are considered to be addressed and are not investigated further.

The remaining Phase 2 SAMAs were dispositioned based on the results of a SAMA specific cost-benefit analysis. This step has been re-performed using the 7 percent real discount rate to calculate the net values for the SAMAs.

As shown below, the determination of cost effectiveness changed for two Phase 2 SAMAs when the 7 percent RDR was used in lieu of 3 percent. The margin by which SAMA 2a becomes "not cost beneficial" is large; however, this does not mean that this SAMA would be screened from consideration if a 7 percent real discount rate were applied in the SAMA analysis as other factors influence the decision making process, such as the 95th percentile sensitivity analysis.

Summary of the Impact of the RDR Value on the Detailed SAMA Analyses (Post EPU)

SAMA ID	Cost of Implementation	Averted Cost- Risk (3 percent RDR)	Net Value (3 percent RDR)	Averted Cost- Risk (7 percent RDR)	Net Value (7 percent RDR)	Change in Cost Effective-ness?
1	$2,798,000	$749,073	-$2,048,927	$562,622	-$2,235,378	No
2a	$656,000	$694,331	$38,331	$521,124	-$134,876	Yes
3	$150,000	$137,758	-$12,242	$107,402	-$42,598	No
5	$398,000	$368,403	-$29,597	$274,582	-$123,418	No
6	$203,000	$266,665	$63,665	$198,759	-$4,241	Yes
7	$970,000	$75,890	-$894,110	$58,884	-$911,116	No
8	$600,000	$9,896	-$590,104	$8,865	-$591,135	No
9	$346,000	$34,521	-$311,479	$28,144	-$317,856	No
10	$386,000	$18,612	-$367,388	$15,884	-$370,116	No
12	$50,000	$240	-$49,760	$171	-$49,829	No

E.7.2 95th Percentile PRA Results

The results of the SAMA analysis can be impacted by implementing conservative values from the PRA's uncertainty distribution. If the best estimate failure probability values were consistently lower than the "actual" failure probabilities, the PRA model would underestimate plant risk and yield lower than "actual" averted cost-risk values for potential SAMAs. Re-assessing the cost-benefit calculations using the high end of the

failure probability distributions is a means of identifying the impact of having consistently underestimated failure probabilities for plant equipment and operator actions included in the PRA model.

For SSES, the UNCERT32 software code was used to perform the Level 1 internal events model uncertainty analysis for Unit 1 (considered to be representative of both Units). The results of the calculation are provided below:

PARAMETER	Unit 1 Pre-EPU	Unit 1 Post EPU
Mean	2.19E-06	2.88E-06
5 percent	1.28E-06	1.38E-06
50 percent	1.76E-06	1.84E-06
95 percent	3.82E-06	4.16E-06
Standard Deviation	2.68E-06	1.49E-05

For Pre-EPU conditions, the PRA uncertainty calculation identifies the 95th percentile CDF as 3.82E-06 per year. This is a factor of 2.0 greater than the CDF point estimate produced by the SSES PRA (1.86E-06). For Post-EPU conditions, the PRA uncertainty calculation identifies the 95th percentile CDF as 4.16E-06 per year, which is a factor of 2.1 greater than the SSES point estimate CDF (1.97E-06). For this analysis, the post-EPU results are used as they bound the Pre-EPU results.

E.7.2.1 Phase 1 Impact

For Phase 1 screening, use of the 95th percentile PRA results will increase the modified maximum averted cost-risk and may prevent the screening of some of the higher cost modifications. There are cases where the SAMAs retained from this process may be cost beneficial using the 95th percentile results, but it is not common for this to occur. This is due to the fact that the benefit gleaned from the implementation of those SAMAs must be extremely large in order to be cost beneficial.

The impact of uncertainty in the PRA results on the Phase 1 SAMA analysis has been examined. The modified maximum averted cost-risk is the primary Phase 1 criteria affected by PRA uncertainty. Thus, this portion of this sensitivity is focused on recalculating the MMACR using the 95th percentile PRA results and re-performing the Phase 1 screening process.

As discussed above, the 95th PRA results are approximately a factor of 2.1 greater than point estimate CDF. The uncertainty analyses that are available for the Level 1 models

are not available for Level 2 and 3 PRA models. In order to simulate the use of the 95th percentile results for the Level 2 and 3 models, the same scaling factor calculated for the Level 1 results was assumed to apply to the Level 2 and 3 models. Because the MMACR calculations scale linearly with the CDF, dose-risk, and offsite economic cost-risk, the 95th percentile MMACR can be calculated by multiplying the base case MMACR by 2.1. This results in a revised MMACR of $2,284,800.

The initial SAMA list has been re-examined using the revised MMACR to identify SAMAs that would be retained for the Phase 2 analysis. Those SAMAs that were previously screened due to costs of implementation that exceeded $1,088,000 are now retained if the costs of implementation are less than $2.28 million. In this case, two additional SAMAs would be retained for Phase 2 analysis that were initially screened based on the point estimate results (SAMAs 2b and 4).

E.7.2.2 Phase 2 Impact

As mentioned above, the 95th percentile PRA results are not available for the Level 2 and 3 models. In order to estimate the impact of using the 95th percentile PRA results in the Phase 2 SAMA analysis, the same process used to calculate the revised MMACR was applied to each of the Phase 2 SAMAs (the averted cost-risk for each SAMA was increased by a factor of 2.1 over the base case).

In addition, it was determined that SAMAs 2b and 4 should be included in the Phase 2 analysis when the 95th percentile PRA results are used. The detailed assessments of these SAMAs are documented below as part of this sensitivity.

E.7.2.2.1 SAMA 2b: Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-B-C-D)

Failure of an EDG combined with the failure of the “E” diesel in conjunction with non-diesel equipment failure in an alternate division results in the unavailability of both divisions of equipment. However, if power could be cross-tied between divisions, the non-failed equipment could be operated. SSES currently relies on the presence of the spare diesel (the “E” EDG) to mitigate EDG failures. While the “E” EDG is a valuable plant asset, emergency 4kV AC cross-tie capability would further reduce plant risk.

This SAMA is similar to SAMA 2a, but it provides the additional capability of providing the ability to cross-tie trains “A” or “D” to trains “B” or “C”. These additional alignments require the operators to backfeed power through one of the Emergency Safeguards

transformers to the 13.8kV AC 10 or 20 bus and then back to the 4kV emergency buses through another Emergency Safeguards transformer. This alignment requires the operators to strip off all unnecessary 13.8kV loads and ensure the 10 and/or 20 buses are isolated from the grid.

The impact of implementing this SAMA has been estimated through the changes summarized in the following table:

SAMA Number 2b Model Changes

Gate and / or Basic Event ID and Description	Description of Change
SAMMA2B-A	This is a new “AND” gate including: • Gate 124-II-D-DGPWRU1 • Gate 224-II-D-DGPWRU2 • Gate 124-II-B-DGPWRU1 • Gate 224-II-B-DGPWRU2 • Gate 124-I-C-DGPWRU1 • Gate 224-I-C-DGPWRU2 The gate represents the ability to power the “A” bus from the other EDGs.
SAMMA2B-D	This is a new “AND” gate including: • Gate 124-I-A-DGPWRU1 • Gate 224-I-A-DGPWRU2 • Gate 124-II-B-DGPWRU1 • Gate 224-II-B-DGPWRU2 • Gate 124-I-C-DGPWRU1 • Gate 224-I-C-DGPWRU2 The gate represents the ability to power the “D” bus from the other EDGs.
SAMMA2B-C	This is a new “AND” gate including: • Gate 124-I-A-DGPWRU1 • Gate 224-I-A-DGPWRU2 • Gate 124-II-B-DGPWRU1 • Gate 224-II-B-DGPWRU2 • Gate 124-II-D-DGPWRU1 • Gate 224-II-D-DGPWRU2 The gate represents the ability to power the “C” bus from the other EDGs.
SAMMA2B-B	This is a new “AND” gate including: • Gate 124-I-A-DGPWRU1 • Gate 224-I-A-DGPWRU2 • Gate 124-I-C-DGPWRU1 • Gate 224-I-C-DGPWRU2 • Gate 124-II-D-DGPWRU1 • Gate 224-II-D-DGPWRU2 The gate represents the ability to power the “B” bus from the other EDGs.
104-I-A-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 1 BUS 1A201 CREDITING THE E DG	Added gate SAMA2B-A

SAMA Number 2b Model Changes

Gate and / or Basic Event ID and Description	Description of Change
104-II-D-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 1 BUS 1A204 CREDITING THE E DG IF A B C DG HA	Added gate SAMA2B-D
104-I-C-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 1 BUS 1A202 CREDITING THE E DG IF A B DG HAS	Added gate SAMA2B-C
104-II-B-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 1 BUS 1A202 CREDITING THE E DG IF A DG HAS NO	Added gate SAMA2B-B
204-I-A-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 2 BUS 2A201 CREDITING THE E DG	Added gate SAMMA2B-A
204-II-D-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 2 BUS 2A204 CREDITING THE E DG IF A B C DG HA	Added gate SAMMA2B-D
204-I-C-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 2 BUS 2A203 CREDITING THE E DG IF A B DG HAS	Added gate SAMMA2B-C
204-II-B-PWR-EDGBU: FAILURE OF 4KV POWER TO THE UNIT 2 BUS 2A202 CREDITING THE E DG IF A DG HAS NO	Added gate SAMMA2B-B

The cross-tie action for this SAMA was conservatively assumed to be 100 percent reliable.

The cost of enhancing the 4kV AC emergency bus cross-tie capability so that any emergency 4kV AC bus can power any other emergency 4kV AC bus has been estimated to be approximately $1,384,000 (PPL 2005h).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for post-EPU conditions (pre-EPU conditions are not addressed in this sensitivity):

	Post-EPU		
	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	8.57E-07	0.73	$3,738
Unit 1 Percent Change	56.5%	62.1%	66.5%
Unit 2_{Base}	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	8.38E-07	0.67	$3,322
Unit 2 Percent Change	56.8%	64.0%	69.4%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 2b, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.51E-07	5.65E-08	1.12E-10	0.00E+00	8.83E-09	5.33E-08	1.07E-07	3.16E-07	8.36E-09	1.56E-09	2.22E-08	**7.25E-07**
Dose-$Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
Dose-$Risk_{SAMA}$	0.44	0.09	0.00	0.00	0.01	0.06	0.02	0.10	0.00	0.00	0.00	**0.72**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,310	$746	$3	$0	$83	$351	$18	$219	$8	$0	$0	**$3,738**

SAMA 2b, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.51E-07	3.36E-08	9.79E-11	0.00E+00	8.52E-09	3.93E-08	1.07E-07	2.98E-07	2.33E-09	6.87E-10	2.11E-08	**6.62E-07**
Dose-$Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
Dose-$Risk_{SAMA}$	0.44	0.05	0.00	0.00	0.01	0.05	0.02	0.10	0.00	0.00	0.00	**0.67**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,310	$444	$3	$0	$80	$259	$18	$206	$2	$0	$0	**$3,322**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 2b Net Value

Unit	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$550,000	$200,204	$349,796
Unit 2	$538,000	$184,821	$353,179
Total	$1,088,000	$385,025	$702,975

In order to obtain the averted cost-risk based on the 95th percentile PRA results, the baseline averted cost-risk is multiplied by a factor of 2.1 to yield $1,476,248. This results in a net value of $92,248 ($1,476,248 - $1,384,000 = $92,248), which implies that this SAMA is cost beneficial.

E.7.2.2.2 SAMA 4: Install 100 Percent Capacity Battery Chargers

Currently, the SSES 125V DC chargers cannot support the full DC load requirements early in LOOP or LOCA sequences. In the event that the 125V batteries fail early in these accident scenarios, DC power is assumed to be unavailable to support injection system operation, which results in core damage even though the 125V DC battery chargers may still be available. For these cases, the DC loads could be supported the existing chargers were replaced with higher capacity units and procedures were developed to remove the failed batteries from the circuit. For LOOP events with concurrent battery failures, changes to the EDGs would be required to allow the EDGs to start and load without DC power.

The impact of implementing this SAMA has been estimated by removing the model logic that dictates 125V DC system failure when the 125V batteries are lost in conjunction with a LOOP or LOCA initiating event. The specific changes are provided below:

- Deleted 102-I-A-BATLOOPLOCA from 102-I-A-D613C.
- Deleted 102-I-C-BATLOOPLOCA from 102-I-C-D633C.
- Deleted 102-II-B-BATLOOPLOCA from 102-II-B-D623C.
- Deleted 102-II-D-BATLOOPLOCA from 102-II-D-D643C.

- Deleted 188-II-N-BATLOOPLOCA from 188-II-N-D663.
- Deleted 188-I-N-BATLOOPLOCA from 188-II-N-D663 and 188-I-B-D653.
- Deleted 202-I-A-BATLOOPLOCA from 202-I-A-D613C.
- Deleted 202-I-C-BATLOOPLOCA from 202-I-C-D633C.
- Deleted 202-II-B-BATLOOPLOCA from 202-II-B-D623C
- Deleted 202-II-D-BATLOOPLOCA from 202-II-D-D643C.
- Deleted 288-II-N-BATLOOPLOCA from 288-II-N-D663.
- Deleted 288-I-N-BATLOOPLOCA from 288-I-A-D653 and 288-I-B-D653

The cost of replacing the current battery chargers with new chargers that can supply 100 percent of the DC loads under all conditions has been estimated to be approximately $1,619,000 (PPL 2005f). This estimate does not address the changes that would be required to allow the EDGs to start without DC power in the event of a LOOP with concurrent battery failures.

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table for Units 1 and 2 for post-EPU conditions (pre-EPU conditions are not addressed in this sensitivity):

	Post-EPU		
	CDF	Dose-Risk	OECR
Unit 1_{Base}	1.97E-06	1.90	$11,151
Unit 1_{SAMA}	1.92E-06	1.86	$10,897
Unit 1 Percent Change	2.5%	2.1%	2.3%
Unit 2_{Base}	1.94E-06	1.86	$10,845
Unit 2_{SAMA}	1.84E-06	1.81	$10,505
Unit 2 Percent Change	5.2%	2.7%	3.1%

A further breakdown of the Dose-risk and OECR information is provided below according to release category.

SAMA 4, Unit 1 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.59E-07	1.31E-10	0.00E+00	5.38E-07	1.51E-07	1.08E-07	4.87E-07	9.46E-09	1.56E-09	2.22E-08	**1.65E-06**
$Frequency_{SAMA}$	1.71E-07	1.58E-07	1.31E-10	0.00E+00	5.30E-07	1.28E-07	1.08E-07	4.97E-07	2.93E-09	1.56E-09	2.08E-08	**1.62E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.25	0.00	0.00	0.79	0.18	0.02	0.16	0.00	0.00	0.00	**1.90**
$Dose\text{-}Risk_{SAMA}$	0.50	0.25	0.00	0.00	0.77	0.15	0.02	0.17	0.00	0.00	0.00	**1.86**
$OECR_{BASE}$	$2,632	$2,099	$4	$0	$5,057	$995	$18	$337	$9	$0	$0	**$11,151**
$OECR_{SAMA}$	$2,616	$2,086	$4	$0	$4,982	$844	$18	$344	$3	$0	$0	**$10,897**

SAMA 4, Unit 2 Results By Release Category (Post-EPU)

Release Category	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L	Total
$Frequency_{BASE}$	1.72E-07	1.39E-07	1.17E-10	0.00E+00	5.50E-07	1.30E-07	1.08E-07	4.73E-07	3.42E-09	6.87E-10	2.11E-08	**1.60E-06**
$Frequency_{SAMA}$	1.70E-07	1.32E-07	1.17E-10	0.00E+00	5.30E-07	1.26E-07	1.08E-07	4.73E-07	2.52E-09	6.87E-10	2.09E-08	**1.56E-06**
$Dose\text{-}Risk_{BASE}$	0.50	0.22	0.00	0.00	0.80	0.16	0.02	0.16	0.00	0.00	0.00	**1.86**
$Dose\text{-}Risk_{SAMA}$	0.50	0.21	0.00	0.00	0.77	0.15	0.02	0.16	0.00	0.00	0.00	**1.81**
$OECR_{BASE}$	$2,632	$1,835	$3	$0	$5,170	$857	$18	$327	$3	$0	$0	**$10,845**
$OECR_{SAMA}$	$2,601	$1,742	$3	$0	$4,982	$830	$18	$327	$2	$0	$0	**$10,505**

This information was used as input to the cost-benefit calculation. The results of this calculation are provided in the following table.

SAMA Number 4 Net Value

Unit	Base Case Cost-Risk (Post-EPU)	Revised Cost-Risk (Post-EPU)	Averted Cost-Risk (Post-EPU)
Unit 1	$550,000	$537,443	$12,557
Unit 2	$538,000	$519,746	$18,254
Total	$1,088,000	$1,057,189	$30,811

In order to obtain the averted cost-risk based on the 95th percentile PRA results, the baseline averted cost-risk is multiplied by a factor of 2.1 to yield $64,703. This results in a net value of -$1,554,297 ($64,703 - $1,619,000 = -$1,554,297), which implies that this SAMA is not cost beneficial.

E.7.2.2.3 SAMA 14: Enhance Fire Main Connection to RHR

In the baseline analysis, SAMA 14 was screened given that the relevant RRW value was below the 1.02 SAMA review cutoff limit. Normally, the RRW review cutoff limit is set to correlate to the lowest expected SAMA implementation cost, which is typically a procedure change of about $50,000. Because the SSES review cutoff limit was artificially lowered to allow a more robust review of the importance list, even when the 95th percentile results are used, the cutoff RRW review value of 1.02 corresponds to an averted cost-risk of only $50,000 (compared with about $21,000 in the base case). Assuming that the RRW values for the events remain constant with the use of the 95th percentile results, it is expected that SAMA 14 would still be screened based on the 1.005 RRW that was calculated for event “013-N-N-EARLY-O”. The importance rankings may actually vary somewhat depending on the failure probability distributions for the basic events, but these values are not calculated as part of the uncertainty analysis and are not available for this sensitivity.

E.7.2.2.4 Summary

The following table provides a summary of the impact of using the 95th percentile PRA results in the detailed cost-benefit calculations that have been performed.

Summary of the Impact of Using the 95th Percentile PRA Results (Post EPU)

SAMA ID	Cost of Implementation	Averted Cost- Risk (Base)	Net Value (Base)	Averted Cost- Risk (95th Percentile)	Net Value (95th Percentile)	Change in Cost Effective-ness?
1	$2,798,000	$749,073	-$2,048,927	$1,573,053	-$1,224,947	No
2a	$656,000	$694,331	$38,331	$1,458,095	$802,095	No
2b	$1,384,000	NA	NA	$1,476,248	$92,248	Yes
3	$150,000	$137,758	-$12,242	$289,292	$139,292	Yes
4	$1,619,000	NA	NA	$64,703	-$1,554,297	No
5	$398,000	$368,403	-$29,597	$773,646	$375,646	Yes
6	$203,000	$266,665	$63,665	$559,997	$356,997	No
7	$970,000	$75,890	-$894,110	$159,369	-$810,631	No
8	$600,000	$9,896	-$590,104	$20,782	-$579,218	No
9	$346,000	$34,521	-$311,479	$38,222	-$307,778	No
10	$386,000	$18,612	-$367,388	$39,085	-$346,915	No
12	$50,000	$240	-$49,760	$504	-$49,496	No

When the 95th percentile PRA results are used, three of the SAMAs that were previously classified as not cost effective are determined to be cost effective, including SAMA 2b, which was initially screened in Phase 1. The use of the 95th percentile PRA results is not considered to provide the most realistic assessment of the cost effectiveness of a SAMA; however, these three additional SAMAs could be considered for implementation to address the uncertainties inherent in the SAMA analysis.

E.7.3 MACCS2 Input variations

The MACC2 model was developed using the best information available for the SSES site; however, reasonable changes to modeling assumptions can lead to variations in the Level 3 results. In order to determine how certain assumptions could impact the SAMA results, a sensitivity analysis was performed on a group of parameters that has previously been shown to impact the Level 3 results. These parameters include:

- Meteorological data (ESSQ2002; ESSQ2003)
- Population estimates(ESS30INC; ESSSIT00)
- Evacuation effectiveness (ESSQSLOW; ESSDELAY)

- Radionuclide release characteristics (ESSQATM1; ESSQATM2)
- Food production factors (ESSQCROP)
- Recovery, decontamination, and resettlement factors (Intermediate Phase) (ESSQCHR, ESSQCHR1)

The risk metrics produced by MACCS2 that are evaluated in the sensitivity analyses are the 50 mile population dose and the 50 mile offsite economic cost. The subsections below discuss the changes in these results for each of the sensitivity cases that are shown below. The final subsection, E.7.3.7, correlates the worst case changes identified in the sensitivity runs to a change in the site's averted cost-risk and discusses the implications of the sensitivity analysis on the SAMA analysis.

Case	Description	Pop. Dose Risk Δ Base (%)	Cost Risk Δ Base (%)
Base Case	Base Case (Year 2001 MET data)	--	--
ESSQ2002	Year 2002 MET data	-6.7%	-8.6%
ESSQ2003	Year 2003 MET data	-8.2%	-7.8%
ESS30INC	Year 2044 population values increased uniformly 30% over base case.	27.9%	28.7%
ESSSit00	Year 2000 population based on SECPOP2000	-8.5%	-9.0%
ESSQSlow	Evacuation speed decreased 50% to 1.1 mph, 0.485 m/sec (Base Case is 2.2 mph).	11.2%	0%
ESSDelay	Evacuation begins 90 minutes after declaration of General Emergency (Base Case is 60 minutes).	2.1%	0%
ESSQATM1	Release height set to ground level	-6.0%	-10.4%
ESSQATM2	Plume thermal heat content set to ambient (i.e., buoyant plume rise not modeled)	-8.0%	-12.1%
ESSQCrop	Site specific crop production values used	-2.5%	0%
ESSQCHR1	Long Term Phase starts immediately after the Early Phase is over	31.4%	-50.41%
ESSQCHR	1/2 Year Intermediate Phase following the Early Phase	14.7%	-25.9%

E.7.3.1 Meteorological Sensitivity

In addition to the base case meteorological data (year 2001), data were also available for the years 2002 and 2003. Analysis of these alternate data sets yielded population dose-risks and offsite economic cost-risks that were lower than the 2001 data by at least 6.5 percent and by as much as 8.5 percent. These are relatively small perturbations.

As no particular criteria have been defined by the industry related to determining which meteorological data set should be used as a base case for a site, the year 2001 data was conservatively chosen for SSES given that it yielded the largest results.

E.7.3.2 Population Sensitivity

The population sensitivity cases (ESS30INC, ESSSIT00) demonstrate a significant dependence on population estimates. This was expected given that the population dose and offsite economic costs are primarily driven by the regional population.

In case ESS30INC, the baseline 2044 population was uniformly increased by 30 percent in all sectors of the 50-mile radius. This change increased the estimated population dose-risk and offsite economic cost by over 27 percent each.

A second population based sensitivity was performed to determine the impact of scaling the year 2000 SECPOP data to account for the expected changes in the site's 50-mile population. The baseline SAMA case assumes that the population around the site has changed by the end of the license renewal period based on the trends shown between the years 1990 and 2000. In summary, the trends show that many areas around the plant have experienced decreases in population while the areas farther from the plant have shown increases over time. When these population projections are removed from the analysis, the overall dose-risk and OECR decrease. Specifically, the dose-risk decreased by about 8.5 percent and the OECR decreased by about 9 percent.

E.7.3.3 Evacuation sensitivity

The evacuation sensitivity cases (ESSQSLOW and ESSDELAY) demonstrate minor population dose-risk impacts associated with evacuation assumptions due to the relatively slow base case Susquehanna evacuation. While evacuation assumptions do impact the population dose-risk estimates, they do not impact MACCS2 offsite economic cost-risk estimates because MACCS2 calculated cost-risks are based on land

contamination levels which remain unaffected by evacuation assumptions and the number of people evacuating.

For Susquehanna, evacuation assumptions have a relatively minor impact on dose-risk. A 50 percent decrease in the evacuation speed increased the dose-risk by only 11 percent while increasing the delay between declaration of a general emergency and the start of evacuation increased the dose-risk by only 2 percent.

E.7.3.4 Radioactive release sensitivity

The sensitivity cases ESSQATM1 and ESSQATM2 quantify the impact of the assumptions related to the height of the release and thermal energy of the plume, respectively. ESSQATM1 assumes that the release occurs at ground level rather than at an elevation that could correspond to a release through the stack or a break high in the reactor building. The lower release height shows a decrease in dose-risk of 6 percent and a reduction in OECR of over 10 percent. Reducing the thermal plume heat content to ambient conditions has a similar impact. ESSQATM2 shows an 8 percent decrease in the dose-risk and a decrease of about 10 percent in the OECR.

E.7.3.5 Food production sensitivity

The food production sensitivity case (ESSQROP) investigates the impact of food contamination and ingestion rates for the 50-mile population. The sensitivity case utilized food production data developed for the counties surrounding the Susquehanna site in lieu of the national averages used in the COMIDA base case modeling. Use of the site specific data resulted in minor changes to the dose-risk (-2.5 percent) and OECR (0.0%). These small changes are consistent with low contribution of the food ingestion pathway to overall population dose (e.g., only about 5% of the total population dose is due to food ingestion).

E.7.3.6 Intermediate Phase Duration Sensitivity

The Intermediate Phase, as modeled by MACCS2, is the time period beginning after the early phase (one week emergency phase) and extends to the time when recovery actions such as decontamination and resettlement are started (long term phase). MACCS2 allows the habitation of land during the intermediate phase unless the projected dose criterion is exceeded. If the projected dose criterion is exceeded during the intermediate phase, the individual is relocated. MACCS2 allows an intermediate phase ranging from no intermediate phase to one (1) year. The Intermediate Phase related sensitivity cases (ESSQCHR and ESSQCHR1) show significant dependence in relation to economic impact, and are therefore discussed further:

- The No Intermediate Phase case (ESSQCHR1) was developed based on the NUREG-1150 modeling approach. However, the 50 percent reduction in economic cost estimates based on the approach are judged too optimistic in that the land decontamination efforts are modeled as starting one week after the accident (i.e., directly after the early phase ends) such that a significant portion of population relocation costs are omitted. For example, the costs associated with temporary housing while decontamination strategies are developed and decontamination teams are contracted are not accounted for without an intermediate phase. It is believed that NUREG-1150 studies omitted the intermediate phase because the MACCS2 intermediate phase coding was not validated at that time. A competing factor is that the population dose increases because people are allowed to re-occupy the land sooner (31 percent increase over the base case).

- The 1 Year Intermediate Phase case (base case) was developed based on the maximum length of time allowed by MACCS2 for the intermediate phase. A long intermediate phase can be unrealistic in that re-occupation of the contaminated land is not performed during this phase even if contamination levels decrease (by natural radioactive decay) to levels which would allow it (i.e., resettlement is evaluated as part of the long term phase, not the intermediate phase). Therefore, population relocation costs may be over estimated using a long (i.e., one year) intermediate phase. Reducing the Intermediate Phase to six months in sensitivity case ESSQCHR showed a 26 percent decrease in the OECR estimates compared with the 1 year Intermediate phase. However, the population dose increased by 15 percent with a shorter Intermediate Phase due to earlier resettlement of contaminated land.

The six month intermediate phase (ESSQCHR) is judged to be a best estimate approach in that it provides a reasonable time for both decontamination efforts and resettlement to begin. The sensitivity cases demonstrate that this six month modeling approach is mid-range of the modeling choices available; however, the one year intermediate phase is used as the base case as it is more conservative for economic cost risk.

E.7.3.7 Impact on SAMA Analysis

Several different Level 3 input parameters have been examined as part of the SSES MACCS2 sensitivity analysis. The primary reason for performing these sensitivity runs was to identify any reasonable changes that could be made to the Level 3 input parameters that would impact the conclusions of the SAMA analysis. While the table in Section E.7.3 summarizes the changes to the dose-risk and OECR estimates for each sensitivity case, it was necessary to determine if any of these changes would result in the retention of the SAMAs that were screened using the baseline results.

Of all the MACCS2 sensitivity cases, the largest increase in the dose-risk was 31 percent in case ESSQCHR1 while the largest increase in OECR was 29 percent in case ESS30INC. While these are separate cases, the SSES MMACR was recalculated using these results to determine the impact of using the worst case for each parameter simultaneously. The resulting MMACR was $1,349,940, which is less than $2,284,800 calculated in Section E.7.2 for the 95th percentile PRA results. The 95th percentile PRA results sensitivity is considered to bound this case and no SAMAs would be retained based on this sensitivity that were not already identified in Section E.7.2.

E.8 CONCLUSIONS

The benefits of revising the operational strategies in place at SSES and/or implementing hardware modifications can be evaluated without the insight from a risk-based analysis. Use of the PRA in conjunction with cost-benefit analysis methodologies has, however, provided an enhanced understanding of the effects of the proposed changes relative to the cost of implementation and projected impact on a larger future population. The results of this study indicate that of the identified potential improvements that can be made at SSES, a few are cost beneficial based on the methodology applied in this analysis and warrant further review for potential implementation.

The base case analysis shows that implementation of the following two SAMAs would be cost beneficial:

- SAMA 2a: Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-D, B-C)
- SAMA 6: Procure Spare 480V AC Portable Station Generator

The 4kV AC emergency bus cross-tie between the “A” and “D” or “B” and “C” buses (SAMA 2a) is a cost beneficial enhancement at Susquehanna. While SSES already has the “E” EDG to compensate for primary EDG failures, the largest contributor to site risk is still the LOOP initiating event. For a moderate cost of implementation, a means of further reducing LOOP risk could be added to the site.

SAMA 6 is also identified as a cost beneficial change; however, common cause failure of the additional generator is not currently included in the analysis. If common cause failures are included and if SAMA 2a is implemented, the benefit of this SAMA would be reduced. Because of these mitigating factors, this SAMA is not recommended for implementation.

The 95th percentile PRA results show that the following additional SAMAs are cost beneficial:

- SAMA 2b: Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-B-C-D)
- SAMA 3: Proceduralize Staggered RPV Depressurization When Fire Protection System Injection is the Only Available Makeup Source
- SAMA 5: Auto Align 480V AC Portable Station Generator

The expanded 4kV AC cross-tie (SAMA 2b) could also be considered to be a cost-effective change for SSES. This SAMA would allow any given EDG the capability to power any particular 4kV AC emergency bus. While the cost of implementation is greater than the monetary equivalent of the associated risk reduction based on the best estimate results, the sensitivity case shows that SAMA 2b is a borderline case and that it could be considered as a possible means of reducing plant risk. However, if lower cost SAMA 2a is implemented, most of the cross-tie benefit would be obtained and the further changes required to implement SAMA 2b would not be cost beneficial. This judgement is based on the difference in averted cost risk-shown for the two SAMAs in Section E.7.2. SAMA 2b yields an additional benefit of only $20,000 for an additional cost input of $728,000. This SAMA is not recommended for consideration.

SAMA 3 provides a means of ensuring that injection with the Fire Main can prevent core damage when it is the only available injection source. As this SAMA only requires procedure changes and supporting analysis to support the use of an existing injection system, this low cost SAMA should be considered for implementation.

SAMA 5 only becomes cost effective by about 7.5 percent of its cost of implementation when the 95th percentile PRA results are used. While this SAMA could be considered cost beneficial, SAMAs 2a and 3 yield larger cost benefit margins and should be considered for implementation before SAMA 5.

E.9 TABLES

Table E.2-1 Release Severity and Timing Classification Scheme (Severity, Timing)

Release Severity		Release Timing	
Classification Category	**Cs Iodide % in Release**	**Classification Category**	**Time of Initial Release Relative to Time for General Emergency Declaration**
High (H)	Greater than 10	Late (L)	Greater than 24 hours
Medium or Moderate (M)	1 to 10	Intermediate (I)	Greater than 6 hours but less than 24 hours
Low (L)	0.1 to 1	Early (E)	Less than 6 hours
Low-low (LL)	Less than 0.1		
Intact (OK)	Leakage		

Table E.2-2 RELEASE SEVERITY AND TIMING CLASSIFICATION MATRIX

Time of Release	Magnitude of Release			
	H	**M**	**L**	**LL**
E	H/E	M/E	L/E	LL/E
I	H/I	M/I	L/I	LL/I
L	H/L	M/L	L/L	LL/L

Table E.2-3 Summary of Containment Evaluation (SAMA Model)

Release Bin[a]	Pre-EPU Unit 1 Release Frequency (Per Year)	Pre-EPU Unit 2 Release Frequency (Per Year)	Post-EPU Unit 1 Release Frequency (Per Year)	Post-EPU Unit 2 Release Frequency (Per Year)
H/E	1.71E-07	1.71E-07	1.72E-07	1.72E-07
H/I	1.47E-07	1.30E-07	1.59E-07	1.39E-07
H/L	1.21E-10	1.07E-10	1.31E-10	1.17E-10
M/E	0.0	0.0	0.0	0.0
M/I	5.05E-07	5.14-E07	5.38E-07	5.50-E07
M/L	1.33E-07	1.13E-07	1.51E-07	1.30E-07
L/E	7.43E-08	7.43E-08	1.08E-07	1.08E-07
L/I	4.20E-07	4.31E-07	4.87E-07	4.73E-07
L/L	5.58E-08	2.28E-08	9.46E-09	3.42E-09
LL/I	0.0	0.0	1.56E-09	6.87E-10
LL/L	2.37E-08	2.18E-08	2.22E-08	2.11E-08

(a) The LL/E bin is not included here as the frequency is always zero and does not contribute to the Level 3 results. For post-EPU, release timing changes moved some of the LL/L results from the pre-EPU model to the LL/I release category.

Table E.2-4a SSES Source Term Summary (Pre-EPU)

	Release Category[1,2]										
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/E	LL/L
MAAP Run	SU0516	SU0500	SU0514	SU0515	SU0500a	SU0505	SU0515a	SU0511	SU0550	SU0516a	SU0556a
Description	IVA-L2-14A-NED-DW	IA-L2-1A-NSPR	IIID-L2-12C-DW	IVA-L2-14A-ED-DW	IIA-L2-9A-DW	ID-L2-7B-NSPR	IVA-L2-14A-ED-WWA	IIA-L2-9A-WWA	IIIB-L2-1A-NSPR	IVA-L2-14A-NED-WWA	IIIC-L2-7BA-SPRY
Time after Scram when General Emergency is declared	.5 hr	1.5 hr	.5 hr	2 hr	1.5 hr	1.0 hr	2.0 hr	18 hr	.5 hr	.75 hr	.1 hr
Fission Product Group:											
1) Noble											
Total Release **Fraction** at 48 Hours	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Start of Release (hr)	0.75	21.40	29.00	2.00	21.00	33.50	2.00	30.70	34.00	1.00	27.70
End of Release (hr)	3.00	21.40	34.00	4.00	22.00	33.50	4.00	30.70	34.00	4.00	27.20
2) CsI											
Total Release Fraction at 48 Hours	5.90E-01	2.40E-01	3.40E-01	6.00E-02	3.80E-02	2.50E-02	1.00E-03	2.00E-03	7.00E-03	7.80E-04	4.00E-06
Start of Release (hr)	3.80	21.40	30.00	2.00	21.00	33.50	2.00	30.70	34.00	1.00	27.70
End of Release (hr)	5.00	48.00	40.00	16.00	48.00	48.00	4.00	34.00	48.00	4.00	48.00
3) TeO2											
Total Release Fraction at 48 Hours	5.00E-01	4.00E-02	3.50E-01	1.70E-01	2.40E-02	4.50E-03	8.00E-04	1.00E-03	2.00E-02	4.00E-04	5.00E-06
Start of Release (hr)	4.00	21.40	30.00	8.00	21.00	33.50	2.00	30.70	38.00	1.00	27.70
End of Release (hr)	4.00	48.00	48.00	10.00	48.00	48.00	4.00	40.00	48.00	4.00	48.00
4) SrO											
Total Release Fraction at 48 Hours	3.00E-04	6.00E-09	3.00E-03	8.50E-04	6.00E-09	1.50E-07	7.00E-06	4.00E-06	8.50E-07	1.00E-06	1.50E-08
Start of Release (hr)	3.80	4.50	30.00	8.00	21.00	6.00	2.00	30.70	2.00	1.00	2.00
End of Release (hr)	3.80	4.50	36.00	8.00	21.00	6.00	4.00	40.00	2.00	4.00	2.00
5) MoO2											
Total Release Fraction at 48 Hours	2.00E-04	5.50E-09	1.30E-02	5.50E-05	6.00E-09	2.00E-08	2.00E-05	9.00E-06	1.00E-06	5.00E-05	1.00E-07
Start of Release (hr)	3.80	4.50	30.00	2.00	21.00	33.50	2.00	30.70	2.00	2.00	2.00
End of Release (hr)	3.80	4.50	36.00	8.00	21.00	33.50	4.00	34.00	2.00	2.00	2.00

Table E.2-4a SSES Source Term Summary (Pre-EPU) (continued)

	Release Category[1]										
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/E	LL/L
6) CsOH											
Total Release Fraction at 48 Hours	4.00E-01	4.00E-02	2.80E-01	1.90E-01	2.30E-02	7.50E-03	7.00E-04	1.00E-03	5.50E-02	4.00E-04	1.00E-04
Start of Release (hr)	4.00	21.40	30.00	8.00	21.00	33.50	2.00	30.70	34.00	1.00	27.70
End of Release (hr)	5.00	48.00	48.00	12.00	48.00	48.00	4.00	48.00	48.00	6.00	48.00
7) BaO											
Total Release Fraction at 48 Hours	4.00E-04	1.50E-08	2.00E-02	4.00E-04	2.00E-08	1.00E-07	4.00E-05	2.00E-05	2.00E-06	8.30E-06	1.00E-07
Start of Release (hr)	3.80	4.50	30.00	8.00	21.00	33.50	2.00	30.70	2.00	1.00	2.00
End of Release (hr)	3.80	4.50	36.00	8.00	21.00	33.50	4.00	34.00	2.00	4.00	2.00
8) La2O3											
Total Release Fraction at 48 Hours	1.00E-05	4.00E-10	2.50E-04	5.00E-06	4.00E-10	1.00E-09	7.00E-07	5.00E-07	8.00E-08	2.00E-07	2.00E-09
Start of Release (hr)	3.80	4.50	30.00	8.00	21.00	33.50	2.00	34.00	2.00	2.00	2.00
End of Release (hr)	3.80	4.50	36.00	8.00	21.00	33.50	4.00	34.00	2.00	4.00	2.00
9) CeO2											
Total Release Fraction at 48 Hours	7.50E-04	2.50E-09	3.00E-04	1.00E-04	2.50E-09	2.00E-08	1.00E-05	9.00E-07	3.50E-07	9.00E-07	2.00E-09
Start of Release (hr)	3.80	4.50	30.00	8.00	21.00	6.00	2.00	30.70	2.00	1.00	2.00
End of Release (hr)	3.80	4.50	36.00	8.00	21.00	6.00	4.00	34.00	6.00	4.00	2.00
10) Sb											
Total Release Fraction at 48 Hours	2.80E-02	1.80E-02	4.00E-01	8.00E-02	5.00E-03	3.00E-02	1.00E-03	4.00E-03	2.00E-02	3.00E-03	7.00E-05
Start of Release (hr)	3.80	21.40	30.00	8.00	21.00	33.50	2.00	30.70	34.00	2.00	27.70
End of Release (hr)	3.80	48.00	40.00	10.00	21.00	48.00	4.00	30.70	48.00	20.00	48.00
11) Te2											
Total Release Fraction at 48 Hours	0.00E+00	8.50E-05	6.80E-09	3.00E-04	9.00E-05	5.00E-05	2.00E-05	5.00E-05	2.00E-04	1.00E-04	1.00E-07
Start of Release (hr)	0.00	21.40	40.00	8.00	21.00	33.50	26.00	37.00	34.00	6.00	27.70
End of Release (hr)	0.00	21.40	40.00	8.00	21.00	48.00	44.00	48.00	34.00	20.00	27.70
12) UO2											
Total Release Fraction at 48 Hours	1.50E-07	1.00E-12	2.00E-12	3.00E-07	1.00E-12	4.00E-11	3.00E-10	2.00E-10	1.00E-09	7.20E-12	2.00E-14
Start of Release (hr)	4.00	4.50	40.00	8.00	4.00	6.00	8.00	37.00	4.00	4.00	4.00
End of Release (hr)	4.00	4.50	40.00	8.00	4.00	6.00	8.00	37.00	4.00	4.00	4.00

(1) Puff releases are denoted in the table by those entries with equivalent start and end times.
(2) Neither the LL/E nor the LL/I Release Categories contribute to the Pre-EPU results, but the LL/E source term is provided for reference purposes.

Table E.2-4b SSES Source Term Summary (Post-EPU)

	Release Category[1,2]										
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L
MAAP Run	ESU0516	ESU0500	ESU0514	ESU0515	ESU0500a	ESU505	ESU0515a	ESE0131	ESE0117	ESE0127	ESU556a
Description	IVA-L2-14A-NED-DW	IA-L2-1A-NSPR	IIID-L2-12C-DW	IVA-L2-14A-ED-DW	IIA-L2-9A-DW	ID-L2-7B-NSPR	IVA-L2-14A-ED-WWA	IIA-L2-9A-WWA	IIIB-L2-1A-NSPR	MSIV Closure	IIIC-L2-7BA-SPRY
Time after Scram when General Emergency is declared	.5 hr	1.5 hr	.5 hr	1.3 hr	1.5 hr	1.0 hr	2.0 hr	13 hr	13 hr	15 hr	0.1 hr
Fission Product Group:											
1) Noble											
Total Release **Fraction** at 48 Hours	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Start of Release (hr)	0.8	17.3	22.9	1.3	17.3	27.2	1.3	20.6	39.6	33.0	23.2
End of Release (hr)	3.8	17.3	29.1	4.7	17.3	27.2	7.7	39.8	47.4	36.7	23.2
2) CsI											
Total Release Fraction at 48 Hours	5.82E-01	3.55E-01	4.75E-01	5.64E-02	6.13E-02	2.85E-02	1.05E-03	3.76E-03	7.42E-03	7.46E-04	1.35E-05
Start of Release (hr)	3.4	17.3	23.8	1.3	17.3	32.5	1.3	21.0	40.0	34.1	23.8
End of Release (hr)	48.0	48.0	48.0	48.0	48.0	48.0	48.0	31.1	58.6	42.5	48.0
3) TeO2											
Total Release Fraction at 48 Hours	5.27E-01	5.42E-02	2.39E-01	1.57E-01	4.77E-02	8.45E-03	8.74E-04	1.16E-03	9.43E-04	4.01E-05	1.40E-05
Start of Release (hr)	3.4	17.3	23.5	2.7	17.3	27.2	1.3	21.2	40.2	34.1	27.7
End of Release (hr)	17.3	48.0	48.0	48.0	48.0	48.0	48.0	48.0	65.5	43.0	48.0
4) SrO											
Total Release Fraction at 48 Hours	3.13E-04	8.47E-09	3.39E-03	9.38E-04	8.47E-09	2.04E-07	8.96E-06	1.75E-05	1.10E-05	3.36E-07	1.32E-08
Start of Release (hr)	3.4	3.0; 17.3	23.5	5.8	3.0; 17.3	4.1	1.3	21.0	40.1	34.1	4.3
End of Release (hr)	3.9	3.0; 17.3	30.2	6.6	3.0; 17.3	8.1	8.6	32.3	51.5	37.2	4.3
5) MoO2											
Total Release Fraction at 48 Hours	2.17E-04	1.07E-08	1.50E-02	2.08E-04	1.07E-08	6.95E-08	4.41E-05	1.11E-04	3.16E-05	1.74E-06	8.25E-08
Start of Release (hr)	2.1	3.0; 17.3	24.2	1.3	3.0; 17.3	1.5	1.3	21.2	40.3	34.1	3.5
End of Release (hr)	3.7	3.0; 17.3	29.2	6.0	3.0;17.3	27.6	6.2	27.8	48.7	36.7	3.5

Table E.2-4b SSES Source Term Summary (Post-EPU) (continued)

	Release Category[1]										
	H/E	H/I	H/L	M/E	M/I	M/L	L/E	L/I	L/L	LL/I	LL/L
6) CsOH											
Total Release Fraction at 48 Hours	4.06E-01	6.80E-02	2.97E-01	1.63E-01	4.23E-02	1.30E-02	7.64E-04	1.45E-03	2.00E-03	1.91E-04	2.73E-04
Start of Release (hr)	3.4	17.3	23.6	1.3	17.3	27.2	1.3	21.0	40.0	34.1	23.7
End of Release (hr)	48.0	48.0	48.0	48.0	17.3	48.0	48.0	48.0	69.5	43.9	48.0
7) BaO											
Total Release Fraction at 48 Hours	5.25E-04	2.61E-08	1.32E-02	6.20E-04	2.54E-08	1.72E-07	5.21E-05	1.06E-05	6.28E-05	2.09E-06	8.73E-08
Start of Release (hr)	2.3	3.0; 17.3	24.1	1.3	3.0; 17.3	1.5	1.3	21.0	40.0	34.1	4.4
End of Release (hr)	3.9	3.0; 17.3	30.1	6.5	3.0; 17.3	27.4	6.8	27.9	49.9	36.5	4.4
8) La2O3											
Total Release Fraction at 48 Hours	8.20E-06	7.00E-10	1.24E-04	8.28E-06	7.00E-10	5.45E-09	1.06E-06	2.34E-06	7.92E-07	3.09E-08	1.21E-09
Start of Release (hr)	2.4	3.0; 17.3	24.2	1.3	3.0; 17.3	1.5	1.3	21.2	40.3	34.1	4.1
End of Release (hr)	3.9	3.0; 17.3	29.6	6.4	3.0; 17.3	27.4	7.0	28.1	50.3	36.5	4.1
9) CeO2											
Total Release Fraction at 48 Hours	6.27E-05	4.92E-09	2.52E-04	1.29E-04	4.92E-09	4.55E-08	1.68E-06	3.33E-06	1.34E-06	3.05E-07	1.59E-09
Start of Release (hr)	2.5	3.0; 17.3	24.0	1.8	3.0; 17.3	4.1	1.3	21.0	40.2	34.1	4.2
End of Release (hr)	3.9	3.0; 17.3	30.1	6.3	3.0; 17.3	27.4	7.5	31.6	52.0	37.5	4.2
10) Sb											
Total Release Fraction at 48 Hours	4.49E-02	2.38E-02	4.80E-01	1.00E-01	1.49E-02	4.64E-02	8.89E-04	4.65E-02	6.25E-02	3.63E-04	1.99E-05
Start of Release (hr)	2.4	17.3	24.1	5.8	17.3	27.2	1.3	21.3	40.4	33.8	22.8
End of Release (hr)	48.0	48.0	44.2	48.0	48.0	48.0	48.0	33.5	49.9	44.1	48.0
11) Te2											
Total Release Fraction at 48 Hours	0.00E+00	2.96E-05	1.09E-09	3.56E-04	2.95E-05	2.18E-04	5.51E-05	1.25E-05	6.80E-05	3.58E-04	5.87E-08
Start of Release (hr)	0.00	17.3	29.2	6.1	17.3	27.2	6.3	29.7	49.1	37.7	22.9
End of Release (hr)	0.00	17.3	40.4	6.5	17.3	48.0	48.0	48.0	72.0	37.7	39.8
12) UO2											
Total Release Fraction at 48 Hours	8.28E-08	1.30E-12	2.77E-07	3.22E-07	1.3E-12	2.20E-10	6.35E-10	1.19E-10	1.18E-10	5.29E-13	1.10E-12
Start of Release (hr)	3.5	3.0	29.2	6.1	3.0	4.3	6.3	29.6	48.9	36.9	3.3
End of Release (hr)	4.0	3.0	30.1	6.4	3.0	8.0	10.1	39.1	52.0	36.9	3.3

(1) Puff releases are denoted in the table by those entries with equivalent start and end times.
(2) LL/E does not contribute to the post-EPU results, but some of the pre-EPU LL/L sequences have been binned into the LL/I category based on the impact of EPU.

Table E.2-5 Open 'B' Peer Review Certification Resolution Prior to Issuance of the FEB06pre/postEPU PRA Model

F&O Identifier	Description	Prior PPL Disposition	Disposition for FEB06pre/postEPU Model
AS-7-4	Conservative RPV Rupture Frequency	Frequency documented in the Initiating Events Notebook.	Since this directly influences the LERF frequency, the initiating event (IE) frequency value was adjusted to 1.0E-8 consistent with many other industry BWRs. (Now closed).
HR-4-1	Missing Pre-Initiator HEPs	Adding more pre-initiators is not expected to affect the insights presently realized.	Acceptable to proceed as is.
IE-13-1	LOOP Frequency Pedigree	Future update to consider using INEEL/EXT-04-02326 LOOP frequency and recovery data.	Incorporated new data directly into the FEB06preEPU and FEB06EPU models. (Now closed).
IE-5-2	Reconsider IE exclusion for loss of service water (LOSW), etc.	Future update to consider LOSW. Others adequately addressed.	Acceptable to proceed as is. Consider sensitivity studies.
IE-6-1	Consider including loss of instrument air (LOIA)	Future update to consider LOIA.	Acceptable to proceed as is. Consider sensitivity studies.
IE-7-1	Consider including break outside containment (BOC)	Future update to consider BOC.	Included in updated models since will influence LERF. (Now closed).
IE-7-2	Consider including LOIA and BOC	Future update to consider LOIA and BOC.	See resolution above for IE-6-1 and IE-7-1.
IE-13-2	Compare IE frequencies with other similar sites.	Results indicate reasonableness of chosen values.	Values are reasonable based on comparison with other similar sites. (Now closed).
L2-5-1	Reconsider timing of containment overtemperature failure (COTF) scenarios	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).
L2-8-2	Adjust CI node placement in event trees	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).
L2-10-1	Reconsider COTF w/o drywell sprays	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).

Table E.2-5 Open ‘B’ Peer Review Certification Resolution Prior to Issuance of the FEB06pre/postEPU PRA Model

F&O Identifier	Description	Prior PPL Disposition	Disposition for FEB06pre/postEPU Model
L2-15-1	Refine ATWS CF assumptions	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).
L2-22-3	Conservative LERF Timing	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).
MU-1	Formalize PRA Model Update Process	Although overall PRA update procedure would be beneficial, the current model is documented and controlled under PPL QA procedures.	Continue existing calculation review and approval processes. No impact on SAMA results.
QU-19-1	Formalize PRA Model Assembly Process	Although overall PRA model assembly procedure would be beneficial, the current model is documented and controlled under PPL QA procedures.	Continue existing calculation review and approval processes. No impact on SAMA results.
ST-5-2	Reconsider COTF Assumptions	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).
ST-5-3	Refine ATWS CF assumptions	Being evaluated as part of the Level 2 update.	Addressed by updated detailed Level 2 analysis included in the FEB06preEPU and FEB06EPU models. (Now closed).
SY-4-1	Complete System Notebooks	10 remaining system notebooks to be completed.	Deferred. No significant model impacts are foreseen from the remaining low risk significant systems.
SY-8-2	Missing Pre-Initiator HEPs	Adding more pre-initiators is not expected to affect the insights presently realized.	Acceptable to proceed as is.

Table E.3-1 Estimated Population Distribution Within a 50-Mile Radius of Susquehanna, Year 2044

Sector	0-1 mile (1.00) (1)	1-2 miles (1.45) (1)	2-3 miles (1.14) (1)	3-4 miles (1.00) (1)	4-5 miles (1.05) (1)	5-10 miles (1.11) (1)	10-mile total
N	0	66	6	695	980	1582	3329
NNE	33	33	0	37	56	2669	2828
NE	0	0	130	169	147	3770	4216
ENE	0	0	0	68	48	2284	2400
E	23	79	83	142	77	1476	1880
ESE	4	0	233	118	214	1801	2370
SE	27	127	0	216	133	4348	4851
SSE	0	20	0	107	67	3329	3523
S	76	82	117	193	47	776	1292
SSW	0	231	106	107	133	867	1444
SW	0	249	148	116	1619	886	3017
WSW	0	397	59	549	4865	12722	18592
W	0	74	179	51	318	1926	2548
WNW	0	51	52	36	31	772	941
NW	0	194	208	0	159	1229	1790
NNW	0	0	0	0	139	1887	2027
Total	163	1604	1320	2604	9034	42323	57048

(1) Radial population multiplier applied to year 2000 census data to develop year 2044 estimate.

Table E.3-2 Estimated Population Distribution Within a 50-Mile Radius of Susquehanna, Year 2044

Sector	0-10 miles	10-20 miles (0.85) [1]	20-30 miles (0.98) [1]	30-40 miles (1.14) [1]	40-50 miles (1.49) [1]	50-mile total
N	3329	4004	553	7385	9802	25074
NNE	2828	14507	10048	19295	14299	60977
NE	4216	98506	77412	166222	58059	404414
ENE	2400	15422	4618	15462	28695	66596
E	1880	5968	3453	19566	74949	105816
ESE	2370	11399	5320	29261	78321	126673
SE	4851	32097	27749	44007	342273	450977
SSE	3523	6319	15523	16634	95795	137795
S	1292	13246	36295	29859	43455	124148
SSW	1444	2815	25562	15624	26349	71794
SW	3017	2195	26829	18247	22680	72968
WSW	18592	21763	16812	43275	49917	150359
W	2548	5075	5694	34197	22368	69882
WNW	941	3133	3706	20566	97495	125842
NW	1790	1867	1253	1601	1846	8357
NNW	2027	1355	880	4909	14656	23828
Total	57048	239670	261710	486111	980961	2025499

(1) Radial population multiplier applied to year 2000 census data to develop year 2044 estimate.

Table E.3-3 MACCS2 Release Categories vs. Susquehanna Release Categories

MACCS Release Categories	Susquehanna Release Categories
1-Xe/Kr	noble gases
2-I	CsI
3-Cs	CsOH
4-Te	TeO2 (Sb(1) & Te2(2) fractions are included)
5-Sr	SrO
6-Ru	MoO2 (Mo is in Ru MACCS category)
7-La	La2O3
8-Ce	CeO2 (included UO2(2) in this category)
9-Ba	BaO

(1) Sb release fractions are not added into the Te category based on the large difference in total mass in the core (97% TeO2 and 3% Sb).

(2) These release fractions are negligible and are not added into the appropriate MACCS radionuclide category

Table E.3-4a MACCS2 Base Case Mean Results (Pre-EPU)

Release Category	SSQ MAAP Run	Dose (sv)	Offsite Economic Cost ($)	Unit 1 Freq. (/yr)	Unit 1 Dose-Risk (p-rem/yr)	Unit 1 OECR ($/yr)	Unit 2 Freq. (/yr)	Unit 2 Dose-Risk (p-rem/yr)	Unit 2 OECR ($/yr)
L2-1 (H/E)	SU0516	2.63E+04	1.46E+10	1.71E-07	0.45	2,497	1.71E-07	0.45	2,497
L2-2 (H/I)	SU0500	1.51E+04	1.20E+10	1.47E-07	0.22	1,764	1.30E-07	0.20	1,560
L2-3 (H/L)	SU0514	3.10E+04	2.68E+10	1.21E-10	0.00	3	1.07E-10	0.00	3
L2-4 (M/E)	SU0515	1.64E+04	1.61E+10	0.0	0.00	0	0.0	0.00	0
L2-5 (M/I)	SU0500a	1.37E+04	8.59E+09	5.05E-07	0.69	4,338	5.14E-07	0.70	4,415
L2-6 (M/L)	SU0505	1.16E+04	5.69E+09	1.33E-07	0.15	757	1.13E-07	0.13	643
L2-7 (L/E)	SU0515a	1.61E+03	1.38E+08	7.43E-08	0.01	10	7.43E-08	0.01	10
L2-8 (L/I)	SU0511	3.02E+03	6.01E+08	4.20E-07	0.13	252	4.31E-07	0.13	259
L2-9 (L/L)	ESE0117	3.52E+03	7.95E+08	5.58E-08	0.02	44	2.28E-08	0.01	18
L2-10 (LL/I)	SU0516a	1.39E+03	4.37E+07	0.0	0.00	0	0.0	0.00	0
L2-11 (LL/L)	SU0556a	7.18E+02	1.47E+07	2.37E-08	0.00	0	2.18E-08	0.00	0
FREQUENCY WEIGHTED TOTALS				1.53E-06	1.67	9,665	1.48E-06	1.63	9,405

Table E.3-4b MACCS2 Base Case Mean Results (Post-EPU)

Release Category	SSQ MAAP Run	Dose (sv)	Offsite Economic Cost ($)	Unit 1 Freq. (/yr)	Unit 1 Dose-Risk (p-rem/yr)	Unit 1 OECR ($/yr)	Unit 2 Freq. (/yr)	Unit 2 Dose-Risk (p-rem/ yr)	Unit 2 OECR ($/yr)
L2-1 (H/E)	ESU0516	2.93E+04	1.53E+10	1.72E-07	0.50	2,632	1.72E-07	0.50	2,632
L2-2 (H/I)	ESU0500	1.57E+04	1.32E+10	1.59E-07	0.25	2,099	1.39E-07	0.22	1,835
L2-3 (H/L)	ESU0514	3.35E+04	2.82E+10	1.31E-10	0.00	4	1.17E-10	0.00	3
L2-4 (M/E)	ESU0515	1.73E+04	1.70E+10	0.0	0.00	0	0.0	0.00	0
L2-5 (M/I)	ESU0500a	1.46E+04	9.40E+09	5.38E-07	0.79	5,057	5.50E-07	0.80	5,170
L2-6 (M/L)	ESU0505	1.21E+04	6.59E+09	1.51E-07	0.18	995	1.30E-07	0.16	857
L2-7 (L/E)	ESU0515a	1.80E+03	1.69E+08	1.08E-07	0.02	18	1.08E-07	0.02	18
L2-8 (L/I)	ESE0131	3.32E+03	6.92E+08	4.87E-07	0.16	337	4.73E-07	0.16	327
L2-9 (L/L)	ESE0117	3.89E+03	9.07E+08	9.46E-09	0.00	9	3.42E-09	0.00	3
L2-10 (LL/I)	ESU0516a	1.58E+03	5.63E+07	1.56E-09	0.00	0	6.87E-10	0.00	0
L2-11 (LL/L)	ESU556	8.28E+02	1.97E+07	2.22E-08	0.00	0	2.11E-08	0.00	0
FREQUENCY WEIGHTED TOTALS				1.65E-06	1.90	11,151	1.60E-06	1.86	10,845

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1CDFNEW-FLAG	1.00E+00	1.00E+30	UNIT 1 CORE DAMAGE FREQUENCY FLAG	N/A – This flag marks all sequences for the Unit 1 CDF model and does not provide any risk based insights. No SAMAs suggested.
LOOP-FLAG	1.00E+00	4.265	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	The importance of the LOOP flag provides limited information about plant risk given that the LOOP category is broad and includes several different contributors. These contributors are represented by other events in this importance list that better define specific failures that can be investigated to identify means of reducing plant risk. No credible means of reducing the SSES LOOP frequency have been identified. Implementation of the Maintenance Rule is considered to address equipment reliability issues such that no measurable improvement is likely available based on enhancing maintenance practices. It may be possible to improve switchyard work planning and/or practices, but a reliable means of quantifying the impact of these types of changes is not available. No SAMAs suggested.
%LOOP-FLAG	1.00E+00	3.629	LOOP FLAG FOR INITIATING EVENT	The importance of the LOOP initiator flag provides limited information about plant risk given that the LOOP category is broad and includes several different contributors. These contributors are represented by other events in this importance list that better define specific failures that can be investigated to identify means of reducing plant risk. No credible means of reducing the SSES LOOP frequency have been identified. Implementation of the Maintenance Rule is considered to address equipment reliability issues such that no measurable improvement is likely available based on enhancing maintenance practices. It may be possible to improve switchyard work planning and/or practices, but a reliable means of quantifying the impact of these types of changes is not available. No SAMAs suggested.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ1TR-7-001CD	1.00E+00	1.942	SEQUENCE FLAG FOR 1TR-7-001CD	The primary contributors to these sequences are LOOP events with failure of on-site AC power to support the DC power requirements for HPI and ADS in conjunction with the failure to recover off-site power. Restoration of AC power is clearly an important priority for this sequence; however, additional onsite AC sources are not likely to provide much benefit given the large impact of common cause EDG failure. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of this sequence by prolonging the time the plant can operate under SBO or degraded AC/DC conditions (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). The FP System is currently available as a low pressure injection source, but the need for AC power to support long term depressurization limits its benefit and flow limitations preclude its success when both units require makeup simultaneously.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
EXTSEVWEATHER	2.32E-03	1.610	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	LOOP due to severe weather, as represented by this event, is grid related and no means are available to the plant to reduce its frequency. While there are many important cutsets that include this event, the largest contributors include failures of the support systems that provide DC power to HPI and ADS. For this general event, an HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to X-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Finally, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).
024-N-E-DSL-P	3.29E-01	1.424	PREVENTATIVE MAINTENANCE 0.328542094	There are multiple important contributors that include this event and for clarity reasons, they are addressed by the more specific events in the importance list below. However, two general SAMAs have been identified in association with this event. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002-N-N-BMS-FLAG	1.00E+00	1.329		This flag is used to identify operator errors related to aligning the station portable diesel generator, including: 002-N-N-BMS-O, Z-BMAX-EDG-O, and Z-BMS-IACIG-O. The events 002-N-N-BMS-O and Z-BMAX-EDG-O are specifically addressed in this table. The event Z-BMS-IACIG-O has a RRW value of 1.001 and does not require further review.
GRIDCENTERED	1.38E-02	1.287	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGS0G501B	2.40E-02	1.270	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGS0G501A	2.40E-02	1.254	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPEW5.6	9.78E-01	1.224	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.6 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
RCVLOOPGR5.6	1.38E-01	1.223	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.6 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
RCVSEQ1TR-1-005CD	1.00E+00	1.205	SEQUENCE FLAG FOR 1TR-1-005CD	The importance of this sequence is tied to LOOP with multiple diesel failures and SPC not available. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSBOWEDG	1.00E+00	1.188	STATION BLACKOUT WITH E DG	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Battery failures that result in the loss of DC for HPI and ADS are also minor contributors. These cases could be addressed by providing battery chargers that can provide 100% of the load without the batteries (SAMA 4).
RCVLOOPEW30.6	7.89E-01	1.182	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 30.6 HOURS	LOOP due to severe weather, as represented by this event, is grid related and no means are available to the plant to reduce its frequency. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolong the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
Z-BMAX-EDG-O	1.63E-02	1.170	DEPENDENT HEP FOR BLUE MAX AND E DG	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Permanently installing the existing 480V AC generator and add hardware to allow it to automatically align to supply power to the required 480V AC buses directly addresses the importance of the HEP (SAMA 5). In addition, cutset review shows that major contributors including the HEP are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGR0G501B	1.57E-02	1.158	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGR0G501A	1.57E-02	1.149	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002DGS0G503	2.40E-02	1.132	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Providing an additional portable 480V AC generator could also potentially provide benefit (SAMA 6). In addition, cutset review shows that major contributors including the 0G503 failure are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
002-N-N-BMS-O	2.93E-02	1.124	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Permanently install the existing 480V AC generator and add hardware to allow it to automatically align to supply power to the required 480V AC buses (SAMA 5).
151-N-N-F005-O	1.00E+00	1.104	OPERATOR FAILS TO OPEN HV152F005A/B MANUALLY	This action is important when HPI fails and Core Spray injection is required for inventory makeup. In these cases, loss of off-site AC power and specific EDG failures result in the loss of "D" RHR due to the Division I ESW cooling dependence for lube oil cooling (ESW pumps A and C cool RHR pump D). The core spray injection valve cannot be opened remotely because it is powered by the "B" EDG, which has failed. A potential means of mitigating these types of accidents is to change RHR pump cooling such that the "B" and "D" ESW pumps provide cooling flow to the "B" and "D" RHR pumps (SAMA 7). This issue could also be addressed through the use of an AC cross-tie (SAMA 2).
RCVSEQ1TR-8-023CD	1.00E+00	1.104	SEQUENCE FLAG FOR 1TR-8-023CD	About 83 percent of this sequence is linked to event 151-N-N-F005-O above and the same SAMAs are considered to be applicable.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%1NONISO	8.94E-01	1.087	TRIP W/O MSIV CLOSURE	About 50 percent of the contribution from this initiator is related to mechanical scram failure ATWS scenarios with subsequent operator failure to run back Feedwater and initiate SLC. Due to operator dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8). Additional major contributors include sequences RCVSEQ1TR-7-001CD (31%) and RCVSEQ1TR-2-001CD (12%). The RCVSEQ1TR-7-001CD sequence is a conditional LOOP case with subsequent SBO or degraded AC/DC conditions. This sequence is addressed by SAMAs 1, 5, and 6. No SAMAs are suggested for the remaining contributors.
002DGR0G503	1.57E-02	1.082	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Providing an additional portable 480V AC generator could also potentially provide benefit (SAMA 6). In addition, cutset review shows that major contributors including the 0G503 failure are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-N-N-DGE-O	1.15E-01	1.078	OPERATOR FAILS TO ALIGN	Failure to align the "E" DG is important for SBO sequences. Due to human dependence issues, further enhancements related to alternate power alignment requiring operator action would provide limited benefit. For this general event, an HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to X-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Finally, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).
SEVEREWEATHER	2.87E-03	1.077	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	LOOP due to severe weather, as represented by this event, is grid related and no means are available to the plant to reduce its frequency. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolong the time the plant can operate without offsite AC power (SAMA 1). In addition, the contributing sequences including EDG A, B, and E failures could be addressed through the use of an AC cross-tie (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ1TR-2-001CD	1.00E+00	1.069	SEQUENCE FLAG FOR 1TR-2-001CD	These sequences include failures of high pressure injection systems and subsequent failures of depressurization. The primary contributors to these sequences are DC failures that fail both functions. Battery failure and DC bus failures preclude credit from the station portable diesel generator. SAMA 1 could provide a means of mitigating these accidents assuming that the pump could be operated without DC power. SAMA 4 can be used to mitigate battery failures by providing all DC power from the "100%" chargers. Failures of the DC buses or panels could be mitigated by providing direct feeds from the chargers to critical loads (SAMA 9). In addition, this sequence contains may cutsets that include event 125-N-N-FXTIACIGO-FLAG, which is addressed separately in the list.
125-N-N-FXTIACIGO-FLAG	1.00E+00	1.066	FLAG FOR IA TO CIG OPERATOR ACTION FAILURE	This flag is linked to the operator action to cross-tie IA to CIG. The importance of this action is primarily based on sequences in which loss of DC power fails HPI and depressurization capability through power and air dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action (SAMA 10).
CCFDG4DGS_ALL	7.41E-05	1.065	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDG3DGS_123	9.39E-05	1.060	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
CCFDG3DGS_124	9.39E-05	1.060	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%1ISLOCA_RHR_S	1.02E-07	1.058	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	A high pressure core spray pump that could use an inexhaustible, high flow, cold suction source would reduce the risk of ISLOCAs by providing an alternate means of injection and precluding pump failures due to room flooding provided the pump is not located in the lower floors of the reactor building (SAMA 11). The engine driven HPI pump from SAMA 1 is not sized to provide the required makeup flow and is not considered to be capable of mitigating an ISLOCA.
RCVSEQ1IS-2-001CD	1.00E+00	1.058	SEQUENCE FLAG FOR 1IS-2-001CD	This sequence is directly tied to %1ISLOCA_RHR_S and is addressed by SAMA 11.
125-N-N-FXTIACIG-O	2.20E-01	1.058	OPERATOR FAILS TO OPEN IA-CIG CROSSTIE VALVES	The importance of this action is primarily based on sequences in which loss of DC power fails HPI and depressurization capability through power and air dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action (SAMA 10).
024-II-B-DSL-P	7.13E-03	1.054	PREVENTATIVE MAINTENANCE 7.13E-03	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCV1ATWS	1.00E+00	1.054		Over 57 percent of the contributors with this flag are related to mechanical scram failure ATWS scenarios with subsequent operator failure to run back Feedwater and initiate SLC. Due to dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8). The remainder of the contributions are spread among the following types of initiators: - SLC initiation/level control operator errors (29%) - Other failures (14%) Auto SLC initiation could be installed to address the SLC initiation failures, the cost of which is likely comparable to auto Feedwater runback. No changes to the ADS/inhibit logic are suggested. As Feedwater runback failures are the largest contributors, the SAMA analysis focuses on that issue. No SAMAs are suggested for the remaining contributors.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFMEATWS-PE	2.10E-06	1.054	CCF RPS MECHANICAL SCRAM FAILURE - UNIT 1	Over 57 percent of the contributors with mechanical scram failure ATWS scenarios also contain subsequent operator failure to run back Feedwater. Due to the limited time for response and dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8). The remainder of the contributions are spread among the following types of initiators: - SLC initiation/level control operator errors (29%) - Other failures (14%) Auto SLC initiation could be installed to address the SLC initiation failures, the cost of which is likely comparable to auto Feedwater runback. No changes to the ADS/inhibit logic are suggested. As Feedwater runback failures are the largest contributors, the SAMA analysis focuses on that issue. No SAMAs are suggested for the remaining contributors.
024-I-A-DSL-P	7.13E-03	1.052	PREVENTATIVE MAINTENANCE 7.13E-03	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDE3DGS_5	4.45E-01	1.051	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, SAMA X addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
RCVLOOPSW5.6	2.04E-01	1.050	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 5.6 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SWITCHYARDCENTERED	7.87E-03	1.049	LOOP DUE TO SWITCHYARD CENTERED FAILURES	The LOOP frequency due to switchyard centered failures could theoretically be reduced through preventative strategies or recovery actions; however, given the existence of maintenance review practices and operator training programs, no reliable means of measuring the improvement from any such enhancements has been identified. While the LOOP frequency is not considered to be easily influenced, there are other recovery mitigative options. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Contributors that include battery failures could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4).
CCFDG2DGS_12	1.85E-04	1.048	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSPC_INJ_L-O	6.00E-04	1.046	OPERATOR FAILS TO REPOSITION VALVE MANUALLY	This event represents operator failure to perform local, manual action to open valves to recover DHR in long term Class II accidents. In these scenarios, onsite AC power is available through the "E" diesel or another diesel, but valve failures prevent successful operation of DHR other than containment vent. Due to human dependence issues, further operator actions related to DHR recovery will offer limited benefit. While containment venting is a successful heat removal option, its use fails the initially operating injection system. For the relevant scenarios, late containment injection systems also fail. Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).
%1LODCBUS_622	1.50E-03	1.045	LOSS OF 1D622	The importance of this event is primarily based on sequences in which loss of DC power fails HPI and depressurization capability through direct and indirect dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action (SAMA 10).
RCVLOOPGR5.4	1.46E-01	1.044	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.4 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). This initiator also includes the same sequences as for event 151-N-N-F005-O, which is addressed by SAMA 7.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGS0G501D	2.40E-02	1.039	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
COND-LOOP-TRANS	2.40E-03	1.039	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Contributors that include battery failures could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4).
102BCR1D613	1.68E-04	1.038	125VDC BATTERY CHARGER 1D613 BATTERY CHARGER FAILS TO OPERATE	Failure of this battery charger in conjunction with the failure of 125V DC bus 622 results in the loss of both divisions of 125V DC power in the long term (after battery depletion). Providing the ability to power required loads directly from the available DC charger would allow for recovery on one DC division's essential equipment (SAMA 9). In addition, a large majority of the cutsets including this event include the failure of the IA to CIG cross tie (125-N-N-FXTIACIG-O). These contributors are addressed by SAMA 10.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPEW5.4	9.79E-01	1.037	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.4 HOURS	The cutsets including this recovery event are dominated by cases where either the "C" or "D" EDG is the only source of AC power and the RHR pumps are failed due to the lack of ESW cooling. SAMA 7 addresses these conditions.
024DGS0G501C	2.40E-02	1.036	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
102BTS1D610	5.00E-04	1.035	125VDC BATTERY BANK A FAILS TO START	The contributors that include battery failures could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4).
150PTS1P203	2.00E-02	1.033	1P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Over 93% of the cutsets including this event are related to the failure of RHR due to the non-divisionalized ESW cooling alignment. This is addressed by SAMA 7.
145-N-N-REDFW-O	1.00E+00	1.030	OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS .15	Installation of logic to automate Feedwater runback is a potential means of reducing the risk of ATWS sequences (SAMA 8).
145-N-N-REDFWO-FLAG	1.00E+00	1.030	FLAG FOR OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS	Installation of logic to automate Feedwater runback is a potential means of reducing the risk of ATWS sequences (SAMA 8).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDE2DGS_5	3.84E-01	1.026	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
1CLPIA-O	1.60E-01	1.025	OPERATOR FAILS TO CONTROL LOW PRESSURE INJECTION DURING ATWS	Over 70% of the cutset contributions including this event include failures of 145-N-N-REDFW-O. As CLPIA-O is also a level/power control event, there is a dependence between the actions. Automating the Feedwater runback function would remove this dependence (SAMA 8).
RCVSEQ1TR-3-038CD	1.00E+00	1.025	SEQUENCE FLAG FOR 1TR-3-038CD	about 70% of the cutsets including this event are related to the failure of RHR due to the non-divisionalized ESW cooling alignment. This is addressed by SAMA 7.
RCVLOOPSY5.6	3.85E-02	1.025	PROBABILITY OF NONRECOVERY FROM A SWITCHYARD RELATED LOOP IN 5.6 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%1LOCA-SM-LQD	2.32E-03	1.024	SMALL LIQUID LINE BREAK LOCA	There are several different types of contributors to the CDF give this initiating event. These are either addressed by the SSES SAMAs identified for other contributors or have contributions below the RRW review cutoff for this analysis: • 30.0%: ESW failures result in long term loss of HPI and LPI due to lack of SPC and equipment cooling. After initial success of HPI and subsequent depressurization, SAMA 1 would be capable of providing core cooling. • 4.6%: Consequential LOOP events result in conditions similar to the ESW failures and are addressed by SAMA 1. • 27.1%: Vapor suppression failures are addressed by SAMA 13. • 38.3%: The remaining contributors represent an RRW of only 1.009, which is well below the review cutoff of 1.02 for the SAMA list development and no SAMAs are required to address this contribution.

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGR0G501D	1.57E-02	1.023	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling. Finally, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
1RWST-FLAG	1.00E+00	1.023	FLAG FOR OPERATOR FAILING TO CROSSTIE RWST TO CST	The cutsets including this flag require replenishment of the CST for extended high pressure makeup success. These contributors could potentially be reduced by automating the cross-tie between the RWST and the CST, but this would introduce the potential to drain both the CST and the RWST in the event of a CST rupture or pumpdown. This is not considered to be a desirable option. Another possibility is providing automated makeup from the Fire Protection system. However, the dominate contributors including 1RWST-FLAG are evolutions that could be mitigated by divisionalizing the ESW cooling to the RHR pumps (SAMA 7). This is considered to be the most appropriate approach for SSES.
%1ISO	1.36E-01	1.021	INADVERTENT ISOLATION - MSIV	There are no dominant contributors for this initiating event and no viable method has been identified that could be implemented to reduce the initiating event frequency. Some of the contribution could be eliminated by providing a means of providing power directly to critical loads given DC bus or distribution panel failures (SAMA 9).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGR0G501C	1.57E-02	1.021	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling. Finally, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
016-N-N-VENT-O	9.90E-03	1.020	OPERATOR FAILS TO OPEN DOORS AND DAMPERS IN ESW PUMP HOUSE 9.9E-3	This event is important due to its role in SBO sequences in which the station portable diesel generator is available. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1a Unit 1 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
116-F073/075-O	1.00E+00	1.020	OPERATOR FAILS TO OPEN HV112F073A/B OR HV112F075A/B MANUALLY	This event is important due to its role in SBO sequences in which the station portable diesel generator is available. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
2CDFNEW-FLAG	1.00E+00	1.00E+30	UNIT 2 CORE DAMAGE FREQUENCY FLAG	Addressed in the Unit 1 Level 1 Importance List Review
LOOP-FLAG	1.00E+00	4.252	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	Addressed in the Unit 1 Level 1 Importance List Review
%LOOP-FLAG	1.00E+00	3.617	LOOP FLAG FOR INITIATING EVENT	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-7-001CD	1.00E+00	1.971	SEQUENCE FLAG FOR 2TR-7-001CD	Addressed in the Unit 1 Level 1 Importance List Review
EXTSEVWEATHER	2.32E-03	1.621	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review
024-N-E-DSL-P	3.29E-01	1.438	PREVENTATIVE MAINTENANCE 0.328542094	Addressed in the Unit 1 Level 1 Importance List Review
002-N-N-BMS-FLAG	1.00E+00	1.338		Addressed in the Unit 1 Level 1 Importance List Review
GRIDCENTERED	1.38E-02	1.280	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501B	2.40E-02	1.262	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501A	2.40E-02	1.262	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPEW5.6	9.78E-01	1.229	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.6 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPGR5.6	1.38E-01	1.228	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.6 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-1-005CD	1.00E+00	1.216	SEQUENCE FLAG FOR 2TR-1-005CD	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPEW30.6	7.89E-01	1.193	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 30.6 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
Z-BMAX-EDG-O	1.63E-02	1.176	DEPENDENT HEP FOR BLUE MAX AND E DG	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501B	1.57E-02	1.154	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501A	1.57E-02	1.154	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002DGS0G503	2.40E-02	1.133	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
RCVSBOWEDG	1.00E+00	1.130	STATION BLACKOUT WITH E DG	Addressed in the Unit 1 Level 1 Importance List Review
002-N-N-BMS-O	2.93E-02	1.125	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	Addressed in the Unit 1 Level 1 Importance List Review
251-N-N-F005-O	1.00E+00	1.099	OPERATOR FAILS TO OPEN HV252F005A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
%2NONISO	8.94E-01	1.088	UNIT 2 TRIP W/O MSIV CLOSURE 2	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-8-023CD	1.00E+00	1.085	SEQUENCE FLAG FOR 2TR-8-023CD	Addressed in the Unit 1 Level 1 Importance List Review
002DGR0G503	1.57E-02	1.083	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024-N-N-DGE-O	1.15E-01	1.080	OPERATOR FAILS TO ALIGN	Addressed in the Unit 1 Level 1 Importance List Review
SEVEREWEATHER	2.87E-03	1.077	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ2TR-2-001CD	1.00E+00	1.071	SEQUENCE FLAG FOR 2TR-2-001CD	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG4DGS_ALL	7.41E-05	1.067	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
225-N-N-FXTIACIGO-FLAG	1.00E+00	1.066	FLAG FOR IA TO CIG OPERATOR ACTION FAILURE	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_124	9.39E-05	1.061	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_123	9.39E-05	1.061	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
%2ISLOCA_RHR_S	1.02E-07	1.059	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2IS-2-001CD	1.00E+00	1.059	SEQUENCE FLAG FOR 2IS-2-001CD	Addressed in the Unit 1 Level 1 Importance List Review
225-N-N-FXTIACIG-O	2.20E-01	1.059	OPERATOR FAILS TO OPEN IA-CIG CROSSTIE VALVES	Addressed in the Unit 1 Level 1 Importance List Review
RCV2ATWS	1.00E+00	1.055		Addressed in the Unit 1 Level 1 Importance List Review
CCFMEATWS-PE-UNIT2	2.10E-06	1.055	CCF RPS MECHANICAL SCRAM FAILURE - UNIT 2	Addressed in the Unit 1 Level 1 Importance List Review
024-I-A-DSL-P	7.13E-03	1.053	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-II-B-DSL-P	7.13E-03	1.053	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE3DGS_5	4.45E-01	1.052	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPSW5.6	2.04E-01	1.051	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 5.6 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG2DGS_12	1.85E-04	1.049	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
SWITCHYARDCENTERED	7.87E-03	1.048	LOOP DUE TO SWITCHYARD CENTERED FAILURES	Addressed in the Unit 1 Level 1 Importance List Review
%2LODCBUS_622	1.50E-03	1.046	LOSS OF 2D622	Addressed in the Unit 1 Level 1 Importance List Review
RCVSPC_INJ_L-O	6.00E-04	1.046	OPERATOR FAILS TO REPOSITION VALVE MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
COND-LOOP-TRANS	2.40E-03	1.039	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501D	2.40E-02	1.038	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPGR5.4	1.46E-01	1.037	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
202BCR2D613	1.68E-04	1.037	125VDC BATTERY CHARGER 2D613 BATTERY CHARGER FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501C	2.40E-02	1.033	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
250PTS2P203	2.00E-02	1.033	2P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
245-N-N-REDFW-O	1.00E+00	1.031	OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS	Addressed in the Unit 1 Level 1 Importance List Review
245-N-N-REDFWO-FLAG	1.00E+00	1.031	FLAG FOR OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPEW5.4	9.79E-01	1.031	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE2DGS_5	3.84E-01	1.027	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
2CLPIA-O	1.60E-01	1.026	OPERATOR FAILS TO CONTROL LOW PRESSURE INJECTION DURING ATWS	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPSY5.6	3.85E-02	1.026	PROBABILITY OF NONRECOVERY FROM A SWITCHYARD RELATED LOOP IN 5.6 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-3-038CD	1.00E+00	1.024	SEQUENCE FLAG FOR 2TR-3-038CD	Addressed in the Unit 1 Level 1 Importance List Review
%2LOCA-SM-LQD	2.32E-03	1.024	SMALL LIQUID LINE BREAK LOCA	Addressed in the Unit 1 Level 1 Importance List Review
2RWST-FLAG	1.00E+00	1.023	FLAG FOR OPERATOR FAILING TO CROSSTIE RWST TO CST	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501D	1.57E-02	1.022	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
%2ISO	1.36E-01	1.021	UNIT 2 INADVERTENT ISOLATION	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1b Unit 2 Level 1 Importance List Review (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGS0G501E	2.40E-02	1.020	DIESEL GENERATOR 'E' 0G501E FAILS TO START	Failure to align the "E" DG is important for SBO sequences. Due to human dependence issues, further enhancements related to alt power alignment requiring operator action would provide limited benefit. For this general event, an HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to X-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Finally, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).
216-F073/075-O	1.00E+00	1.020	OPERATOR FAILS TO OPEN HV212F073A/B OR HV212F075A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1CDFNEW-FLAG	1.00E+00	1.00E+30	UNIT 1 CORE DAMAGE FREQUENCY FLAG	N/A – This flag marks all sequences for the Unit 1 CDF model and does not provide any risk based insights. No SAMAs suggested.
LOOP-FLAG	1.00E+00	4.128	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	The importance of the LOOP flag provides limited information about plant risk given that the LOOP category is broad and includes several different contributors. These contributors are represented by other events in this importance list that better define specific failures that can be investigated to identify means of reducing plant risk. No credible means of reducing the SSES LOOP frequency have been identified. Implementation of the Maintenance Rule is considered to address equipment reliability issues such that no measurable improvement is likely available based on enhancing maintenance practices. It may be possible to improve switchyard work planning and/or practices, but a reliable means of quantifying the impact of these types of changes is not available. No SAMAs suggested.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%LOOP-FLAG	1.00E+00	3.533	LOOP FLAG FOR INITIATING EVENT	The importance of the LOOP initiator flag provides limited information about plant risk given that the LOOP category is broad and includes several different contributors. These contributors are represented by other events in this importance list that better define specific failures that can be investigated to identify means of reducing plant risk. No credible means of reducing the SSES LOOP frequency have been identified. Implementation of the Maintenance Rule is considered to address equipment reliability issues such that no measurable improvement is likely available based on enhancing maintenance practices. It may be possible to improve switchyard work planning and/or practices, but a reliable means of quantifying the impact of these types of changes is not available. No SAMAs suggested.
RCVSEQ1TR-7-001CD	1.00E+00	1.892	SEQUENCE FLAG FOR 1TR-7-001CD	The primary contributors to these sequences are LOOP events with failure of on-site AC power to support the DC power requirements for HPI and ADS in conjunction with the failure to recover off-site power. Restoration of AC power is clearly an important priority for this sequence; however, additional onsite AC sources are not likely to provide much benefit given the large impact of common cause EDG failure. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of this sequence by prolonging the time the plant can operate under SBO or degraded AC/DC conditions (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). The FP System is currently available as a low pressure injection source, but the need for AC power to support long term depressurization limits its benefit and flow limitations preclude its success when both units require makeup simultaneously.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
EXTSEVWEATHER	2.32E-03	1.583	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	LOOP due to severe weather, as represented by this event, is grid related and no means are available to the plant to reduce its frequency. While there are multiple important contributors that include this event, the primary types of events include failures of on-site AC power to support the DC power requirements for HPI and ADS in conjunction with the failure to recover off-site power and SBO sequences with the station portable generator available. For this general event, a HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolong the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Finally, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).
024-N-E-DSL-P	3.29E-01	1.421	PREVENTATIVE MAINTENANCE 0.328542094	There are multiple important contributors that include this event and for clarity reasons, they are addressed by the more specific events in the importance list below. However, two general SAMAs have been identified in association with this event. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002-N-N-BMS-FLAG	1.00E+00	1.318		This flag is used to identify operator errors related to aligning the station portable diesel generator, including: 002-N-N-BMS-O, Z-BMAX-EDG-O, and Z-BMS-IACIG-O. The events 002-N-N-BMS-O and Z-BMAX-EDG-O are specifically addressed in this table. The event Z-BMS-IACIG-O has a RRW value of 1.001 and does not require further review.
GRIDCENTERED	1.38E-02	1.290	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGS0G501B	2.40E-02	1.264	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGS0G501A	2.40E-02	1.249	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPGR5.4	1.46E-01	1.223	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.4 HOURS	The primary contributors to the cutsets including this recovery are LOOP events with failure of on-site AC power to support the DC power requirements for HPI and ADS. Restoration of AC power is clearly an important priority for this sequence; however, additional onsite AC sources are not likely to provide much benefit given the large impact of common cause EDG failure. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of this sequence by prolonging the time the plant can operate under SBO conditions (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2)
RCVLOOPEW5.4	9.79E-01	1.209	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.4 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
RCVSEQ1TR-1-005CD	1.00E+00	1.209	SEQUENCE FLAG FOR 1TR-1-005CD	The importance of this sequence is tied to SBO and LOOP without SPC (portable station diesel generator available). A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSBOWEDG	1.00E+00	1.186	STATION BLACKOUT WITH E DG	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Battery failure that result in the loss of DC for HPI and ADS are also minor contributors. These cases could be addressed by providing battery chargers that can provide 100% of the load without the batteries (SAMA 4).
RCVLOOPEW25.4	8.33E-01	1.181	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 25.4 HOURS	LOOP due to severe weather, as represented by this event, is grid related and no means are available to the plant to reduce its frequency. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolong the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
Z-BMAX-EDG-O	1.63E-02	1.165	DEPENDENT HEP FOR BLUE MAX AND E DG	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Permanently installing the existing 480V AC generator and add hardware to allow it to automatically align to supply power to the required 480V AC buses directly addresses the importance of the HEP (SAMA 5). In addition, cutset review shows that major contributors including the HEP are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGR0G501B	1.57E-02	1.155	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGR0G501A	1.57E-02	1.147	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002DGS0G503	2.40E-02	1.128	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Providing an additional portable 480V AC generator could also potentially provide benefit (SAMA 6). In addition, cutset review shows that major contributors including the 0G503 failure are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
002-N-N-BMS-O	2.93E-02	1.120	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Providing an additional portable 480V AC generator could also potentially provide benefit (SAMA 6). In addition, cutset review shows that major contributors including the HEP are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ1TR-8-023CD	1.00E+00	1.108	SEQUENCE FLAG FOR 1TR-8-023CD	This sequence is dominated by loss of HPI due to support system failures and subsequent Core Spray injection alignment difficulties. For example, in these cases, loss of off-site AC power and specific EDG failures result in the loss of "D" RHR due to the Division I ESW cooling dependence for lube oil cooling (ESW pumps A and C cool RHR pump D). The core spray injection valve cannot be opened remotely because it is powered by the "B" EDG, which has failed. A potential means of mitigating these types of accidents is to change RHR pump cooling such that the "B" and "D" ESW pumps provide cooling flow to the "B" and "D" RHR pumps (SAMA 7). This issue could also be addressed through the use of an AC cross-tie (SAMA 2).
151-N-N-F005-O	1.00E+00	1.107	OPERATOR FAILS TO OPEN HV152F005A/B MANUALLY	This action is important when HPI fails and Core Spray injection is required for inventory makeup. For example, in these cases, loss of off-site AC power and specific EDG failures result in the loss of "D" RHR due to the Division I ESW cooling dependence for lube oil cooling (ESW pumps A and C cool RHR pump D). The core spray injection valve cannot be opened remotely because it is powered by the "B" EDG, which has failed. A potential means of mitigating these types of accidents is to change RHR pump cooling such that the "B" and "D" ESW pumps provide cooling flow to the "B" and "D" RHR pumps (SAMA 7). This issue could also be addressed through the use of an AC cross-tie (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%1NONISO	8.94E-01	1.104	TRIP W/O MSIV CLOSURE	Over 58 percent of the contribution from this initiator is related to mechanical scram failure ATWS scenarios with subsequent operator failure to run back Feedwater and initiate SLC. Due to operator dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8). Additional major contributors include sequences RCVSEQ1TR-7-001CD (27%) and RCVSEQ1TR-2-001CD (10%). The RCVSEQ1TR-7-001CD sequence is a conditional LOOP with subsequent SBO or degraded AC/DC conditions. This sequence is addressed by SAMAs 1, 5, and 6. No SAMAs are suggested for the remaining contributors.
002DGR0G503	1.57E-02	1.080	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Provide an additional portable 480V AC generator (SAMA 6). In addition, cutset review shows that major contributors including the 0G503 failure are cases where the "C" and "D" EDGs are typically available. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-N-N-DGE-O	1.15E-01	1.079	OPERATOR FAILS TO ALIGN	Failure to align the alternate 4kV AC DG is important for SBO sequences. Due to human dependence issues, further plant enhancements related to alternate power alignment requiring operator action would provide limited benefit. In general, a diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). For cases in which the 0G503 diesel is available, Fire Protection could be used for injection. The Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Finally, the contributing sequences including EDG A, B, and E failures could be addressed through the use of an AC cross-tie (SAMA 2).
SEVEREWEATHER	2.87E-03	1.078	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	LOOP due to severe weather, as represented by this event, is grid related and no means are available to the plant to reduce its frequency. In general, a diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolong the time the plant can operate without offsite AC power (SAMA 1). In addition, the contributing sequences including EDG A, B, and E failures could be addressed through the use of an AC cross-tie (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCV1ATWS	1.00E+00	1.074		Over 59 percent of the contributors with this flag are related to mechanical scram failure ATWS scenarios with subsequent operator failure to run back Feedwater. Due to the limited time for response and dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8). The remainder of the contributions are spread among the following types of initiators: - SLC initiation/level control operator errors (29%) - Other failures (>12%) Auto SLC initiation could be installed to address the SLC initiation failures, the cost of which is likely comparable to auto Feedwater runback. No changes to the ADS/inhibit logic are suggested. As Feedwater runback failures are the largest contributors, the SAMA analysis focuses on that issue. No SAMAs are suggested for the remaining contributors.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFMEATWS-PE	2.10E-06	1.074	CCF RPS MECHANICAL SCRAM FAILURE - UNIT 1	Over 59 percent of the contributors with mechanical scram failure ATWS scenarios also contain subsequent operator failure to run back Feedwater. Due to the limited time for response and dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8). The remainder of the contributions are spread among the following types of initiators: - SLC initiation/level control operator errors (30%) - Other failures (11%) Auto SLC initiation could be installed to address the SLC initiation failures, the cost of which is likely comparable to auto Feedwater runback. As Feedwater runback failures are the largest contributors, the SAMA analysis focuses on that issue. No SAMAs are suggested for the remaining contributors.
CCFDG4DGS_ALL	7.41E-05	1.066	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). The Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ1TR-2-001CD	1.00E+00	1.065	SEQUENCE FLAG FOR 1TR-2-001CD	These sequences include failures of high pressure injection systems and subsequent failures of depressurization. The primary contributors to these sequences are DC failures that fail both functions. Battery failure and DC bus failures preclude credit from the station portable diesel generator. SAMA 1 could provide a means of mitigating these accidents assuming that the pump could be operated without DC power. In addition, many FW failures are linked to event flag 125-N-N-FXTIACIGO-FLAG, which is addressed separately in the list.
125-N-N-FXTIACIGO-FLAG	1.00E+00	1.063	FLAG FOR IA TO CIG OPERATOR ACTION FAILURE	This flag is linked to the operator action to cross-tie IA to CIG. The importance of this action is primarily based on sequences in which loss of DC power fails HPI and depressurization capability through power and air dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action (SAMA 10).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDG3DGS_123	9.39E-05	1.060	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
CCFDG3DGS_124	9.39E-05	1.060	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
125-N-N-FXTIACIG-O	2.20E-01	1.055	OPERATOR FAILS TO OPEN IA-CIG CROSSTIE VALVES	The importance of this action is primarily based on sequences in which loss of DC power fails HPI and depressurization capability through power and air dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action (SAMA 10).
%1ISLOCA_RHR_S	1.02E-07	1.055	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	A high pressure core spray pump that could use an inexhaustible, high flow, cold suction source would reduce the risk of ISLOCAs by providing an alternate means of injection and precluding pump failures due to room flooding provided the pump is not located in the lower floors of the reactor building (SAMA 11). The engine driven HPI pump from SAMA 1 is not sized to provide the required makeup flow and is not considered to be capable of mitigating an ISLOCA.
RCVSEQ1IS-2-001CD	1.00E+00	1.055	SEQUENCE FLAG FOR 1IS-2-001CD	This sequence is directly tied to %1ISLOCA_RHR_S and is addressed by SAMA 11.
024-II-B-DSL-P	7.13E-03	1.053	PREVENTATIVE MAINTENANCE 7.13E-03	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDE3DGS_5	4.45E-01	1.052	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
024-I-A-DSL-P	7.13E-03	1.051	PREVENTATIVE MAINTENANCE 7.13E-03	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
SWITCHYARDCENTERED	7.87E-03	1.049	LOOP DUE TO SWITCHYARD CENTERED FAILURES	The LOOP frequency due to switchyard centered failures could theoretically be reduced through preventative strategies or recovery actions; however, given the existence of maintenance review practices and operator training programs, no reliable means of measuring the improvement from any such enhancements has been identified. While the LOOP frequency is not considered to be easily influenced, there are other recovery mitigative options. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Contributors that include battery failures could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4).
RCVLOOPSW5.4	2.09E-01	1.048	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 5.4 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
CCFDG2DGS_12	1.85E-04	1.047	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	The cutsets including this recovery event are dominated by cases where either the "C" or "D" EDG is the only source of AC power and the RHR pumps are failed due to the lack of ESW cooling. SAMA 7 addresses these conditions.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPGR5.2	1.55E-01	1.047	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.2 HOURS	This recovery is important when HPI fails due to loss of AC power and Core Spray injection is required for inventory makeup. In these cases, loss of off-site AC power and specific EDG failures result in the loss of "D" RHR due to the Division I ESW cooling dependence for lube oil cooling (ESW pumps A and C cool RHR pump D). The core spray injection valve cannot be opened remotely because it is powered by the "B" EDG, which has failed. A potential means of mitigating these types of accidents is to change RHR pump cooling such that the "B" and "D" ESW pumps provide cooling flow to the "B" and "D" RHR pumps (SAMA 7). This issue could also be addressed through the use of an AC cross-tie (SAMA 2).
RCVSPC_INJ_L-O	6.00E-04	1.046	OPERATOR FAILS TO REPOSITION VALVE MANUALLY	This event represents Op failure to perform local, manual action to open valves to recover DHR in Class II accidents. In these scenarios, onsite AC power is available through the “E” EDG or another EDG, but valve failures prevent successful operation of DHR other than containment vent. Due to human dependence issues, further operator actions related to DHR recovery will offer limited benefit. While venting is a successful DHR option, its use fails the initially operating injection system. For the relevant scenarios, injection systems fail after containment failure as well. Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3).
145-N-N-REDFW-O	1.00E+00	1.043	OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS .15	Installation of logic to automate Feedwater runback is a potential means of reducing the risk of ATWS sequences (SAMA 8).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
145-N-N-REDFWO-FLAG	1.00E+00	1.043	FLAG FOR OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS	Installation of logic to automate Feedwater runback is a potential means of reducing the risk of ATWS sequences (SAMA 8).
%1LODCBUS_622	1.50E-03	1.043	LOSS OF 1D622	The importance of this event is primarily based on sequences in which loss of DC power fails HPI and depressurization capability through direct and indirect dependencies. In order to recover to a safe, stable endstate from these sequences, injection and heat removal must be restored. Installing a pressure control valve between the IA and CIG systems would automate the cross-tie and remove the primary dependence on human action (SAMA 10).
024DGS0G501D	2.40E-02	1.040	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.
1CLPIA-O	2.30E-01	1.039	OPERATOR FAILS TO CONTROL LOW PRESSURE INJECTION DURING ATWS	Over 70% of the cutset contributions including this event include failures of 145-N-N-REDFW-O. As CLPIA-O is also a level/power control event, there is a dependence between the actions. Automating the Feedwater runback function would remove this dependence (SAMA 8).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
COND-LOOP-TRANS	2.40E-03	1.039	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). Contributors that include battery failures could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4).
RCVLOOPEW5.2	9.80E-01	1.037	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.2 HOURS	The cutsets including this recovery event are dominated by cases where either the "C" or "D" EDG is the only source of AC power and the RHR pumps are failed due to the lack of ESW cooling. SAMA 7 addresses these conditions.
024DGS0G501C	2.40E-02	1.037	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
102BCR1D613	1.68E-04	1.035	125VDC BATTERY CHARGER 1D613 BATTERY CHARGER FAILS TO OPERATE	Failure of this battery charger in conjunction with the failure of 125V DC bus 622 results in the loss of both divisions of 125V DC power in the long term (after battery depletion). Providing the ability to power required loads directly from the available DC charger would allow for recovery on one DC division's essential equipment (SAMA 9). In addition, a large majority of the cutsets including this event include the failure of the IA to CIG cross tie (125-N-N-FXTIACIG-O). These contributors are addressed by SAMA 10.
102BTS1D610	5.00E-04	1.034	125VDC BATTERY BANK A FAILS TO START	The contributors that include battery failures could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4).
150PTS1P203	2.00E-02	1.032	1P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Over 86% of the cutsets including this event are related to the failure of RHR due to the non-divisionalized ESW cooling alignment. This is addressed by SAMA 7.
RCVSEQ1TR-6-011CD	1.00E+00	1.028	SEQUENCE FLAG FOR 1TR-6-011CD	This sequence includes the failure of 145-N-N-REDFW-O. Automating the Feedwater runback function would remove the need for this action (SAMA 8).
CCFDE2DGS_5	3.84E-01	1.026	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPSY5.4	4.17E-02	1.026	PROBABILITY OF NONRECOVERY FROM A SWITCHYARD RELATED LOOP IN 5.4 HOURS	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
RCVSEQ1TR-3-038CD	1.00E+00	1.024	SEQUENCE FLAG FOR 1TR-3-038CD	Over 66% of the cutsets including this event are related to the failure of RHR due to the non-divisionalized ESW cooling alignment. This is addressed by SAMA 7.
024DGR0G501D	1.57E-02	1.023	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling. Finally, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%1ISO	1.36E-01	1.023	INADVERTENT ISOLATION - MSIV	There are no dominant contributors for this initiating event and no viable method has been identified that could be implemented to reduce the initiating event frequency. Some of the contribution could be eliminated by providing a means of providing power directly to critical loads given DC bus or distribution panel failures (SAMA 9). The ATWS contributors (about 38%) include multiple different failure paths including failures of level control, SLC injection, ADS inhibit failures. No SAMAs have been identified to address these events, especially given the low RRW value of this initiating event.
%1LOCA-SM-LQD	2.32E-03	1.022	SMALL LIQUID LINE BREAK LOCA	There are several different types of contributors to the CDF give this initiating event. These are either addressed by the SSES SAMAs identified for other contributors or have contributions below the RRW review cutoff for this analysis: • 29.5%: ESW failures result in long term loss of HPI and LPI due to lack of SPC and equipment cooling. After initial success of HPI and subsequent depressurization, SAMA 1 would be capable of providing core cooling. • 4.5%: Consequential LOOP events result in conditions similar to the ESW failures and are addressed by SAMA 1. • 26.8%: Vapor suppression failures are addressed by SAMA 13. 39.2%: The remaining contributors represent an RRW of only 1.009, which is well below the review cutoff of 1.02 for the SAMA list development and no SAMAs are required to address this contribution.

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1RWST-FLAG	1.00E+00	1.022	FLAG FOR OPERATOR FAILING TO XTIE RWST	The cutsets including this flag require of the CST for extended high pressure makeup success. These contributors could potentially be reduced by automating the cross-tie between the RWST and the CST, but this would introduce the potential to drain both the CST and the RWST in the event of a CST rupture or pumpdown. This is not considered to be a desirable option. Another possibility is providing automated makeup from the Fire Protection system. However, the dominate contributors including 1RWST-FLAG are evolutions that could be mitigated by divisionalizing the ESW cooling to the RHR pumps (SAMA 7). This is considered to be the most appropriate approach for SSES.
024DGR0G501C	1.57E-02	1.022	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, SAMA 7 addresses the sequences in which RHR the "C" or "D" RHR pump cooling function is failed by the cross-divisionalized ESW cooling. Finally, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-1c Unit 1 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
183-N-N-ADS_INH_10-O	4.70E-02	1.020	OPERATOR FAILS TO INHIBIT ADS WITHIN 9 MINUTES DURING ATWS	Over 70 percent of the contribution from this initiator is related to mechanical scram failure ATWS scenarios with subsequent operator failure to run back Feedwater and initiate SLC. Due to operator dependence issues, credit for any enhancements that would require further operator actions would be difficult to justify. Installation of logic to automate Feedwater runback may be a means of reducing the risk of ATWS sequences (SAMA 8).
016-N-N-VENT-O	9.90E-03	1.020	OPERATOR FAILS TO OPEN DOORS AND DAMPERS IN ESW PUMP HOUSE 9.9E-3	"A", "B", and "E" EDG failures dominate the cutsets including 016-N-N-VENT-O. The ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
116-F073/075-O	1.00E+00	1.020	OPERATOR FAILS TO OPEN HV112F073A/B OR HV112F075A/B MANUALLY	This event is completely tied to event "RCVSPC_INJ_L" which is addressed above.

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
2CDFNEW-FLAG	1.00E+00	1.00E+30	UNIT 2 CORE DAMAGE FREQUENCY FLAG	Addressed in the Unit 1 Level 1 Importance List Review
LOOP-FLAG	1.00E+00	4.116	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	Addressed in the Unit 1 Level 1 Importance List Review
%LOOP-FLAG	1.00E+00	3.518	LOOP FLAG FOR INITIATING EVENT	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-7-001CD	1.00E+00	1.917	SEQUENCE FLAG FOR 2TR-7-001CD	Addressed in the Unit 1 Level 1 Importance List Review
EXTSEVWEATHER	2.32E-03	1.593	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review
024-N-E-DSL-P	3.29E-01	1.434	PREVENTATIVE MAINTENANCE 0.328542094	Addressed in the Unit 1 Level 1 Importance List Review
002-N-N-BMS-FLAG	1.00E+00	1.326	BLUE MAX FAILS DUE TO OPERATOR ERROR	Addressed in the Unit 1 Level 1 Importance List Review
GRIDCENTERED	1.38E-02	1.283	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501B	2.40E-02	1.256	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGS0G501A	2.40E-02	1.256	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPGR5.4	1.46E-01	1.228	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-1-005CD	1.00E+00	1.219	SEQUENCE FLAG FOR 2TR-1-005CD	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPEW5.4	9.79E-01	1.213	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPEW25.4	8.33E-01	1.192	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 25.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
Z-BMAX-EDG-O	1.63E-02	1.171	DEPENDENT HEP FOR BLUE MAX AND E DG	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501B	1.57E-02	1.151	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501A	1.57E-02	1.150	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSBOWEDG	1.00E+00	1.132	STATION BLACKOUT WITH E DG	Addressed in the Unit 1 Level 1 Importance List Review
002DGS0G503	2.40E-02	1.130	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
002-N-N-BMS-O	2.93E-02	1.121	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	Addressed in the Unit 1 Level 1 Importance List Review
%2NONISO	8.94E-01	1.105	UNIT 2 TRIP W/O MSIV CLOSURE 2	Addressed in the Unit 1 Level 1 Importance List Review
251-N-N-F005-O	1.00E+00	1.103	OPERATOR FAILS TO OPEN HV252F005A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-8-023CD	1.00E+00	1.090	SEQUENCE FLAG FOR 2TR-8-023CD	Addressed in the Unit 1 Level 1 Importance List Review
002DGR0G503	1.57E-02	1.081	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024-N-N-DGE-O	1.15E-01	1.080	OPERATOR FAILS TO ALIGN	Addressed in the Unit 1 Level 1 Importance List Review
SEVEREWEATHER	2.87E-03	1.077	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review
RCV2ATWS	1.00E+00	1.075		Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFMEATWS-PE-UNIT2	2.10E-06	1.075	CCF RPS MECHANICAL SCRAM FAILURE - UNIT 2	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG4DGS_ALL	7.41E-05	1.067	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-2-001CD	1.00E+00	1.066	SEQUENCE FLAG FOR 2TR-2-001CD	Addressed in the Unit 1 Level 1 Importance List Review
225-N-N-FXTIACIGO-FLAG	1.00E+00	1.062	FLAG FOR IA TO CIG OPERATOR ACTION FAILURE	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_124	9.39E-05	1.062	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_123	9.39E-05	1.061	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
%2ISLOCA_RHR_S	1.02E-07	1.055	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2IS-2-001CD	1.00E+00	1.055	SEQUENCE FLAG FOR 2IS-2-001CD	Addressed in the Unit 1 Level 1 Importance List Review
225-N-N-FXTIACIG-O	2.20E-01	1.055	OPERATOR FAILS TO OPEN IA-CIG CROSSTIE VALVES	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE3DGS_5	4.45E-01	1.053	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review
024-I-A-DSL-P	7.13E-03	1.052	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review
024-II-B-DSL-P	7.13E-03	1.052	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPSW5.4	2.09E-01	1.049	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 5.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
SWITCHYARDCENTERED	7.87E-03	1.048	LOOP DUE TO SWITCHYARD CENTERED FAILURES	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG2DGS_12	1.85E-04	1.048	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
RCVSPC_INJ_L-O	6.00E-04	1.047	OPERATOR FAILS TO REPOSITION VALVE MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
245-N-N-REDFW-O	1.00E+00	1.044	OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS	Addressed in the Unit 1 Level 1 Importance List Review
245-N-N-REDFWO-FLAG	1.00E+00	1.044	FLAG FOR OPERATOR FAILS TO RUN BACK FEEDWATER IN 3.5 MINUTES FOLLOWING AN ATWS	Addressed in the Unit 1 Level 1 Importance List Review
%2LODCBUS_622	1.50E-03	1.043	LOSS OF 2D622	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPGR5.2	1.55E-01	1.040	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 5.2 HOURS	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
2CLPIA-O	2.30E-01	1.040	OPERATOR FAILS TO CONTROL LOW PRESSURE INJECTION DURING ATWS	Addressed in the Unit 1 Level 1 Importance List Review
COND-LOOP-TRANS	2.40E-03	1.039	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501D	2.40E-02	1.038	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
202BCR2D613	1.68E-04	1.035	125VDC BATTERY CHARGER 2D613 BATTERY CHARGER FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501C	2.40E-02	1.034	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
250PTS2P203	2.00E-02	1.032	2P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPEW5.2	9.80E-01	1.031	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 5.2 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-6-011CD	1.00E+00	1.028	SEQUENCE FLAG FOR 2TR-6-011CD	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE2DGS_5	3.84E-01	1.026	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPSY5.4	4.17E-02	1.026	PROBABILITY OF NONRECOVERY FROM A SWITCHYARD RELATED LOOP IN 5.4 HOURS	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2TR-3-038CD	1.00E+00	1.023	SEQUENCE FLAG FOR 2TR-3-038CD	Addressed in the Unit 1 Level 1 Importance List Review
%2ISO	1.36E-01	1.023	UNIT 2 INADVERTENT ISOLATION	Addressed in the Unit 1 Level 1 Importance List Review
%2LOCA-SM-LQD	2.32E-03	1.023	SMALL LIQUID LINE BREAK LOCA	Addressed in the Unit 1 Level 1 Importance List Review
2RWST-FLAG	1.00E+00	1.022	FLAG FOR OPERATOR FAILS TO XTIE CST	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501D	1.57E-02	1.022	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
283-N-N-ADS_INH_10-O	4.70E-02	1.021	OPERATOR FAILS TO INHIBIT ADS WITHIN 10 MINUTES DURING ATWS	Addressed in the Unit 1 Level 1 Importance List Review
216-F073/075-O	1.00E+00	1.020	OPERATOR FAILS TO OPEN HV212F073A/B OR HV212F075A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501C	1.57E-02	1.020	DIESEL GENERATOR 'C' 0G501C D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-1d Unit 2 Level 1 Importance List Review (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGS0G501E	2.40E-02	1.020	DIESEL GENERATOR 'E' 0G501E FAILS TO START	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolong the time the plant can operate without offsite AC power (SAMA 1). Currently, the Fire Protection System is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. Procedure changes to stagger depressurization between units will allow FPS to be used as a viable makeup source (SAMA 3). In addition, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1LEVEL2-FLAG	1.00E+00	1.07E+07	FLAG FOR UNIT 1 LEVEL 2	N/A - This flag marks all sequences for the Unit 1 Level 2 model and does not provide any risk based insights. No SAMAs suggested.
LOOP-FLAG	1.00E+00	5.915	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	Addressed in the Unit 1 Level 1 Importance List Review.
%LOOP-FLAG	1.00E+00	4.964	LOOP FLAG FOR INITIATING EVENT	Addressed in the Unit 1 Level 1 List Review.
1MI-FLAG	1.00E+00	2.119	FLAG FOR UNIT 1 MEDIUM INTERMEDIATE RELEASE	The M/I release category is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, this release category contains sequences that include containment failure after core damage when venting is not credited. Clarifying the procedures to direct wetwell venting to protect the containment is assumed to improve the reliability of venting after core damage (SAMA 12). While this modeling strategy is not limited to sequences binned into the M/I release category, this release category has been used to identify the issue for the SSES model.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVREL-1MI	1.00E+00	2.119	FLAG FOR MEDIMUM INTERMEDIATE RELEASE	The M/I release category is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, this release category contains sequences that include containment failure after core damage when venting is not credited. Clarifying the procedures to direct wetwell venting to protect the containment is assumed to improve the reliability of venting after core damage (SAMA 12). While this modeling strategy is not limited to sequences binned into the M/I release category, this release category has been used to identify the issue for the SSES model.
RCVSEQ1TR-7-010A	1.00E+00	2.081	SEQUENCE FLAG FOR 1TR-7-010A	SAMA 1 is a means of reducing the frequency of this high pressure core melt sequence by providing an alternate means of high pressure injection. In addition, these sequences are predominantly long term SBO scenarios, which would be mitigated by SAMA 13.
EXTSEVWEATHER	2.32E-03	2.032	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	Addressed in the Unit 1 Level 1 enlist Review.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPEW9.2	9.57E-01	1.679	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 9.2 HOURS	The cutsets that include RCVLOOPEW9.2 are dominated by the M/I release category, which is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
002-N-N-BMS-FLAG	1.00E+00	1.614		Addressed in the Unit 1 Level 1 Importance List Review.
024-N-E-DSL-P	3.29E-01	1.507	PREVENTATIVE MAINTENANCE 0.328542094	Addressed in the Unit 1 Level 1 Importance List Review.
024DGS0G501B	2.40E-02	1.403	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	Addressed in the Unit 1 Level 1 Importance List Review.
024DGS0G501A	2.40E-02	1.379	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review.
Z-BMAX-EDG-O	1.63E-02	1.281	DEPENDENT HEP FOR BLUE MAX AND E DG	Addressed in the Unit 1 Level 1 Importance List Review.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGR0G501B	1.57E-02	1.227	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review.
1HE-FLAG	1.00E+00	1.218	FLAG FOR HIGH EARLY RELEASE	About 70% of the H/E release category contributors are ISLOCA events, which are addressed by SAMA 11. Most of the remaining contributors are LOCA events that would also be mitigated by the high pressure core spray system.
RCVREL-1HE	1.00E+00	1.218	FLAG FOR HIGH EARLY RELEASE	About 70% of the H/E release contributors are ISLOCA events, which are addressed by SAMA 11. Most of the remaining contributors are LOCA events that would also be mitigated by the high pressure core spray system.
002DGS0G503	2.40E-02	1.215	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review.
024DGR0G501A	1.57E-02	1.215	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review.
GRIDCENTERED	1.38E-02	1.212	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	Addressed in the Unit 1 Level 1 Importance List Review.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002-N-N-BMS-O	2.93E-02	1.204	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	Addressed in the Unit 1 Level 1 Importance List Review.
RCVLOOPGR9.2	5.11E-02	1.182	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 9.2 HOURS	The cutsets that include RCVLOOPEW9.2 are dominated by the M/I release category, which is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
1HI-FLAG	1.00E+00	1.182	FLAG FOR UNIT 1 HIGH INTERMEDIATE RELEASE	The H/I release category includes many different contributors. LOOP initiating events, however, are responsible for about 65 percent of the release category's frequency, much of which includes failure of the station portable diesel generator. Potential SAMAs that could reduce the H/I frequency include SAMAs 1, 5, 6, and 2.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVREL-1HI	1.00E+00	1.182	FLAG FOR HIGH INTERMEDIATE RELEASE	The H/I release category includes many different contributors. LOOP initiating events, however, are responsible for about 65 percent of the release category's frequency, much of which includes failure of the station portable diesel generator. Potential SAMAs that could reduce the H/I frequency include SAMAs 1, 5, 6, and 2.
1ML-FLAG	1.00E+00	1.162	FLAG FOR UNIT 1 MEDIUM LATE RELEASE	Over 60% of the M/L release category is related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include a mixture of SBO sequences that could be addressed by SAMA 3 and other initiating events.
RCVREL-1ML	1.00E+00	1.162	FLAG FOR MEDIMUM LATE RELEASE	Over 60% of the M/L release category is related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include a mixture of SBO sequences that could be addressed by SAMA 3 and other initiating events.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ1TR-7-010B	1.00E+00	1.148	SEQUENCE FLAG FOR 1TR-7-010B	All of the RCVSEQ1TR-7-010B sequences belong to the H/I release category. All of these sequences include failure of the station portable diesel generator. Potential SAMAs that could reduce the H/I frequency include SAMAs 1, 5, 6, and 2.
RCVSEQ1TR-8-032	1.00E+00	1.132	SEQUENCE FLAG FOR 1TR-8-032	This sequence is completely comprised of M/L contributors. About 80% of the contributors to this sequence are related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include cutsets with failure of all on-site 4kV AC power to operate (portable station generator is available), which could be mitigated by SAMA 3.
002DGR0G503	1.57E-02	1.129	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review.
%1ISLOCA_RHR_S	1.02E-07	1.119	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	Addressed in the Unit 1 Level 1 Importance List Review.
RCVSEQ1IS-2-001	1.00E+00	1.119	SEQUENCE FLAG FOR 1IS-2-001	Addressed in the Unit 1 Level 1 Importance List Review.
SEVEREWEATHER	2.87E-03	1.102	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSBOWEDG	1.00E+00	1.099	STATION BLACKOUT WITH E DG	Addressed in the Unit 1 Level 1 Importance List Review.
151-N-N-F005-O	1.00E+00	1.097	OPERATOR FAILS TO OPEN HV152F005A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review.
RCVLOOPEW11	9.45E-01	1.087	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 11 HOURS	About 80% of the cutsets including this recovery are related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category mostly include cutsets with failure of all 4kV AC EDGs to operate (portable station generator is available), which could be mitigated by SAMA 3.
RCVLOOPSW9.2	1.41E-01	1.080	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 9.2 HOURS	All of the cutsets containing this recovery event include the failure of the station portable diesel generator in conjunction with 4kV EDG failures. Potential SAMAs that could reduce the frequency of these cutsets include SAMAs 1, 5, 6, and 2.
024-N-N-DGE-O	1.15E-01	1.076	OPERATOR FAILS TO ALIGN	Addressed in the Unit 1 Level 1 Importance List Review.
024-II-B-DSL-P	7.13E-03	1.075	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review.
024-I-A-DSL-P	7.13E-03	1.072	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDG2DGS_12	1.85E-04	1.069	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review.
CCFDG3DGS_123	9.39E-05	1.061	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review.
CCFDG3DGS_124	9.39E-05	1.059	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review.
CCFDE3DGS_5	4.45E-01	1.049	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review.
013-N-N-EARLY-O	7.50E-02	1.044	OPERATOR FAILS TO TIE IN FIRE MAIN OR RHRSW FOR EARLY SEQUENCES 1 HOUR	The reliability of injection with the fire main could be improved by installing a permanent connection to the RHR system. The hard pipe connection would reduce the alignment time, improve man machine interface, and increase the injection flow rate (SAMA 14).
102BTS1D610	5.00E-04	1.036	125VDC BATTERY BANK A FAILS TO START	Addressed in the Unit 1 Level 1 List Review.
CCFDG4DGS_ALL	7.41E-05	1.035	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review.
150PTS1P203	2.00E-02	1.034	1P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review.
COND-LOOP-TRANS	2.40E-03	1.031	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	Addressed in the Unit 1 Level 1 Importance List Review.
CCFDE2DGS_5	3.84E-01	1.031	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1RWST-FLAG	1.00E+00	1.031	FLAG FOR OPERATOR FAILING TO CROSSTIE RWST TO CST	Addressed in the Unit 1 Level 1 Importance List Review.
1DCH	2.70E-02	1.028	DIRECT CONTAINMENT HEATING PROBABILITY	The majority of the contributors including direct containment heating are high pressure core melt sequences with failure of the portable station generator to supply power for depressurization. If the RPV could be depressurized, the contribution of DCH would be reduced. SAMAs 5 and 6 provide means of addressing portable diesel generator failures. Alternatively, SAMA 1 would mitigate these scenarios by providing a high pressure injection source.
%1NONISO	8.94E-01	1.027	TRIP W/O MSIV CLOSURE	Addressed in the Unit 1 Level 1 Importance List Review.
024DGS0G501D	2.40E-02	1.026	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 enlist Review.
RCVSEQ1TR-2-023B	1.00E+00	1.025	SEQUENCE FLAG FOR 1TR-2-023B	This sequence is dominated by battery failures that could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4). In order to mitigate battery failures concurrent with LOOP events, changes would also be required to ensure the EDGs could be started without DC power.

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-II-B-DSL-H	2.30E-03	1.025	DGB FAILS DUE TO HUMAN ERROR IN MAINTENANCE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
RCVSEQ1TR-7-013	1.00E+00	1.025	SEQUENCE FLAG FOR 1TR-7-013	This sequence is dominated by EDG "A" and "B" failures in combination with failures of the portable station EDG. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024-I-A-DSL-H	2.30E-03	1.024	DGA FAILS DUE TO HUMAN ERROR IN MAINTENANCE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
SWITCHYARDCENTERED	7.87E-03	1.023	LOOP DUE TO SWITCHYARD	Addressed in the Unit 1 Level 1 Importance List

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
			CENTERED FAILURES	Review.
RCVLOOPGR11	3.20E-02	1.022	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 11 HOURS	About 80% of the cutsets including this recovery are related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category mostly include cutsets with failure of all 4kV AC EDGs to operate (portable station generator is available), which could be mitigated by SAMA 3.
024DGS0G501E	2.40E-02	1.022	DIESEL GENERATOR 'E' 0G501E FAILS TO START	As with the maintenance event for this EDG in the Level 1 list, a diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-2a Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
Z-EARLY-RWST-O	1.08E-02	1.021	JHEP OPERATOR FAILS TO ALIGN FIRE MAIN OR RHRSW AND XTIE RWST	Over 50% of the contributors requiring these operator actions result in the need for alternate low pressure injection because the RHR pumps are unavailable to provide SPC for HPCI operation or ECCS injection. This is due to the non-divisionalized nature of the RHR pump cooling alignment with ESW. SAMA 7 addresses this issue. Many of the remaining cutsets include loss of long term DC through portable station generator and EDG failures. These scenarios are addressed by SAMAs 1 and 2.

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
2LEVEL2-FLAG	1.00E+00	1.09E+07	FLAG FOR UNIT 2 LEVEL 2	N/A - This flag marks all sequences for the Unit 1 Level 2 model and does not provide any risk based insights. No SAMAs suggested.
LOOP-FLAG	1.00E+00	5.836	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	Addressed in the Unit 1 Level 2 Importance List Review.
%LOOP-FLAG	1.00E+00	4.911	LOOP FLAG FOR INITIATING EVENT	Addressed in the Unit 1 Level 2 Importance List Review.
2MI-FLAG	1.00E+00	2.243	FALAG FOR 2MI	Addressed in the Unit 1 Level 2 Importance List Review.
RCVREL-2MI	1.00E+00	2.243	FLAG FOR MEDIMUM INTERMEDIATE RELEASE	Addressed in the Unit 1 Level 2 Importance List Review.
RCVSEQ2TR-7-010A	1.00E+00	2.159	SEQUENCE FLAG FOR 2TR-7-010A	Addressed in the Unit 1 Level 2 Importance List Review.
EXTSEVWEATHER	2.32E-03	2.034	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	Addressed in the Unit 1 Level 2 Importance List Review.
RCVLOOPEW9.2	9.57E-01	1.718	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 9.2 HOURS	Addressed in the Unit 1 Level 2 Importance List Review.
002-N-N-BMS-FLAG	1.00E+00	1.652		Addressed in the Unit 1 Level 2 Importance List Review.

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-N-E-DSL-P	3.29E-01	1.555	PREVENTATIVE MAINTENANCE 0.328542094	Addressed in the Unit 1 Level 2 Importance List Review.
024DGS0G501B	2.40E-02	1.400	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	Addressed in the Unit 1 Level 2 Importance List Review.
024DGS0G501A	2.40E-02	1.400	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 2 Importance List Review.
Z-BMAX-EDG-O	1.63E-02	1.299	DEPENDENT HEP FOR BLUE MAX AND E DG	Addressed in the Unit 1 Level 2 Importance List Review.
024DGR0G501B	1.57E-02	1.226	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	
2HE-FLAG	1.00E+00	1.226	FLAG FOR 2HE	Addressed in the Unit 1 Level 2 Importance List Review.
RCVREL-2HE	1.00E+00	1.226	FLAG FOR HIGH EARLY RELEASE	Addressed in the Unit 1 Level 2 Importance List Review.
024DGR0G501A	1.57E-02	1.226	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 2 Importance List Review.
002DGS0G503	2.40E-02	1.223	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 2 Importance List Review.

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
002-N-N-BMS-O	2.93E-02	1.209	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	
GRIDCENTERED	1.38E-02	1.209	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	Addressed in the Unit 1 Level 2 Importance List Review.
RCVLOOPGR9.2	5.11E-02	1.190	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 9.2 HOURS	Addressed in the Unit 1 Level 2 Importance List Review.
2HI-FLAG	1.00E+00	1.163	FLAG FOR 2HI	Addressed in the Unit 1 Level 2 Importance List Review.
RCVREL-2HI	1.00E+00	1.163	FLAG FOR HIGH INTERMEDIATE RELEASE	Addressed in the Unit 1 Level 2 Importance List Review.
RCVSEQ2TR-7-010B	1.00E+00	1.154	SEQUENCE FLAG FOR 2TR-7-010B	Addressed in the Unit 1 Level 2 Importance List Review.
2ML-FLAG	1.00E+00	1.139	FLAG FOR 2ML	Addressed in the Unit 1 Level 2 Importance List Review.
RCVREL-2ML	1.00E+00	1.139	FLAG FOR MEDIMUM LATE RELEASE	Addressed in the Unit 1 Level 2 Importance List Review.
002DGR0G503	1.57E-02	1.133	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	Addressed in the Unit 1 Level 2 Importance List Review.
%2ISLOCA_RHR_S	1.02E-07	1.123	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	Addressed in the Unit 1 Level 2 Importance List Review.

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ2IS-2-001	1.00E+00	1.123	SEQUENCE FLAG FOR 2IS-2-001	Addressed in the Unit 1 Level 2 Importance List Review.
RCVSEQ2TR-8-032	1.00E+00	1.114	SEQUENCE FLAG FOR 2TR-8-032	Addressed in the Unit 1 Level 2 Importance List Review.
SEVEREWEATHER	2.87E-03	1.102	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	Addressed in the Unit 1 Level 2 Importance List Review.
251-N-N-F005-O	1.00E+00	1.092	OPERATOR FAILS TO OPEN HV252F005A/B MANUALLY	Addressed in the Unit 1 Level 2 Importance List Review.
RCVLOOPSW9.2	1.41E-01	1.083	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 9.2 HOURS	Addressed in the Unit 1 Level 2 Importance List Review.
024-N-N-DGE-O	1.15E-01	1.081	OPERATOR FAILS TO ALIGN	Addressed in the Unit 1 Level 2 Importance List Review.
RCVLOOPEW11	9.45E-01	1.075	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 11 HOURS	Addressed in the Unit 1 Level 2 Importance List Review.
024-II-B-DSL-P	7.13E-03	1.075	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 2 Importance List Review.
024-I-A-DSL-P	7.13E-03	1.075	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 2 Importance List Review.
CCFDG2DGS_12	1.85E-04	1.071	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	Addressed in the Unit 1 Level 2 Importance List Review.
CCFDG3DGS_123	9.39E-05	1.062	CCF 3 OF 4 EDGs (A, B, C) TO	Addressed in the Unit 1 Level 2 Importance List

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
			START AND RUN (8)	Review.
CCFDG3DGS_124	9.39E-05	1.060	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	Addressed in the Unit 1 Level 2 Importance List Review.
RCVSBOWEDG	1.00E+00	1.057	STATION BLACKOUT WITH E DG	Addressed in the Unit 1 Level 2 Importance List Review.
CCFDE3DGS_5	4.45E-01	1.050	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 2 Importance List Review.
013-N-N-EARLY-O	7.50E-02	1.045	OPERATOR FAILS TO TIE IN FIRE MAIN OR RHRSW FOR EARLY SEQUENCES 1 HOUR	Addressed in the Unit 1 Level 2 Importance List Review.
CCFDG4DGS_ALL	7.41E-05	1.036	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	Addressed in the Unit 1 Level 2 Importance List Review.
250PTS2P203	2.00E-02	1.034	2P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Addressed in the Unit 1 Level 2 Importance List Review.
CCFDE2DGS_5	3.84E-01	1.032	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 2 Importance List Review.
2RWST-FLAG	1.00E+00	1.031	FLAG FOR OPERATOR FAILING TO CROSSTIE RWST TO CST	Addressed in the Unit 1 Level 2 Importance List Review.
COND-LOOP-TRANS	2.40E-03	1.031	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	Addressed in the Unit 1 Level 2 Importance List Review.
2DCH	2.70E-02	1.029	DIRECT CONTAINMENT HEATING PROBABILITY	Addressed in the Unit 1 Level 2 Importance List Review.

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%2NONISO	8.94E-01	1.027	UNIT 2 TRIP W/O MSIV CLOSURE 2	Addressed in the Unit 1 Level 2 Importance List Review.
RCVSEQ2TR-7-013	1.00E+00	1.025	SEQUENCE FLAG FOR 2TR-7-013	Addressed in the Unit 1 Level 2 Importance List Review.
024-II-B-DSL-H	2.30E-03	1.025	DGB FAILS DUE TO HUMAN ERROR IN MAINTENANCE	Addressed in the Unit 1 Level 2 Importance List Review.
024-I-A-DSL-H	2.30E-03	1.025	DGA FAILS DUE TO HUMAN ERROR IN MAINTENANCE	Addressed in the Unit 1 Level 2 Importance List Review.
024DGS0G501D	2.40E-02	1.023	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 2 Importance List Review.
024DGS0G501E	2.40E-02	1.023	DIESEL GENERATOR 'E' 0G501E FAILS TO START	Addressed in the Unit 1 Level 2 Importance List Review.
SWITCHYARDCENTERED	7.87E-03	1.022	LOOP DUE TO SWITCHYARD CENTERED FAILURES	Addressed in the Unit 1 Level 2 Importance List Review.
Z-EARLY-RWST-O	1.08E-02	1.021	JHEP OPERATOR FAILS TO ALIGN FIRE MAIN OR RHRSW AND XTIE RWST	Addressed in the Unit 1 Level 2 Importance List Review.

Table E.5-2b Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Pre-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ2LT-7-001	1.00E+00	1.020	SEQUENCE FLAG FOR 2LT-7-001	This sequence corresponds to LOCA events combined with the SP to DW vacuum breakers failed open such that vapor suppression is failed. Depressurizing the RPV before the containment can overpressurize is a means of mitigating this accident; however, the time available to prevent containment failure is short. Decreasing the response time of the ADS system is not suggested as it may result in premature blowdowns in circumstances when emergency depressurization is not desired. Operators are trained to deal with these scenarios and existing procedures guide them toward depressurization as soon as is practical. No credible means of providing a method of ensuring depressurization before containment failure has been identified. An alternate method of preventing drywell failure could be to install a passive vent path that is forced through a pool of water (SAMA 13). Including a vent path below the SP water line is not suggested as it introduced an additional drain path in the pool.
RCVLOOPGR11	3.20E-02	1.020	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 11 HOURS	Addressed in the Unit 1 Level 2 Importance List Review.

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1LEVEL2-FLAG	1.00E+00	9.53E+06	FLAG FOR UNIT 1 LEVEL 2	N/A - This flag marks all sequences for the Unit 1 Level 2 model and does not provide any risk based insights. No SAMAs suggested.
LOOP-FLAG	1.00E+00	6.253	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	Addressed in the Unit 1 Level 1 Importance List Review
%LOOP-FLAG	1.00E+00	5.093	LOOP FLAG FOR INITIATING EVENT	Addressed in the Unit 1 Level 1 Importance List Review
1MI-FLAG	1.00E+00	2.114	FLAG FOR UNIT 1 MEDIUM INTERMEDIATE RELEASE	The M/I release category is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, this release category contains sequences that include containment failure after core damage when venting is not credited. Clarifying the procedures to direct wetwell venting to protect the containment is assumed to improve the reliability of venting after core damage (SAMA 12). While this modeling strategy is not limited to sequences binned into the M/I release category, this release category has been used to identify the issue for the SSES model.

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVREL-1MI	1.00E+00	2.114	FLAG FOR MEDIMUM INTERMEDIATE RELEASE	The M/I release category is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2). In addition, this release category contains sequences that include containment failure after core damage when venting is not credited. Clarifying the procedures to direct wetwell venting to protect the containment is assumed to improve the reliability of venting after core damage (SAMA 12). While this modeling strategy is not limited to sequences binned into the M/I release category, this release category has been used to identify the issue for the SSES model.
RCVSEQ1TR-7-010A	1.00E+00	2.074	SEQUENCE FLAG FOR 1TR-7-010A	Addressed in the Unit 1 Level 1 Importance List Review
EXTSEVWEATHER	2.32E-03	1.937	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPEW8.5	9.61E-01	1.614	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 8.5 HOURS	The cutsets that include RCVLOOPEW8.5 are dominated by the M/I release category, which is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
002-N-N-BMS-FLAG	1.00E+00	1.610		Addressed in the Unit 1 Level 1 Importance List Review
024-N-E-DSL-P	3.29E-01	1.514	PREVENTATIVE MAINTENANCE 0.328542094	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501B	2.40E-02	1.404	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501A	2.40E-02	1.380	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
Z-BMAX-EDG-O	1.63E-02	1.280	DEPENDENT HEP FOR BLUE MAX AND E DG	Addressed in the Unit 1 Level 1 Importance List Review
GRIDCENTERED	1.38E-02	1.248	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGR0G501B	1.57E-02	1.228	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501A	1.57E-02	1.216	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
002DGS0G503	2.40E-02	1.214	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPGR8.5	6.16E-02	1.210	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 8.5 HOURS	The cutsets that include RCVLOOPEW8.5 are dominated by the M/I release category, which is primarily comprised of LOOP events with EDGs A, B, and E failed combined with the failure of the station portable diesel generator. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
002-N-N-BMS-O	2.93E-02	1.203	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1HE-FLAG	1.00E+00	1.202	FLAG FOR HIGH EARLY RELEASE	About 70% of the HE release category contributors are ISLOCA events, which are addressed by SAMA 11. Most of the remaining contributors are LOCA events that would also be mitigated by the high pressure core spray system.
RCVREL-1HE	1.00E+00	1.202	FLAG FOR HIGH EARLY RELEASE	About 70% of the HE release category contributors are ISLOCA events, which are addressed by SAMA 11. Most of the remaining contributors are LOCA events that would also be mitigated by the high pressure core spray system.
1HI-FLAG	1.00E+00	1.185	FLAG FOR UNIT 1 HIGH INTERMEDIATE RELEASE	The H/I release category includes many different contributors. LOOP initiating events, however, are responsible for about 95 percent of the release category's frequency, much of which includes failure of the station portable diesel generator. Potential SAMAs that could reduce the H/I frequency include SAMAs 1, 5, 6, and 2.
RCVREL-1HI	1.00E+00	1.185	FLAG FOR HIGH INTERMEDIATE RELEASE	The H/I release category includes many different contributors. LOOP initiating events, however, are responsible for about 95 percent of the release category's frequency, much of which includes failure of the station portable diesel generator. Potential SAMAs that could reduce the H/I frequency include SAMAs 1, 5, 6, and 2.

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
1ML-FLAG	1.00E+00	1.173	FLAG FOR UNIT 1 MEDIUM LATE RELEASE	Over 60% of the M/L release category is related to the failure to provide injection dud to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include a mixture of sequences including 4kV AC EDG failures that could be addressed by SAMA 3 and other low contribution, initiating events.
RCVREL-1ML	1.00E+00	1.173	FLAG FOR MEDIMUM LATE RELEASE	Over 60% of the M/L release category is related to the failure to provide injection dud to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include a mixture of sequences including 4kV AC EDG failures that could be addressed by SAMA 3 and other low contribution, initiating events.
RCVSEQ1TR-7-010B	1.00E+00	1.148	SEQUENCE FLAG FOR 1TR-7-010B	All of the RCVSEQ1TR-7-010B sequences belong to the H/I release category. All of these sequences include failure of the station portable diesel generator. Potential SAMAs that could reduce the H/I frequency include SAMAs 1, 5, 6, and 2.

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ1TR-8-032	1.00E+00	1.144	SEQUENCE FLAG FOR 1TR-8-032	This sequence is completely comprised of M/L contributors. About 80% of the contributors to this sequence are related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include cutsets with failure of all on-site 4kV AC power to operate (portable station generator is available), which could be mitigated by SAMA 3.
002DGR0G503	1.57E-02	1.129	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
%1ISLOCA_RHR_S	1.02E-07	1.111	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ1IS-2-001	1.00E+00	1.111	SEQUENCE FLAG FOR 1IS-2-001	Addressed in the Unit 1 Level 1 Importance List Review
151-N-N-F005-O	1.00E+00	1.105	OPERATOR FAILS TO OPEN HV152F005A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
RCVSBOWEDG	1.00E+00	1.104	STATION BLACKOUT WITH E DG	Addressed in the Unit 1 Level 1 Importance List Review
SEVEREWEATHER	2.87E-03	1.103	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPEW10	9.52E-01	1.088	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 10 HOURS	This sequence is completely comprised of M/L contributors. About 80% of the contributors to this sequence are related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include cutsets with failure of all on-site 4kV AC power to operate (portable station generator is available), which could be mitigated by SAMA 3.
RCVLOOPSW8.5	1.51E-01	1.080	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 8.5 HOURS	All of the cutsets containing this recovery event include the failure of the station portable diesel generator in conjunction with 4kV EDG failures. Potential SAMAs that could reduce the frequency of these cutsets include SAMAs 1, 5, 6, and 2.
024-N-N-DGE-O	1.15E-01	1.077	OPERATOR FAILS TO ALIGN	Addressed in the Unit 1 Level 1 Importance List Review
024-II-B-DSL-P	7.13E-03	1.076	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review
024-I-A-DSL-P	7.13E-03	1.072	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG2DGS_12	1.85E-04	1.069	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_123	9.39E-05	1.063	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_124	9.39E-05	1.061	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDE3DGS_5	4.45E-01	1.051	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review
013-N-N-EARLY-O	7.50E-02	1.044	OPERATOR FAILS TO TIE IN FIRE MAIN OR RHRSW FOR EARLY SEQUENCES 1 HOUR	The reliability of injection with the fire main could be improved by installing a permanent connection to the RHR system. The hard pipe connection would reduce the alignment time, improve man machine interface, and increase the injection flow rate (SAMA 14).
102BTS1D610	5.00E-04	1.037	125VDC BATTERY BANK A FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG4DGS_ALL	7.41E-05	1.037	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
COND-LOOP-TRANS	2.40E-03	1.035	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	Addressed in the Unit 1 Level 1 Importance List Review
150PTS1P203	2.00E-02	1.034	1P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE2DGS_5	3.84E-01	1.031	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review
%1NONISO	8.94E-01	1.031	TRIP W/O MSIV CLOSURE	Addressed in the Unit 1 Level 1 Importance List Review
1RWST-FLAG	1.00E+00	1.031	FLAG FOR OPERATOR FAILING TO XTIE RWST	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPGR10	4.14E-02	1.029	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 10 HOURS	This sequence is completely comprised of M/L contributors. About 80% of the contributors to this sequence are related to the failure to provide injection due to the dependence of RHR pump cooling on non-divisionalized ESW flow. This is addressed in the Unit 1 Level 1 importance list by event 151-N-N-F005-O. The remaining contributors in this release category include cutsets with failure of all on-site 4kV AC power to operate (portable station generator is available), which could be mitigated by SAMA 3.
SWITCHYARDCENTERED	7.87E-03	1.027	LOOP DUE TO SWITCHYARD CENTERED FAILURES	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ1TR-2-023B	1.00E+00	1.027	SEQUENCE FLAG FOR 1TR-2-023B	This sequence is dominated (over 80%) by battery failures that could be mitigated by installing 100% battery chargers and ensuring that the DC system can operate without the batteries (SAMA 4). In order to mitigate battery failures concurrent with LOOP events, changes would also be required to ensure the EDGs could be started without DC power.
1DCH	2.70E-02	1.027	DIRECT CONTAINMENT HEATING PROBABILITY	The majority of the contributors including direct containment heating are high pressure core melt sequences with failure of the portable station generator to supply power for depressurization. If the RPV could be depressurized, the contribution of DCH would be reduced. SAMAs 5 and 6 provide means of addressing portable diesel generator failures. Alternatively, SAMA 1 would mitigate these scenarios by providing a high pressure injection source.

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024DGS0G501D	2.40E-02	1.027	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
150-152RXLEVELCTRL-FLAG	1.00E+00	1.025	FLAG FOR OPERATOR FAILURE TO CONTROL LEVEL	This cutsets including this event are dominated by loss of HPI due to support system failures and subsequent Core Spray injection alignment difficulties. For example, in these cases, loss of off-site AC power and specific EDG failures result in the loss of "D" RHR due to the Division I ESW cooling dependence for lube oil cooling (ESW pumps A and C cool RHR pump D). The core spray injection valve cannot be opened remotely because it is powered by the "B" EDG, which has failed. A potential means of mitigating these types of accidents is to change RHR pump cooling such that the "B" and "D" ESW pumps provide cooling flow to the "B" and "D" RHR pumps (SAMA 7). This issue could also be addressed through the use of an AC cross-tie (SAMA 2).
024-II-B-DSL-H	2.30E-03	1.025	DGB FAILS DUE TO HUMAN ERROR IN MAINTENANCE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-I-A-DSL-H	2.30E-03	1.024	DGA FAILS DUE TO HUMAN ERROR IN MAINTENANCE	A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
RCVSEQ1TR-7-013	1.00E+00	1.024	SEQUENCE FLAG FOR 1TR-7-013	This sequence is dominated by LOOP with failure of HPI and ADS due to failures that result in loss of DC power. A diesel driven, HPI pump that could use a large volume, cold suction source would reduce the risk of LOOP by prolonging the time the plant can operate without offsite AC power (SAMA 1). Alternatively, the ability to cross-tie emergency 4kV AC buses would allow the operators to power functional equipment in divisions where the corresponding EDG has failed (SAMA 2).
024DGS0G501E	2.40E-02	1.022	DIESEL GENERATOR 'E' 0G501E FAILS TO START	Addressed in the Unit 2 Level 1 Importance List Review
150-152RXLEVELCTRL-O	1.50E-02	1.021	OPERATOR FAILS TO CONTROL REACTOR WATER LEVEL	This event is completely tied to flag 150-152RXLEVELCTRL-FLAG, which is addressed above.

Table E.5-2c Unit 1 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
Z-EARLY-RWST-O	1.08E-02	1.021	JHEP OPERATOR FAILS TO ALIGN FIRE MAIN OR RHRSW AND XTIE RWST	Over 50% of the contributors requiring these operator actions result in the need for alternate low pressure injection because the RHR pumps are unavailable to provide SPC for HPCI operation or ECCS injection. This is due to the non-divisionalized nature of the RHR pump cooling alignment with ESW. SAMA 7 addresses this issue. Many of the remaining cutsets include loss of long term DC through portable station generator and EDG failures. These scenarios are addressed by SAMAs 1 and 2.

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
2LEVEL2-FLAG	1.00E+00	9.68E+06	FLAG FOR UNIT 2 LEVEL 2	N/A - This flag marks all sequences for the Unit 1 Level 2 model and does not provide any risk based insights. No SAMAs suggested.
LOOP-FLAG	1.00E+00	6.199	FLAG TO BE USED FOR ANY CONDITIONAL OR NON CONDITIONAL LOOP	Addressed in the Unit 1 Level 1 Importance List Review
%LOOP-FLAG	1.00E+00	5.056	LOOP FLAG FOR INITIATING EVENT	Addressed in the Unit 1 Level 1 Importance List Review
2MI-FLAG	1.00E+00	2.245	FALAG FOR 2MI	Addressed in the Unit 1 Level 2 Importance List Review
RCVREL-2MI	1.00E+00	2.245	FLAG FOR MEDIMUM INTERMEDIATE RELEASE	Addressed in the Unit 1 Level 2 Importance List Review
RCVSEQ2TR-7-010A	1.00E+00	2.154	SEQUENCE FLAG FOR 2TR-7-010A	Addressed in the Unit 1 Level 1 Importance List Review
EXTSEVWEATHER	2.32E-03	1.942	LOSS OF OFF SITE POWER DUE TO EXTREMELY SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review
002-N-N-BMS-FLAG	1.00E+00	1.649		Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPEW8.5	9.61E-01	1.649	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 8.5 HOURS	Addressed in the Unit 1 Level 2 Importance List Review

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
024-N-E-DSL-P	3.29E-01	1.565	PREVENTATIVE MAINTENANCE 0.328542094	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501B	2.40E-02	1.403	DIESEL GENERATOR 'B' 0G501B D.G. FAIL WITHIN THE FIRST HOUR	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501A	2.40E-02	1.402	DIESEL GENERATOR 'A' 0G501A DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
Z-BMAX-EDG-O	1.63E-02	1.299	DEPENDENT HEP FOR BLUE MAX AND E DG	Addressed in the Unit 1 Level 1 Importance List Review
GRIDCENTERED	1.38E-02	1.245	LOSS OF OFF SITE POWER DUE TO GRID FAILURE	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501B	1.57E-02	1.227	DIESEL GENERATOR 'B' 0G501B D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
024DGR0G501A	1.57E-02	1.227	DIESEL GENERATOR 'A' 0G501A D.G. FAIL AFTER FIRST HOUR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review
002DGS0G503	2.40E-02	1.222	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVLOOPGR8.5	6.16E-02	1.220	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 8.5 HOURS	Addressed in the Unit 1 Level 2 Importance List Review
2HE-FLAG	1.00E+00	1.210	FLAG FOR 2HE	Addressed in the Unit 1 Level 2 Importance List Review
RCVREL-2HE	1.00E+00	1.210	FLAG FOR HIGH EARLY RELEASE	Addressed in the Unit 1 Level 2 Importance List Review
002-N-N-BMS-O	2.93E-02	1.209	OPERATOR ERROR FOR ALIGNING THE STATION PORTABLE DIESEL GENERATOR	Addressed in the Unit 1 Level 1 Importance List Review
2HI-FLAG	1.00E+00	1.164	FLAG FOR 2HI	Addressed in the Unit 1 Level 2 Importance List Review
RCVREL-2HI	1.00E+00	1.164	FLAG FOR HIGH INTERMEDIATE RELEASE	Addressed in the Unit 1 Level 2 Importance List Review
RCVSEQ2TR-7-010B	1.00E+00	1.154	SEQUENCE FLAG FOR 2TR-7-010B	Addressed in the Unit 1 Level 2 Importance List Review
2ML-FLAG	1.00E+00	1.151	FLAG FOR 2ML	Addressed in the Unit 1 Level 2 Importance List Review
RCVREL-2ML	1.00E+00	1.151	FLAG FOR MEDIMUM LATE RELEASE	Addressed in the Unit 1 Level 2 Importance List Review
002DGR0G503	1.57E-02	1.133	STATION PORTABLE DIESEL GEN - BLUE MAX 0G503 DIESEL GENERATOR FAILS TO OPERATE	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
RCVSEQ2TR-8-032	1.00E+00	1.126	SEQUENCE FLAG FOR 2TR-8-032	Addressed in the Unit 1 Level 2 Importance List Review
%2ISLOCA_RHR_S	1.02E-07	1.115	INTERFACING SYSTEM LOCA FOR RHR PUMP SUCTION (F008-F009) BREAK	Addressed in the Unit 1 Level 1 Importance List Review
RCVSEQ2IS-2-001	1.00E+00	1.115	SEQUENCE FLAG FOR 2IS-2-001	Addressed in the Unit 1 Level 1 Importance List Review
SEVEREWEATHER	2.87E-03	1.104	LOSS OF OFF SITE POWER DUE TO SEVERE WEATHER	Addressed in the Unit 1 Level 1 Importance List Review
251-N-N-F005-O	1.00E+00	1.101	OPERATOR FAILS TO OPEN HV252F005A/B MANUALLY	Addressed in the Unit 1 Level 1 Importance List Review
024-N-N-DGE-O	1.15E-01	1.083	OPERATOR FAILS TO ALIGN	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPSW8.5	1.51E-01	1.083	PROBABILITY OF NONRECOVERY FROM A SEVERE WEATHER RELATED LOOP IN 8.5 HOURS	Addressed in the Unit 1 Level 2 Importance List Review
RCVLOOPEW10	9.52E-01	1.077	PROBABILITY OF NONRECOVERY FROM A EXTREME WEATHER RELATED LOOP IN 10 HOURS	Addressed in the Unit 1 Level 2 Importance List Review
024-II-B-DSL-P	7.13E-03	1.075	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review
024-I-A-DSL-P	7.13E-03	1.075	PREVENTATIVE MAINTENANCE 7.13E-03	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
CCFDG2DGS_12	1.85E-04	1.071	CCF 2 OF 4 EDGs (A, B) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_123	9.39E-05	1.065	CCF 3 OF 4 EDGs (A, B, C) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
CCFDG3DGS_124	9.39E-05	1.063	CCF 3 OF 4 EDGs (A, B, D) TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
RCVSBOWEDG	1.00E+00	1.060	STATION BLACKOUT WITH E DG	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE3DGS_5	4.45E-01	1.053	CCF DG E W/ FAILURE OF 3 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review
013-N-N-EARLY-O	7.50E-02	1.045	OPERATOR FAILS TO TIE IN FIRE MAIN OR RHRSW FOR EARLY SEQUENCES 1 HOUR	Addressed in the Unit 1 Level 2 Importance List Review
CCFDG4DGS_ALL	7.41E-05	1.038	CCF 4 OF 4 DGs FAIL TO START AND RUN (8)	Addressed in the Unit 1 Level 1 Importance List Review
COND-LOOP-TRANS	2.40E-03	1.035	CONDITIONAL LOOP PROBABILITY GIVEN TRANSIENT	Addressed in the Unit 1 Level 1 Importance List Review
250PTS2P203	2.00E-02	1.035	2P203 TURBINE-DRIVEN PUMP STAND-BY FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
CCFDE2DGS_5	3.84E-01	1.032	CCF DG E W/ FAILURE OF 2 OF 4 OTHER DGS (11)	Addressed in the Unit 1 Level 1 Importance List Review
2RWST-FLAG	1.00E+00	1.031	FLAG FOR OPERATOR FAILS TO XTIE CST	Addressed in the Unit 1 Level 1 Importance List Review

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
%2NONISO	8.94E-01	1.031	UNIT 2 TRIP W/O MSIV CLOSURE 2	Addressed in the Unit 1 Level 1 Importance List Review
2DCH	2.70E-02	1.028	DIRECT CONTAINMENT HEATING PROBABILITY	Addressed in the Unit 1 Level 2 Importance List Review
SWITCHYARDCENTERED	7.87E-03	1.026	LOOP DUE TO SWITCHYARD CENTERED FAILURES	Addressed in the Unit 1 Level 1 Importance List Review
RCVLOOPGR10	4.14E-02	1.026	PROBABILITY OF NONRECOVERY FROM A GRID RELATED LOOP IN 10 HOURS	Addressed in the Unit 1 Level 2 Importance List Review
250-252RXLEVELCTRL-FLAG	1.00E+00	1.026	FLAG FOR OPERATOR FAILURE TO CONTROL LEVEL	Addressed in the Unit 1 Level 2 Importance List Review
024-II-B-DSL-H	2.30E-03	1.025	DGB FAILS DUE TO HUMAN ERROR IN MAINTENANCE	Addressed in the Unit 1 Level 2 Importance List Review
024-I-A-DSL-H	2.30E-03	1.025	DGA FAILS DUE TO HUMAN ERROR IN MAINTENANCE	Addressed in the Unit 1 Level 2 Importance List Review
RCVSEQ2TR-7-013	1.00E+00	1.025	SEQUENCE FLAG FOR 2TR-7-013	Addressed in the Unit 1 Level 2 Importance List Review
024DGS0G501D	2.40E-02	1.024	DIESEL GENERATOR 'D' 0G501D D.G. FAIL AFTER FIRST HOUR FAILS TO START	Addressed in the Unit 1 Level 1 Importance List Review
024DGS0G501E	2.40E-02	1.023	DIESEL GENERATOR 'E' 0G501E FAILS TO START	Addressed in the Unit 2 Level 1 Importance List Review
250-252RXLEVELCTRL-O	1.50E-02	1.022	OPERATOR FAILS TO CONTROL REACTOR WATER LEVEL	Addressed in the Unit 1 Level 2 Importance List Review

Table E.5-2d Unit 2 Level 2 Importance List Review (Based on Level 2 Results) (Post-EPU)

Event Name	Probability	Risk Reduction Worth	Description	Potential SAMAs
Z-EARLY-RWST-O	1.08E-02	1.021	JHEP OPERATOR FAILS TO ALIGN FIRE MAIN OR RHRSW AND XTIE RWST	Addressed in the Unit 1 Level 2 Importance List Review

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
1	Diesel Driven High Pressure Injection Pump	SBO sequences at SSES result in core damage even with the availability of the low pressure diesel driven fire pump due to unavailability of the SRVs in long term accidents. Given the existence of an alternate 4kV AC diesel generator and a portable 480V AC generator, additional AC power assets are not likely to provide a large benefit due to hardware and human dependence issues. The installation of a diesel driven, high pressure injection pump with a long term, cold, injection source could prolong the time to core damage. This would allow additional time for off-site AC power recovery. While some benefit would be gained even if this pump required DC power for success, the ability to operate the pump without DC support would enhance the benefit of this change.	SSES Level 1 Importance List (pre-EPU, post-EPU), IPEEE Fire Review	The cost of implementation for this SAMA was estimated to be $2,798,000 by PPL (PPL 2006c).	While the cost of this SAMA exceeds the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis in order to demonstrate the large potential risk reduction that is available through implementation of a SAMA of this type.	While the cost of this SAMA exceeds the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis in order to demonstrate the large potential risk reduction that is available through implementation of a SAMA of this type.
2a	Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-D, B-C)	At least two strategies are available at SSES to improve the 4kV AC bus cross-tie capability. The strategy for this SAMA includes providing a mechanism to easily bypass the emergency 4kV AC feeder breaker interlocks such that new procedures would allow the operators to cross-tie buses which share a common emergency safeguards transformer. The inter-train cross-ties that would be supported by this SAMA include the "A" to "D" connection and the "B" to "C" connection.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The cost of implementation for this SAMA was estimated to be $656,000 by PPL (PPL 2005g).	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
2b	Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-B-C-D)	At least two strategies are available at SSES to improve the 4kV AC bus cross-tie capability. This strategy includes updating procedures and adding the hardware necessary to provide the ability to tie any 4kV AC emergency bus to any other 4kV AC emergency bus. In addition to the changes required for SAMA 2a, this SAMA would require the operators to have the ability to strip all 13.8kV loads from the startup bus, backfeed power through one Emergency Safeguards transformer, and then energize the opposite train's Emergency Safeguards transformer to power the required bus.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The cost of implementation for this SAMA was estimated to be $1,384,000 by PPL (PPL 2005h).	As the cost of implementation is greater than the SSES Pre-EPU MMACR, it has been precluded from Phase 2 analysis	As the cost of implementation is greater than the SSES Post-EPU MMACR, it has been precluded from Phase 2 analysis
3	Proceduralize Staggered RPV Depressurization When Fire Protection System Injection is the Only Available Makeup Source	Currently, the Fire Protection system is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. During depressurization, the loss of RPV inventory results in a makeup requirement greater than the 50% Fire Protection flow that is assumed to be available to prevent core damage. A potential SAMA for this scenarios is a procedure change that directs staggering RPV depressurization between the units such that 100% flow is available to a given unit level is restored after blowdown. Part of this procedure change would require temporarily valving out injection to the unit that has undergone depressurization after level recovery so that flow is not split when the second unit is depressurized. MAAP must be run to confirm that this is a viable option.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The cost of procedure changes varies depending on the scope of the changes; however, the $50,000 value used in the Brunswick SAMA analysis (CPL 2004) is used here as a rough estimate of the cost for SSES. In addition to the cost of the procedure changes, flow analysis is required to confirm that the proposed changes would be effective. The cost of this analysis is estimated to be $100,000. The total cost of implementation for this SAMA is, therefore, $150,000. This estimate does not account for any changes that would be required for operator training.	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
4	Install 100 Percent Capacity Battery Chargers	For cases in which the batteries have failed, the chargers could supply the DC loads if they were replaced with higher capacity units and procedures were developed to remove the failed batteries from the circuit. Currently, the chargers cannot support the full DC load requirements early in LOOP or LOCA sequences.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The cost of implementation for this SAMA was estimated to be $1,619,000 by PPL (PPL 2005f).	As the cost of implementation is greater than the SSES Pre-EPU MMACR, it has been precluded from Phase 2 analysis	As the cost of implementation is greater than the SSES Post-EPU MMACR, it has been precluded from Phase 2 analysis
5	Auto Align 480V AC Portable Station Generator	Auto alignment of the portable 480V AC diesel generator would remove the requirement for the operators to perform the alignment action and increase the reliability of the alternate 480V AC supply. This enhancement would require changes to permanently install the portable generator.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The cost of implementation for this SAMA was estimated to be $398,000 by PPL (PPL 2005b).	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis
6	Procure Spare 480V AC Portable Station Generator	An additional portable 480V AC diesel generator would reduce the impact of 480V AC generator hardware failures.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The cost of implementation for this SAMA was estimated to be $203,000 by PPL (PPL 2005c).	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis
7	Re-Divisionalize ESW Cooling to RHR	Due to a previous change that was implemented to address a plant issue, ESW cooling for RHR is not aligned according to divisional groupings: 1) ESW divisions "A" and "C" provide cooling for RHR pumps "A" and "D", and 2) ESW divisions "B" and "D" provide cooling for RHR pumps "B" and "C". This results in the unavailability of RHR when only the "C" or "D" EDGs are available. Re-piping the cooling paths so that each ESW division cools the corresponding RHR division would eliminate this failure mode. The issue which forced the original ESW change is no longer present at SSES.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The cost of implementation for this SAMA was estimated to be $970,000 by PPL (PPL 2006a, PPL 2006b).	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
8	Automate Feedwater Runback	The largest ATWS contributors for SSES include scenarios in which Feedwater injection is not reduced to lower level. Without Feedwater runback, SLC injection is not credited to prevent core damage. Automating Feedwater flow reduction in ATWS conditions would reduce the failure probability of level control.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The cost of installing logic to automate feedwater runback is considered to be similar in scope to the ABWR SAMDA to install computer aided instrumentation. This enhancement was estimated to cost approximately $600,000 for a single unit in the reactor's design phase (GE 1994). While this estimate would likely be larger for SSES to account for installation at both units, the need to retrofit an existing plant, and for inflation from the time the ABWR study was performed in 1994, $600,000 is used as a lower bound cost of implementation for this SAMA.	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis
9	Direct Feeds From the 125V DC Battery Chargers to Critical Loads	Failure of the DC buses prevents powering required loads even when the batteries or chargers are available. Temporary direct feeds from the batteries or chargers to the required loads could be aligned in emergency conditions if the cables are staged in such a way that the alignment could be performed in a short period of time. While this could not likely be done in ATWS or LOCA accidents, transient initiators with loss of injection would allow about 30 to 40 minutes for power alignment.	SSES Level 1 Importance List (pre-EPU, post-EPU), IPEEE Fire Review	The cost of implementation for this SAMA was estimated to be $346,000 by PPL (PPL 2005e).	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
10	Install a Pressure Control Valve Between the IA and CIG Systems	The current requirement for plant operators to perform a manual cross-tie between the IA and CIG system on loss of CIG pressure in order to maintain Feedwater/Condensate injection and prevent a plant trip could be eliminated through the installation of the pressure control valve (PCV). The PCV would operate by opening a flowpath from IA system to the CIG system on low CIG pressure; however, a flow limiting orifice would be required in the cross-tie line to prevent depressurizing the IA system in the event that the CIG system ruptures.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The cost of implementation for this SAMA was estimated to be $386,000 by PPL (PPL 2005d).	As the cost of implementation is less than the SSES Pre-EPU MMACR, it has been retained for Phase 2 analysis	As the cost of implementation is less than the SSES Post-EPU MMACR, it has been retained for Phase 2 analysis
11	Install a High Pressure Core Spray System with an Inexhaustible Suction Source	The HPCS system could provide some protection against an ISLOCA that existing systems can not. HPCI and RCIC will not be available in the short term due to vessel depressurization from the initiator while LPCI and Core Spray could initially function, but would eventually deplete the CST and Suppression Pool suction sources and/or fail due to room flooding. Condensate would also deplete its inventory. RHRSW is a potentially inexhaustible injection supply, but core cooling issues preclude crediting it for success. It should be noted that even with HPCS operating from a long term supply, a steady state will not have been achieved. Continued injection for core cooling may result in turbine building flooding, which could damage the alternate unit.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The cost of installing an engine driven high pressure injection pump capable of mitigating LOCA and ATWS scenarios has been estimated to be $4,000,000 for the Brunswick site (CPL 2004). The type of high pressure system required for SAMA 11 is considered to be comparable to the Brunswick system and the cost of implementation is assumed to be the same.	As the cost of implementation is greater than the SSES Pre-EPU MMACR, it has been precluded from Phase 2 analysis	As the cost of implementation is greater than the SSES Post-EPU MMACR, it has been precluded from Phase 2 analysis

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
12	Enhance Procedures for Containment Venting After Core Damage When Containment Failure is Imminent	While SSES procedures exist to vent the primary containment irrespective of offsite dose, they are not directly referenced in the EOP flowcharts on high containment pressure given that core damage has occurred. The decision to vent is deferred to the TSC, which may conclude that venting is appropriate even after core damage has occurred and containment failure is imminent. While venting containment would not eliminate a release, it would ensure that the release was scrubbed through the wetwell and reduce the release's impact on the population. The current PRA model does not currently credit venting after core damage, but even if the current procedures were credited, some potential to clarify the EOPs may exist.	SSES Level 2 Importance List (pre-EPU, post-EPU)	N/A - Discussions with SSES operations personnel indicate that plant procedures already support containment venting after core damage. This item is further analyzed in the Phase 2 analysis to demonstrate that when credit is taken for the existing plant capabilities, the potential averted cost-risk that could be claimed for any further venting improvements would be less than any realistic cost of implementation.	Passed to Phase 2 analysis to demonstrate appropriate venting credit reduces the RRW value of the relevant events to a point below the SAMA review cutoff.	Passed to Phase 2 analysis to demonstrate appropriate venting credit reduces the RRW value of the relevant events to a point below the SAMA review cutoff.
13	Passive Overpressure Relief	In order to address in-containment LOCA events with vapor suppression failures, a passive vent path could be installed that would force air from the Suppression Pool air space through a water pool (or some filtering system) and then out of the stack. This would require the installation of a pressure capable water tank or filter and a rupture disk in addition to the new vent path piping.	SSES Level 2 Importance List (pre-EPU)	The cost of a filtered containment vent was estimated to be about $5.7 million in 1989 (PECO 1989). While that vent design required valve manipulation for operation, the cost is considered to be representative of the type of changes required to mitigate the LOCA events identified for SSES. $5.7 million is used for the cost of implementation for this SAMA (not updated to present dollars).	As the cost of implementation is greater than the SSES Pre-EPU MMACR, it has been precluded from Phase 2 analysis	As the cost of implementation is greater than the SSES Post-EPU MMACR, it has been precluded from Phase 2 analysis

Table E.5-3 Phase 1 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Cost Estimate	Pre-EPU Phase 1 Baseline Disposition	Post-EPU Phase 1 Baseline Disposition
14	Enhance Fire Main Connection to RHR	The reliability of injection with the fire main could be improved by installing a permanent connection to the RHR system that would facilitate local alignment and increase the injection flow rate.	SSES Level 2 Importance List	N/A - Review of the PRA model revealed that conservative modeling methods resulted in overestimating the importance of the action to align alternate injection for SSES. This item is further analyzed in the Phase 2 analysis to demonstrate that when credit is taken for the existing plant capabilities, the importance of aligning alternate injection is reduced below the threshold of review for the SAMA analysis.	Passed to Phase 2 analysis to demonstrate appropriate venting credit reduces the RRW value of the relevant events to a point below the SAMA review cutoff.	Passed to Phase 2 analysis to demonstrate appropriate venting credit reduces the RRW value of the relevant events to a point below the SAMA review cutoff.

Table E.6-1 Phase 2 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Pre-EPU Phase 2 Baseline Disposition	Post-EPU Phase 2 Baseline Disposition
1	Diesel Driven High Pressure Injection Pump	SBO sequences at SSES result in core damage even with the availability of the low pressure diesel driven fire pump due to unavailability of the SRVs in long term accidents. Given the existence of an alternate 4kV AC diesel generator and a portable 480V AC generator, additional AC power assets are not likely to provide a large benefit due to hardware and human dependence issues. The installation of a diesel driven, high pressure injection pump with a long term, cold, injection source could prolong the time to core damage. This would allow additional time for off-site AC power recovery. While some benefit would be gained even if this pump required DC power for success, the ability to operate the pump without DC support would enhance the benefit of this change.	SSES Level 1 Importance List (pre-EPU, post-EPU), IPEEE Fire Review	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.
2a	Improve Cross-Tie Capability Between 4kV AC Emergency Buses (A-D, B-C)	At least two strategies are available at SSES to improve the 4kV AC bus cross-tie capability. The strategy for this SAMA includes providing a mechanism to easily bypass the emergency 4kV AC feeder breaker interlocks such that new procedures would allow the operators to cross-tie buses which share a common emergency safeguards transformer. The inter-train cross-ties that would be supported by this SAMA include the "A" to "D" connection and the "B" to "C" connection.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is greater than the cost of implementation and the SAMA is cost beneficial.

Table E.6-1 Phase 2 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Pre-EPU Phase 2 Baseline Disposition	Post-EPU Phase 2 Baseline Disposition
3	Proceduralize Staggered RPV Depressurization When Fire Protection System Injection is the Only Available Makeup Source	Currently, the Fire Protection system is not credited due to flow limitations even in the very late time frames in some LOOP evolutions. During depressurization, the loss of RPV inventory results in a makeup requirement greater than the 50% Fire Protection flow that is assumed to be available to prevent core damage. A potential SAMA for this scenarios is a procedure change that directs staggering RPV depressurization between the units such that 100% flow is available to a given unit level is restored after blowdown. Part of this procedure change would require temporarily valving out injection to the unit that has undergone depressurization after level recovery so that flow is not split when the second unit is depressurized. MAAP must be run to confirm that this is a viable option.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.
5	Auto Align 480V AC Portable Station Generator	Auto alignment of the portable 480V AC diesel generator would remove the requirement for the operators to perform the alignment action and increase the reliability of the alternate 480V AC supply. This enhancement would require changes to permanently install the portable generator.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.
6	Procure Spare 480V AC Portable Station Generator	An additional portable 480V AC diesel generator would reduce the impact of 480V AC generator hardware failures.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The averted cost-risk for this SAMA is greater than the cost of implementation and the SAMA is cost beneficial.	The averted cost-risk for this SAMA is greater than the cost of implementation and the SAMA is cost beneficial.
7	Re-Divisionalize ESW Cooling to RHR	Due to a previous change that was implemented to address a plant issue, ESW cooling for RHR is not aligned according to divisional groupings: 1) ESW divisions "A" and "C" provide cooling for RHR pumps "A" and "D", and 2) ESW divisions "B" and "D" provide cooling for RHR pumps "B" and "C". This results in the unavailability of RHR when only the "C" or "D" EDGs are available. Re-piping the cooling paths so that each ESW division cools the corresponding RHR division would eliminate this failure mode. The issue which forced the original ESW change is no longer present at SSES.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.

Table E.6-1 Phase 2 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Pre-EPU Phase 2 Baseline Disposition	Post-EPU Phase 2 Baseline Disposition
8	Automate Feedwater Runback	The largest ATWS contributors for SSES include scenarios in which Feedwater injection is not reduced to lower level. Without Feedwater runback, SLC injection is not credited to prevent core damage. Automating Feedwater flow reduction in ATWS conditions would reduce the failure probability of level control.	SSES Level 1 Importance List (pre-EPU, post-EPU), SSES PRA Group	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.
9	Direct Feeds From the 125V DC Battery Chargers to Critical Loads	Failure of the DC buses prevents powering required loads even when the batteries or chargers are available. Temporary direct feeds from the batteries or chargers to the required loads could be aligned in emergency conditions if the cables are staged in such a way that the alignment could be performed in a short period of time. While this could not likely be done in ATWS or LOCA accidents, transient initiators with loss of injection would allow about 30 to 40 minutes for power alignment.	SSES Level 1 Importance List (pre-EPU, post-EPU), IPEEE Fire Review	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.
10	Install a Pressure Control Valve Between the IA and CIG Systems	The current requirement for plant operators to perform a manual cross-tie between the IA and CIG system on loss of CIG pressure in order to maintain Feedwater/Condensate injection and prevent a plant trip could be eliminated through the installation of the pressure control valve (PCV). The PCV would operate by opening a flowpath from IA system to the CIG system on low CIG pressure; however, a flow limiting orifice would be required in the cross-tie line to prevent depressurizing the IA system in the event that the CIG system ruptures.	SSES Level 1 Importance List (pre-EPU, post-EPU)	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.

Table E.6-1 Phase 2 SAMA

SAMA NUMBER	SAMA TITLE	SAMA DESCRIPTION	SOURCE	Pre-EPU Phase 2 Baseline Disposition	Post-EPU Phase 2 Baseline Disposition
12	Enhance Procedures for Containment Venting After Core Damage When Containment Failure is Imminent	While SSES procedures exist to vent the primary containment irrespective of offsite dose, they are not directly referenced in the EOP flowcharts on high containment pressure given that core damage has occurred. The decision to vent is deferred to the TSC, which may conclude that venting is appropriate even after core damage has occurred and containment failure is imminent. While venting containment would not eliminate a release, it would ensure that the release was scrubbed through the wetwell and reduce the release's impact on the population. The current PRA model does not currently credit venting after core damage, but even if the current procedures were credited, some potential to clarify the EOPs may exist.	SSES Level 2 Importance List (pre-EPU, post-EPU)	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.	The averted cost-risk for this SAMA is less than the cost of implementation and the SAMA is not cost beneficial.
14	Enhance Fire Main Connection to RHR	The reliability of injection with the fire main could be improved by installing a permanent connection to the RHR system that would facilitate local alignment and increase the injection flow rate.	SSES Level 2 Importance List	When credit is taken for the available alternate injection credit, the risk reduction worth value related to Fire Main injection is 1.005 or less, which is well below the 1.02 cutoff value used for SAMA. This SAMA would not be cost beneficial.	When credit is taken for the available alternate injection credit, the risk reduction worth value related to Fire Main injection is 1.005 or less, which is well below the 1.02 cutoff value used for SAMA. This SAMA would not be cost beneficial.

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Addendum 1 Selected Previous Industry SAMAs

SAMA ID Number	SAMA Title	Result of Potential Enhancement
	Improvements Related to RCP Seal LOCAs (Loss of CC or SW)	
1	Cap downstream piping of normally closed component cooling water drain and vent valves.	SAMA would reduce the frequency of a loss of component cooling event, a large portion of which was derived from catastrophic failure of one of the many single isolation valves.
2	Enhance loss of component cooling procedure to facilitate stopping reactor coolant pumps.	SAMA would reduce the potential for reactor coolant pump (RCP) seal damage due to pump bearing failure.
3	Enhance loss of component cooling procedure to present desirability of cooling down reactor coolant system (RCS) prior to seal LOCA.	SAMA would reduce the potential for RCP seal failure.
4	Provide additional training on the loss of component cooling.	SAMA would potentially improve the success rate of operator actions after a loss of component cooling (to restore RCP seal damage).
5	Provide hardware connections to allow another essential raw cooling water system to cool charging pump seals.	SAMA would reduce effect of loss of component cooling by providing a means to maintain the centrifugal charging pump seal injection after a loss of component cooling.
6	Procedure changes to allow cross connection of motor cooling for RHRSW pumps.	SAMA would allow continued operation of both RHRSW pumps on a failure of one train of PSW.
7	Proceduralize shedding component cooling water loads to extend component cooling heatup on loss of essential raw cooling water.	SAMA would increase time before the loss of component cooling (and reactor coolant pump seal failure) in the loss of essential raw cooling water sequences.
8	Increase charging pump lube oil capacity.	SAMA would lengthen the time before centrifugal charging pump failure due to lube oil overheating in loss of CC sequences.

Addendum 1 Selected Previous Industry SAMAs

SAMA ID Number	SAMA Title	Result of Potential Enhancement
9	Eliminate the RCP thermal barrier dependence on component cooling such that loss of component cooling does not result directly in core damage.	SAMA would prevent the loss of recirculation pump seal integrity after a loss of component cooling. Watts Bar Nuclear Plant IPE said that they could do this with essential raw cooling water connection to RCP seals.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
10	Add redundant DC control power for PSW pumps C & D.	SAMA would increase reliability of PSW and decrease core damage frequency due to a loss of SW.
11	Create an independent RCP seal injection system, with a dedicated diesel.	SAMA would add redundancy to RCP seal cooling alternatives, reducing CDF from loss of component cooling or service water or from a station blackout event.
12	Use existing hydro-test pump for RCP seal injection.	SAMA would provide an independent seal injection source, without the cost of a new system.
13	Replace ECCS pump motor with air-cooled motors.	SAMA would eliminate ECCS dependency on component cooling system (but not on room cooling).
14	Install improved RCS pumps seals.	SAMA would reduce probability of RCP seal LOCA by installing RCP seal O-ring constructed of improved materials
15	Install additional component cooling water pump.	SAMA would reduce probability of loss of component cooling leading to RCP seal LOCA.
16	Prevent centrifugal charging pump flow diversion from the relief valves.	SAMA modification would reduce the frequency of the loss of RCP seal cooling if relief valve opening causes a flow diversion large enough to prevent RCP seal injection.
17	Change procedures to isolate RCP seal letdown flow on loss of component cooling, and guidance on loss of injection during seal LOCA.	SAMA would reduce CDF from loss of seal cooling.
18	Implement procedures to stagger high pressure safety injection (HPSI) pump use after a loss of service water.	SAMA would allow HPSI to be extended after a loss of service water.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
19	Use FP system pumps as a backup seal injection and high pressure makeup.	SAMA would reduce the frequency of the RCP seal LOCA and the SBO CDF.
20	Enhance procedural guidance for use of cross-tied component cooling or service water pumps.	SAMA would reduce the frequency of the loss of component cooling water and service water.
21	Procedure enhancements and operator training in support system failure sequences, with emphasis on anticipating problems and coping.	SAMA would potentially improve the success rate of operator actions subsequent to support system failures.
22	Improved ability to cool the residual heat removal heat exchangers.	SAMA would reduce the probability of a loss of decay heat removal by implementing procedure and hardware modifications to allow manual alignment of the FP system or by installing a component cooling water cross-tie.
23	8.a. Additional Service Water Pump	SAMA would conceivably reduce common cause dependencies from SW system and thus reduce plant risk through system reliability improvement.
24	Create an independent RCP seal injection system, without dedicated diesel	This SAMA would add redundancy to RCP seal cooling alternatives, reducing the CDF from loss of CC or SW, but not SBO.
	Improvements Related to Heating, Ventilation, and Air Conditioning	
25	Provide reliable power to control building fans.	SAMA would increase availability of control room ventilation on a loss of power.
26	Provide a redundant train of ventilation.	SAMA would increase the availability of components dependent on room cooling.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
27	Procedures for actions on loss of HVAC.	SAMA would provide for improved credit to be taken for loss of HVAC sequences (improved affected electrical equipment reliability upon a loss of control building HVAC).
28	Add a diesel building switchgear room high temperature alarm.	SAMA would improve diagnosis of a loss of switchgear room HVAC. Option 1: Install high temp alarm. Option 2: Redundant louver and thermostat
29	Create ability to switch fan power supply to DC in an SBO event.	SAMA would allow continued operation in an SBO event. This SAMA was created for reactor core isolation cooling system room at Fitzpatrick Nuclear Power Plant.
30	Enhance procedure to instruct operators to trip unneeded RHR/CS pumps on loss of room ventilation.	SAMA increases availability of required RHR/CS pumps. Reduction in room heat load allows continued operation of required RHR/CS pumps, when room cooling is lost.
31	Stage backup fans in switchgear (SWGR) rooms	This SAMA would provide alternate ventilation in the event of a loss of SWGR Room ventilation
	Improvements Related to Ex-Vessel Accident Mitigation/Containment Phenomena	
32	Delay containment spray actuation after large LOCA.	SAMA would lengthen time of RWST availability.
33	Install containment spray pump header automatic throttle valves.	SAMA would extend the time over which water remains in the RWST, when full Containment Spray flow is not needed
34	Install an independent method of suppression pool cooling.	SAMA would decrease the probability of loss of containment heat removal. For PWRs, a potential similar enhancement would be to install an independent cooling system for sump water.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
35	Develop an enhanced drywell spray system.	SAMA would provide a redundant source of water to the containment to control containment pressure, when used in conjunction with containment heat removal.
36	Provide dedicated existing drywell spray system.	SAMA would provide a source of water to the containment to control containment pressure, when used in conjunction with containment heat removal. This would use an existing spray loop instead of developing a new spray system.
37	Install an unfiltered hardened containment vent.	SAMA would provide an alternate decay heat removal method for non-ATWS events, with the released fission products not being scrubbed.
38	Install a filtered containment vent to remove decay heat.	SAMA would provide an alternate decay heat removal method for non-ATWS events, with the released fission products being scrubbed. Option 1: Gravel Bed Filter Option 2: Multiple Venturi Scrubber
39	Install a containment vent large enough to remove ATWS decay heat.	Assuming that injection is available, this SAMA would provide alternate decay heat removal in an ATWS event.
40	Create/enhance hydrogen recombiners with independent power supply.	SAMA would reduce hydrogen detonation at lower cost, Use either 1) a new independent power supply 2) a nonsafety-grade portable generator 3) existing station batteries 4) existing AC/DC independent power supplies.
41	Install hydrogen recombiners.	SAMA would provide a means to reduce the chance of hydrogen detonation.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
42	Create a passive design hydrogen ignition system.	SAMA would reduce hydrogen denotation system without requiring electric power.
43	Create a large concrete crucible with heat removal potential under the basemat to contain molten core debris.	SAMA would ensure that molten core debris escaping from the vessel would be contained within the crucible. The water cooling mechanism would cool the molten core, preventing a melt-through of the basemat.
44	Create a water-cooled rubble bed on the pedestal.	SAMA would contain molten core debris dropping on to the pedestal and would allow the debris to be cooled.
45	Provide modification for flooding the drywell head.	SAMA would help mitigate accidents that result in the leakage through the drywell head seal.
46	Enhance FP system and/or standby gas treatment system hardware and procedures.	SAMA would improve fission product scrubbing in severe accidents.
47	Create a reactor cavity flooding system.	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing.
48	Create other options for reactor cavity flooding.	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing.
49	Enhance air return fans (ice condenser plants).	SAMA would provide an independent power supply for the air return fans, reducing containment failure in SBO sequences.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
50	Create a core melt source reduction system.	SAMA would provide cooling and containment of molten core debris. Refractory material would be placed underneath the reactor vessel such that a molten core falling on the material would melt and combine with the material. Subsequent spreading and heat removal form the vitrified compound would be facilitated, and concrete attack would not occur
51	Provide a containment inerting capability.	SAMA would prevent combustion of hydrogen and carbon monoxide gases.
52	Use the FP system as a backup source for the containment spray system.	SAMA would provide redundant containment spray function without the cost of installing a new system.
53	Install a secondary containment filtered vent.	SAMA would filter fission products released from primary containment.
54	Install a passive containment spray system.	SAMA would provide redundant containment spray method without high cost.
55	Strengthen primary/secondary containment.	SAMA would reduce the probability of containment overpressurization to failure.
56	Increase the depth of the concrete basemat or use an alternative concrete material to ensure melt-through does not occur.	SAMA would prevent basemat melt-through.
57	Provide a reactor vessel exterior cooling system.	SAMA would provide the potential to cool a molten core before it causes vessel failure, if the lower head could be submerged in water.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
58	Construct a building to be connected to primary/secondary containment that is maintained at a vacuum.	SAMA would provide a method to depressurize containment and reduce fission product release.
59	Refill CST	SAMA would reduce the risk of core damage during events such as extended station blackouts or LOCAs which render the suppression pool unavailable as an injection source due to heat up.
60	Maintain ECCS suction on CST	SAMA would maintain suction on the CST as long as possible to avoid pump failure as a result of high suppression pool temperature
61	Modify containment flooding procedure to restrict flooding to below Top of Active Fuel	SAMA would avoid forcing containment venting
62	Enhance containment venting procedures with respect to timing, path selection and technique.	SAMA would improve likelihood of successful venting strategies.
63	1.a. Severe Accident EPGs/Accident Management Guidelines	SAMA would lead to improved arrest of core melt progress and prevention of containment failure
64	1.h. Simulator Training for Severe Accident	SAMA would lead to improved arrest of core melt progress and prevention of containment failure
65	2.g. Dedicated Suppression Pool Cooling	SAMA would decrease the probability of loss of containment heat removal. While PWRs do not have suppression pools, a similar modification may be applied to the sump. Installation of a dedicated sump cooling system would provide an alternate method of cooling injection water.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
66	3.a. Larger Volume Containment	SAMA increases time before containment failure and increases time for recovery
67	3.b. Increased Containment Pressure Capability (sufficient pressure to withstand severe accidents)	SAMA minimizes likelihood of large releases
68	3.c. Improved Vacuum Breakers (redundant valves in each line)	SAMA reduces the probability of a stuck open vacuum breaker.
69	3.d. Increased Temperature Margin for Seals	This SAMA would reduce containment failure due to drywell head seal failure caused by elevated temperature and pressure.
70	3.e. Improved Leak Detection	This SAMA would help prevent LOCA events by identifying pipes which have begun to leak. These pipes can be replaced before they break.
71	3.f. Suppression Pool Scrubbing	Directing releases through the suppression pool will reduce the radionuclides allowed to escape to the environment.
72	3.g. Improved Bottom Penetration Design	SAMA reduces failure likelihood of RPV bottom head penetrations
73	4.a. Larger Volume Suppression Pool (double effective liquid volume)	SAMA would increase the size of the suppression pool so that heatup rate is reduced, allowing more time for recovery of a heat removal system
74	5.a/d. Unfiltered Vent	SAMA would provide an alternate decay heat removal method with the released fission products not being scrubbed.
75	5.b/c. Filtered Vent	SAMA would provide an alternate decay heat removal method with the released fission products being scrubbed.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
76	6.a. Post Accident Inerting System	SAMA would reduce likelihood of gas combustion inside containment
77	6.b. Hydrogen Control by Venting	Prevents hydrogen detonation by venting the containment before combustible levels are reached.
78	6.c. Pre-inerting	SAMA would reduce likelihood of gas combustion inside containment
79	6.d. Ignition Systems	Burning combustible gases before they reach a level which could cause a harmful detonation is a method of preventing containment failure.
80	6.e. Fire Suppression System Inerting	Use of the FP system as a back up containment inerting system would reduce the probability of combustible gas accumulation. This would reduce the containment failure probability for small containments (e.g. BWR MKI).
81	7.a. Drywell Head Flooding	SAMA would provide intentional flooding of the upper drywell head such that if high drywell temperatures occurred, the drywell head seal would not fail.
82	7.b. Containment Spray Augmentation	This SAMA would provide additional means of providing flow to the containment spray system.
83	12.b. Integral Basemat	This SAMA would improve containment and system survivability for seismic events.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
84	13.a. Reactor Building Sprays	This SAMA provides the capability to use firewater sprays in the reactor building to mitigate release of fission products into the Rx Bldg following an accident.
85	14.a. Flooded Rubble Bed	SAMA would contain molten core debris dropping on to the pedestal and would allow the debris to be cooled.
86	14.b. Reactor Cavity Flooder	SAMA would enhance debris coolability, reduce core concrete interaction, and provide fission product scrubbing.
87	14.c. Basaltic Cements	SAMA minimizes carbon dioxide production during core concrete interaction.
88	Provide a core debris control system	(Intended for ice condenser plants): This SAMA would prevent the direct core debris attack of the primary containment steel shell by erecting a barrier between the seal table and the containment shell.
89	Add ribbing to the containment shell	This SAMA would reduce the risk of buckling of containment under reverse pressure loading.
	Improvements Related to Enhanced AC/DC Reliability/Availability	
90	Proceduralize alignment of spare diesel to shutdown board after loss of offsite power and failure of the diesel normally supplying it.	SAMA would reduce the SBO frequency.
91	Provide an additional diesel generator.	SAMA would increase the reliability and availability of onsite emergency AC power sources.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
92	Provide additional DC battery capacity.	SAMA would ensure longer battery capability during an SBO, reducing the frequency of long-term SBO sequences.
93	Use fuel cells instead of lead-acid batteries.	SAMA would extend DC power availability in an SBO.
94	Procedure to cross-tie high pressure core spray diesel.	SAMA would improve core injection availability by providing a more reliable power supply for the high pressure core spray pumps.
95	Improve 4.16-kV bus cross-tie ability.	SAMA would improve AC power reliability.
96	Incorporate an alternate battery charging capability.	SAMA would improve DC power reliability by either cross-tying the AC busses, or installing a portable diesel-driven battery charger.
97	Increase/improve DC bus load shedding.	SAMA would extend battery life in an SBO event.
98	Replace existing batteries with more reliable ones.	SAMA would improve DC power reliability and thus increase available SBO recovery time.
99	Mod for DC Bus A reliability.	SAMA would increase the reliability of AC power and injection capability. Loss of DC Bus A causes a loss of main condenser prevents transfer from the main transformer to offsite power, and defeats one half of the low vessel pressure permissive for LPCI/CS injection valves.
100	Create AC power cross-tie capability with other unit.	SAMA would improve AC power reliability.
101	Create a cross-tie for diesel fuel oil.	SAMA would increase diesel fuel oil supply and thus diesel generator, reliability.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
102	Develop procedures to repair or replace failed 4-kV breakers.	SAMA would offer a recovery path from a failure of the breakers that perform transfer of 4.16-kV non-emergency busses from unit station service transformers, leading to loss of emergency AC power.
103	Emphasize steps in recovery of offsite power after an SBO.	SAMA would reduce human error probability during offsite power recovery.
104	Develop a severe weather conditions procedure.	For plants that do not already have one, this SAMA would reduce the CDF for external weather-related events.
105	Develop procedures for replenishing diesel fuel oil.	SAMA would allow for long-term diesel operation.
106	Install gas turbine generator.	SAMA would improve onsite AC power reliability by providing a redundant and diverse emergency power system.
107	Create a backup source for diesel cooling. (Not from existing system)	This SAMA would provide a redundant and diverse source of cooling for the diesel generators, which would contribute to enhanced diesel reliability.
108	Use FP system as a backup source for diesel cooling.	This SAMA would provide a redundant and diverse source of cooling for the diesel generators, which would contribute to enhanced diesel reliability.
109	Provide a connection to an alternate source of offsite power.	SAMA would reduce the probability of a loss of offsite power event.
110	Bury offsite power lines.	SAMA could improve offsite power reliability, particularly during severe weather.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
111	Replace anchor bolts on diesel generator oil cooler.	Millstone Nuclear Power Station found a high seismic SBO risk due to failure of the diesel oil cooler anchor bolts. For plants with a similar problem, this would reduce seismic risk. Note that these were Fairbanks Morse DGs.
112	Change undervoltage (UV), auxiliary feedwater actuation signal (AFAS) block and high pressurizer pressure actuation signals to 3-out-of-4, instead of 2-out-of-4 logic.	SAMA would reduce risk of 2/4 inverter failure.
113	Provide DC power to the 120/240-V vital AC system from the Class 1E station service battery system instead of its own battery.	SAMA would increase the reliability of the 120-VAC Bus.
114	Bypass Diesel Generator Trips	SAMA would allow D/Gs to operate for longer.
115	2.i. 16 hour Station Blackout Injection	SAMA includes improved capability to cope with longer station blackout scenarios.
116	9.a. Steam Driven Turbine Generator	This SAMA would provide a steam driven turbine generator which uses reactor steam and exhausts to the suppression pool. If large enough, it could provide power to additional equipment.
117	9.b. Alternate Pump Power Source	This SAMA would provide a small dedicated power source such as a dedicated diesel or gas turbine for the feedwater or condensate pumps, so that they do not rely on offsite power.
118	9.d. Additional Diesel Generator	SAMA would reduce the SBO frequency.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
119	9.e. Increased Electrical Divisions	SAMA would provide increased reliability of AC power system to reduce core damage and release frequencies.
120	9.f. Improved Uninterruptable Power Supplies	SAMA would provide increased reliability of power supplies supporting front-line equipment, thus reducing core damage and release frequencies.
121	9.g. AC Bus Cross-Ties	SAMA would provide increased reliability of AC power system to reduce core damage and release frequencies.
122	9.h. Gas Turbine	SAMA would improve onsite AC power reliability by providing a redundant and diverse emergency power system.
123	9.i. Dedicated RHR (bunkered) Power Supply	SAMA would provide RHR with more reliable AC power.
124	10.a. Dedicated DC Power Supply	This SAMA addresses the use of a diverse DC power system such as an additional battery or fuel cell for the purpose of providing motive power to certain components (e.g., RCIC).
125	10.b. Additional Batteries/Divisions	This SAMA addresses the use of a diverse DC power system such as an additional battery or fuel cell for the purpose of providing motive power to certain components (e.g., RCIC).
126	10.c. Fuel Cells	SAMA would extend DC power availability in an SBO.
127	10.d. DC Cross-ties	This SAMA would improve DC power reliability.
128	10.e. Extended Station Blackout Provisions	SAMA would provide reduction in SBO sequence frequencies.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
129	Add an automatic bus transfer feature to allow the automatic transfer of the 120V vital AC bus from the on-line unit to the standby unit	Plants are typically sensitive to the loss of one or more 120V vital AC buses. Manual transfers to alternate power supplies could be enhanced to transfer automatically.
	Improvements in Identifying and Mitigating Containment Bypass	
130	Install a redundant spray system to depressurize the primary system during a steam generator tube rupture (SGTR).	SAMA would enhance depressurization during a SGTR.
131	Improve SGTR coping abilities.	SAMA would improve instrumentation to detect SGTR, or additional system to scrub fission product releases.
132	Add other SGTR coping abilities.	SAMA would decrease the consequences of an SGTR.
133	Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	SAMA would eliminate direct release pathway for SGTR sequences.
134	Replace steam generators (SG) with a new design.	SAMA would lower the frequency of an SGTR.
135	Revise EOPs to direct that a faulted SG be isolated.	SAMA would reduce the consequences of an SGTR.
136	Direct SG flooding after a SGTR, prior to core damage.	SAMA would provide for improved scrubbing of SGTR releases.
137	Implement a maintenance practice that inspects 100% of the tubes in a SG.	SAMA would reduce the potential for an SGTR.
138	Locate residual heat removal (RHR) inside of containment.	SAMA would prevent intersystem LOCA (ISLOCA) out the RHR pathway.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
139	Install additional instrumentation for ISLOCAs.	SAMA would decrease ISLOCA frequency by installing pressure of leak monitoring instruments in between the first two pressure isolation valves on low-pressure inject lines, RHR suction lines, and HPSI lines.
140	Increase frequency for valve leak testing.	SAMA could reduce ISLOCA frequency.
141	Improve operator training on ISLOCA coping.	SAMA would decrease ISLOCA effects.
142	Install relief valves in the CC System.	SAMA would relieve pressure buildup from an RCP thermal barrier tube rupture, preventing an ISLOCA.
143	Provide leak testing of valves in ISLOCA paths.	SAMA would help reduce ISLOCA frequency. At Kewaunee Nuclear Power Plant, four MOVs isolating RHR from the RCS were not leak tested.
144	Revise EOPs to improve ISLOCA identification.	SAMA would ensure LOCA outside containment could be identified as such. Salem Nuclear Power Plant had a scenario where an RHR ISLOCA could direct initial leakage back to the pressurizer relief tank, giving indication that the LOCA was inside containment.
145	Ensure all ISLOCA releases are scrubbed.	SAMA would scrub all ISLOCA releases. One example is to plug drains in the break area so that the break point would be covered with water.
146	Add redundant and diverse limit switches to each containment isolation valve.	SAMA could reduce the frequency of containment isolation failure and ISLOCAs through enhanced isolation valve position indication.
147	Early detection and mitigation of ISLOCA	SAMA would limit the effects of ISLOCA accidents by early detection and isolation

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
148	8.e. Improved MSIV Design	This SAMA would improve isolation reliability and reduce spurious actuations that could be initiating events.
149	Proceduralize use of pressurizer vent valves during steam generator tube rupture (SGTR) sequences	Some plants may have procedures to direct the use of pressurizer sprays to reduce RCS pressure after an SGTR. Use of the vent valves would provide a back-up method.
150	Implement a maintenance practice that inspects 100% of the tubes in an SG	This SAMA would reduce the potential for a tube rupture.
151	Locate RHR inside of containment	This SAMA would prevent ISLOCA out the RHR pathway.
152	Install self-actuating containment isolation valves	For plants that do not have this, it would reduce the frequency of isolation failure.
	Improvements in Reducing Internal Flooding Frequency	
153	Modify swing direction of doors separating turbine building basement from areas containing safeguards equipment.	SAMA would prevent flood propagation, for a plant where internal flooding from turbine building to safeguards areas is a concern.
154	Improve inspection of rubber expansion joints on main condenser.	SAMA would reduce the frequency of internal flooding, for a plant where internal flooding due to a failure of circulating water system expansion joints is a concern.
155	Implement internal flood prevention and mitigation enhancements.	This SAMA would reduce the consequences of internal flooding.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
156	Implement internal flooding improvements such as those implemented at Fort Calhoun.	This SAMA would reduce flooding risk by preventing or mitigating rupture in the RCP seal cooler of the component cooling system and ISLOCA in a shutdown cooling line, an auxiliary feedwater (AFW) flood involving the need to remove a watertight door.
157	Shield electrical equipment from potential water spray	SAMA would decrease risk associated with seismically induced internal flooding
158	13.c. Reduction in Reactor Building Flooding	This SAMA reduces the Reactor Building Flood Scenarios contribution to core damage and release.
	Improvements Related to Feedwater/Feed and Bleed Reliability/Availability	
159	Install a digital feedwater upgrade.	This SAMA would reduce the chance of a loss of main feedwater following a plant trip.
160	Perform surveillances on manual valves used for backup AFW pump suction.	This SAMA would improve success probability for providing alternative water supply to the AFW pumps.
161	Install manual isolation valves around AFW turbine-driven steam admission valves.	This SAMA would reduce the dual turbine-driven AFW pump maintenance unavailability.
162	Install accumulators for turbine-driven AFW pump flow control valves (CVs).	This SAMA would provide control air accumulators for the turbine-driven AFW flow CVs, the motor-driven AFW pressure CVs and SG power-operated relief valves (PORVs). This would eliminate the need for local manual action to align nitrogen bottles for control air during a LOOP.
163	Install separate accumulators for the AFW cross-connect and block valves	This SAMA would enhance the operator's ability to operate the AFW cross-connect and block valves following loss of air support.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
164	Install a new condensate storage tank (CST)	Either replace the existing tank with a larger one, or install a back-up tank.
165	Provide cooling of the steam-driven AFW pump in an SBO event	This SAMA would improve success probability in an SBO by: (1) using the FP system to cool the pump, or (2) making the pump self cooled.
166	Proceduralize local manual operation of AFW when control power is lost.	This SAMA would lengthen AFW availability in an SBO. Also provides a success path should AFW control power be lost in non-SBO sequences.
167	Provide portable generators to be hooked into the turbine driven AFW, after battery depletion.	This SAMA would extend AFW availability in an SBO (assuming the turbine driven AFW requires DC power)
168	Add a motor train of AFW to the Steam trains	For PWRs that do not have any motor trains of AFW, this would increase reliability in non-SBO sequences.
169	Create ability for emergency connections of existing or alternate water sources to feedwater/condensate	This SAMA would be a back-up water supply for the feedwater/condensate systems.
170	Use FP system as a back-up for SG inventory	This SAMA would create a back-up to main and AFW for SG water supply.
171	Procure a portable diesel pump for isolation condenser make-up	This SAMA would provide a back-up to the city water supply and diesel FP system pump for isolation condenser make-up.
172	Install an independent diesel generator for the CST make-up pumps	This SAMA would allow continued inventory make-up to the CST during an SBO.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
173	Change failure position of condenser make-up valve	This SAMA would allow greater inventory for the AFW pumps by preventing CST flow diversion to the condenser if the condenser make-up valve fails open on loss of air or power.
174	Create passive secondary side coolers.	This SAMA would reduce CDF from the loss of Feedwater by providing a passive heat removal loop with a condenser and heat sink.
175	Replace current PORVs with larger ones such that only one is required for successful feed and bleed.	This SAMA would reduce the dependencies required for successful feed and bleed.
176	Install motor-driven feedwater pump.	SAMA would increase the availability of injection subsequent to MSIV closure.
177	Use Main FW pumps for a Loss of Heat Sink Event	This SAMA involves a procedural change that would allow for a faster response to loss of the secondary heat sink. Use of only the feedwater booster pumps for injection to the SGs requires depressurization to about 350 psig; before the time this pressure is reached, conditions would be met for initiating feed and bleed. Using the available turbine driven feedwater pumps to inject water into the SGs at a high pressure rather than using the feedwater booster alone allows injection without the time consuming depressurization.
	Improvements in Core Cooling Systems	
178	Provide the capability for diesel driven, low pressure vessel make-up	This SAMA would provide an extra water source in sequences in which the reactor is depressurized and all other injection is unavailable (e.g., FP system)

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
179	Provide an additional HPSI pump with an independent diesel	This SAMA would reduce the frequency of core melt from small LOCA and SBO sequences
180	Install an independent AC HPSI system	This SAMA would allow make-up and feed and bleed capabilities during an SBO.
181	Create the ability to manually align ECCS recirculation	This SAMA would provide a back-up should automatic or remote operation fail.
182	Implement an RWT make-up procedure	This SAMA would decrease CDF from ISLOCA scenarios, some smaller break LOCA scenarios, and SGTR.
183	Stop low pressure safety injection pumps earlier in medium or large LOCAs.	This SAMA would provide more time to perform recirculation swap over.
184	Emphasize timely swap over in operator training.	This SAMA would reduce human error probability of recirculation failure.
185	Upgrade Chemical and Volume Control System to mitigate small LOCAs.	For a plant like the AP600 where the Chemical and Volume Control System cannot mitigate a Small LOCA, an upgrade would decrease the Small LOCA CDF contribution.
186	Install an active HPSI system.	For a plant like the AP600 where an active HPSI system does not exist, this SAMA would add redundancy in HPSI.
187	Change "in-containment" RWT suction from 4 check valves to 2 check and 2 air operated valves.	This SAMA would remove common mode failure of all four injection paths.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
188	Replace 2 of the 4 safety injection (SI) pumps with diesel-powered pumps.	This SAMA would reduce the SI system common cause failure probability. This SAMA was intended for the System 80+, which has four trains of SI.
189	Align low pressure core injection or core spray to the CST on loss of suppression pool cooling.	This SAMA would help to ensure low pressure ECCS can be maintained in loss of suppression pool cooling scenarios.
190	Raise high pressure core injection/reactor core isolation cooling backpressure trip setpoints	This SAMA would ensure high pressure core injection/reactor core isolation cooling availability when high suppression pool temperatures exist.
191	Improve the reliability of the automatic depressurization system.	This SAMA would reduce the frequency of high pressure core damage sequences.
192	Disallow automatic vessel depressurization in non-ATWS scenarios	This SAMA would improve operator control of the plant.
193	Create automatic swap over to recirculation on RWT depletion	This SAMA would reduce the human error contribution from recirculation failure.
194	Proceduralize intermittent operation of HPCI.	SAMA would allow for extended duration of HPCI availability.
195	Increase available net positive suction head (NPSH) for injection pumps.	SAMA increases the probability that these pumps will be available to inject coolant into the vessel by increasing the available NPSH for the injection pumps.
196	Modify Reactor Water Cleanup (RWCU) for use as a decay heat removal system and proceduralize use.	SAMA would provide an additional source of decay heat removal.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
197	CRD Injection	SAMA would supply an additional method of level restoration by using a non-safety system.
198	Condensate Pumps for Injection	SAMA to provide an additional option for coolant injection when other systems are unavailable or inadequate
199	Align EDG to CRD for Injection	SAMA to provide power to an additional injection source during loss of power events
200	Re-open MSIVs	SAMA to regain the main condenser as a heat sink by re-opening the MSIVs.
201	Bypass RCIC Turbine Exhaust Pressure Trip	SAMA would allow RCIC to operate longer.
202	2.a. Passive High Pressure System	SAMA will improve prevention of core melt sequences by providing additional high pressure capability to remove decay heat through an isolation condenser type system
203	2.c. Suppression Pool Jockey Pump	SAMA will improve prevention of core melt sequences by providing a small makeup pump to provide low pressure decay heat removal from the RPV using the suppression pool as a source of water.
204	2.d. Improved High Pressure Systems	SAMA will improve prevention of core melt sequences by improving reliability of high pressure capability to remove decay heat.
205	2.e. Additional Active High Pressure System	SAMA will improve reliability of high pressure decay heat removal by adding an additional system.
206	2.f. Improved Low Pressure System (Firepump)	SAMA would provide FP system pump(s) for use in low pressure scenarios.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
207	4.b. Clean Up Water Decay Heat Removal	This SAMA provides a means for Alternate Decay Heat Removal.
208	4.c. High Flow Suppression Pool Cooling	SAMA would improve suppression pool cooling.
209	8.c. Diverse Injection System	SAMA will improve prevention of core melt sequences by providing additional injection capabilities.
210	Alternate Charging Pump Cooling	This SAMA will improve the high pressure core flooding capabilities by providing the SI pumps with alternate gear and oil cooling sources. Given a total loss of Chilled Water, abnormal operating procedures would direct alignment of preferred Demineralized Water or the Fire System to the Chilled Water System to provide cooling to the SI pumps' gear and oil box (and the other normal loads).
	Instrument Air/Gas Improvements	
211	Modify EOPs for ability to align diesel power to more air compressors.	For plants that do not have diesel power to all normal and back-up air compressors, this change would increase the reliability of IA after a LOOP.
212	Replace old air compressors with more reliable ones	This SAMA would improve reliability and increase availability of the IA compressors.
213	Install nitrogen bottles as a back-up gas supply for safety relief valves.	This SAMA would extend operation of safety relief valves during an SBO and loss of air events (BWRs).
214	Allow cross connection of uninterruptible compressed air supply to opposite unit.	SAMA would increase the ability to vent containment using the hardened vent.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
	ATWS Mitigation	
215	Install MG set trip breakers in control room	This SAMA would provide trip breakers for the MG sets in the control room. In some plants, MG set breaker trip requires action to be taken outside of the control room. Adding control capability to the control room would reduce the trip failure probability in sequences where immediate action is required (e.g., ATWS).
216	Add capability to remove power from the bus powering the control rods	This SAMA would decrease the time to insert the control rods if the reactor trip breakers fail (during a loss of FW ATWS which has a rapid pressure excursion)
217	Create cross-connect ability for standby liquid control trains	This SAMA would improve reliability for boron injection during an ATWS event.
218	Create an alternate boron injection capability (back-up to standby liquid control)	This SAMA would improve reliability for boron injection during an ATWS event.
219	Remove or allow override of low pressure core injection during an ATWS	On failure on high pressure core injection and condensate, some plants direct reactor depressurization followed by 5 minutes of low pressure core injection. This SAMA would allow control of low pressure core injection immediately.
220	Install a system of relief valves that prevents any equipment damage from a pressure spike during an ATWS	This SAMA would improve equipment availability after an ATWS.
221	Create a boron injection system to back up the mechanical control rods.	This SAMA would provide a redundant means to shut down the reactor.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
222	Provide an additional instrument system for ATWS mitigation (e.g., ATWS mitigation scram actuation circuitry).	This SAMA would improve instrument and control redundancy and reduce the ATWS frequency.
223	Increase the safety relief valve (SRV) reseat reliability.	SAMA addresses the risk associated with dilution of boron caused by the failure of the SRVs to reseat after standby liquid control (SBLC) injection.
224	Use control rod drive for alternate boron injection.	SAMA provides an additional system to address ATWS with SBLC failure or unavailability.
225	Bypass MSIV isolation in Turbine Trip ATWS scenarios	SAMA will afford operators more time to perform actions. The discharge of a substantial fraction of steam to the main condenser (i.e., as opposed to into the primary containment) affords the operator more time to perform actions (e.g., SBLC injection, lower water level, depressurize RPV) than if the main condenser was unavailable, resulting in lower human error probabilities
226	Enhance operator actions during ATWS	SAMA will reduce human error probabilities during ATWS
227	Guard against SBLC dilution	SAMA to control vessel injection to prevent boron loss or dilution following SBLC injection.
228	11.a. ATWS Sized Vent	This SAMA would be providing the ability to remove reactor heat from ATWS events.
229	11.b. Improved ATWS Capability	This SAMA includes items which reduce the contribution of ATWS to core damage and release frequencies.
	Other Improvements	

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
230	Provide capability for remote operation of secondary side relief valves in an SBO	Manual operation of these valves is required in an SBO scenario. High area temperatures may be encountered in this case (no ventilation to main steam areas), and remote operation could improve success probability.
231	Create/enhance RCS depressurization ability	With either a new depressurization system, or with existing PORVs, head vents, and secondary side valve, RCS depressurization would allow earlier low pressure ECCS injection. Even if core damage occurs, low RCS pressure would alleviate some concerns about high pressure melt ejection.
232	Make procedural changes only for the RCS depressurization option	This SAMA would reduce RCS pressure without the cost of a new system
233	Defeat 100% load rejection capability.	This SAMA would eliminate the possibility of a stuck open PORV after a LOOP, since PORV opening would not be needed.
234	Change control rod drive flow control valve failure position	Change failure position to the "fail-safest" position.
235	Install secondary side guard pipes up to the MSIVs	This SAMA would prevent secondary side depressurization should a steam line break occur upstream of the main steam isolation valves. This SAMA would also guard against or prevent consequential multiple SGTR following a Main Steam Line Break event.
236	Install digital large break LOCA protection	Upgrade plant instrumentation and logic to improve the capability to identify symptoms/precursors of a large break LOCA (leak before break).

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
237	Increase seismic capacity of the plant to a high confidence, low pressure failure of twice the Safe Shutdown Earthquake.	This SAMA would reduce seismically -induced CDF.
238	Enhance the reliability of the demineralized water (DW) make-up system through the addition of diesel-backed power to one or both of the DW make-up pumps.	Inventory loss due to normal leakage can result in the failure of the CC and the SRW systems. Loss of CC could challenge the RCP seals. Loss of SRW results in the loss of three EDGs and the containment air coolers (CACs).
239	Increase the reliability of safety relief valves by adding signals to open them automatically.	SAMA reduces the probability of a certain type of medium break LOCA. Hatch evaluated medium LOCA initiated by an MSIV closure transient with a failure of SRVs to open. Reducing the likelihood of the failure for SRVs to open, subsequently reduces the occurrence of this medium LOCA.
240	Reduce DC dependency between high pressure injection system and ADS.	SAMA would ensure containment depressurization and high pressure injection upon a DC failure.
241	Increase seismic ruggedness of plant components.	SAMA would increase the availability of necessary plant equipment during and after seismic events.
242	Enhance RPV depressurization capability	SAMA would decrease the likelihood of core damage in loss of high pressure coolant injection scenarios
243	Enhance RPV depressurization procedures	SAMA would decrease the likelihood of core damage in loss of high pressure coolant injection scenarios
244	Replace mercury switches on FP systems	SAMA would decrease probability of spurious fire suppression system actuation given a seismic event+D114

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
245	Provide additional restraints for CO_2 tanks	SAMA would increase availability of FP given a seismic event.
246	Enhance control of transient combustibles	SAMA would minimize risk associated with important fire areas.
247	Enhance fire brigade awareness	SAMA would minimize risk associated with important fire areas.
248	Upgrade fire compartment barriers	SAMA would minimize risk associated with important fire areas.
249	Enhance procedures to allow specific operator actions	SAMA would minimize risk associated with important fire areas.
250	Develop procedures for transportation and nearby facility accidents	SAMA would minimize risk associated with transportation and nearby facility accidents.
251	Enhance procedures to mitigate Large LOCA	SAMA would minimize risk associated with Large LOCA
252	1.b. Computer Aided Instrumentation	SAMA will improve prevention of core melt sequences by making operator actions more reliable.
253	1.c/d. Improved Maintenance Procedures/Manuals	SAMA will improve prevention of core melt sequences by increasing reliability of important equipment
254	1.e. Improved Accident Management Instrumentation	SAMA will improve prevention of core melt sequences by making operator actions more reliable.
255	1.f. Remote Shutdown Station	This SAMA would provide the capability to control the reactor in the event that evacuation of the main control room is required.
256	1.g. Security System	Improvements in the site's security system would decrease the potential for successful sabotage.

Addendum 1 SELECTED PREVIOUS INDUSTRY SAMAs (continued)

SAMA ID Number	SAMA Title	Result of Potential Enhancement
257	2.b. Improved Depressurization	SAMA will improve depressurization system to allow more reliable access to low pressure systems.
258	2.h. Safety Related Condensate Storage Tank	SAMA will improve availability of CST following a Seismic event
259	4.d. Passive Overpressure Relief	This SAMA would prevent vessel overpressurization.
260	8.b. Improved Operating Response	Improved operator reliability would improve accident mitigation and prevention.
261	8.d. Operation Experience Feedback	This SAMA would identify areas requiring increased attention in plant operation through review of equipment performance.
262	8.e. Improved SRV Design	This SAMA would improve SRV reliability, thus increasing the likelihood that sequences could be mitigated using low pressure heat removal.
263	12.a. Increased Seismic Margins	This SAMA would reduce the risk of core damage and release during seismic events.
264	13.b. System Simplification	This SAMA is intended to address system simplification by the elimination of unnecessary interlocks, automatic initiation of manual actions or redundancy as a means to reduce overall plant risk.
265	Train operations crew for response to inadvertent actuation signals	This SAMA would improve chances of a successful response to the loss of two 120V AC buses, which may cause inadvertent signal generation.
266	Install tornado protection on gas turbine generators	This SAMA would improve onsite AC power reliability.

ATTACHMENT F
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

Pennsylvania Department of Environmental Protection

2 Public Square
Wilkes-Barre, PA 18711-0790
August 5, 2005

Northeast Regional Office

570-826-2511
Fax 570-830-3016

Mr. Britt T. McKinney
VP-Nuclear Site Operations
PPL Susquehanna, LLC
769 Salem Boulevard
Berwick, PA 18603-0467

Re: Industrial Waste
PPL Susquehanna, LLC
NPDES Permit No. PA-0047325
APS ID No. 542214
Authorization ID No. 578109
Salem Township, Luzerne County

Dear Mr. McKinney:

Your permit is enclosed.

As part of Pennsylvania's effort to prevent localized impairment, help restore impaired waters, and remove the Chesapeake Bay and its tidal tributaries from the list of impaired waters under the Clean Water Act by the year 2010, the Department of Environmental Protection (DEP) has begun to implement a strategy for reducing our nutrient and sediment loads from the Susquehanna and Potomac River watersheds. As such, the Department has placed monitoring requirements for Total Nitrogen (TN) and Total Phosphorus (TP) in your NPDES permit renewal. Monitoring of nutrient loads discharged from each point source facility is critical to documenting our progress in the restoration effort. Monitoring also helps identify the type of effort you may need to undertake to achieve any future nutrient load reductions.

Please be advised that under 25 Pa. Code §92.8a(a) of the Department's Rules and Regulations, we are notifying you that new cap load limits for TN and TP may change your existing treatment requirements. You will be advised once the cap load limits have been developed for your facility, and how those new limits will be incorporated into your NPDES permit.

Any person aggrieved by this action may appeal, pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. Section 7514, and the Administrative Agency Law, 2 Pa. C.S., Chapter 5A, to the Environmental Hearing Board, Second Floor, Rachel Carson State Office Building, 400 Market Street, P.O. Box 8457, Harrisburg, PA 17105-8457, 717-787-3483. TDD users may contact the Board through the Pennsylvania Relay Service, 800-654-5984. Appeals must be filed with the Environmental Hearing Board within 30 days of receipt of written notice of this action unless the appropriate statute provides a different time period. Copies of the appeal form and the Board's rules of practice and procedure may be obtained from the Board. The appeal form and the Board's rules of practice and procedure are also available in Braille or on audiotape from the Secretary to the Board at 717-787-3483. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST REACH THE BOARD WITHIN 30 DAYS. YOU DO NOT NEED A LAWYER TO FILE AN APPEAL WITH THE BOARD.

Mr. Britt T. McKinney -2- August 5, 2005

IMPORTANT LEGAL RIGHTS ARE AT STAKE, HOWEVER, SO YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD (717-787-3483) FOR MORE INFORMATION.

If you have any questions, please call Brian F. Busher, P.E. at 570-826-2306.

Sincerely

Kate Crowley

Kate Crowley
Program Manager
Water Management Program

Enclosures

cc: U.S. Environmental Protection Agency

3800-PM-WSWM0011 Rev. 4/2005
Permit

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER SUPPLY AND WASTEWATER MANAGEMENT

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM DISCHARGE REQUIREMENTS FOR INDUSTRIAL WASTEWATER FACILITIES

NPDES PERMIT NO: PA-0047325

In compliance with the provisions of the Clean Water Act, 33 U.S.C. Section 1251 *et seq.* ("the Act") and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 *et seq.*,

PPL Susquehanna, LLC
769 Salem Boulevard
Berwick, PA 18603-0467

is authorized to discharge from a facility known as **Susquehanna Steam Electric Station**, located in **Salem Township, Luzerne County** to the **Susquehanna River** in Watershed **5B** in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts A, B and C hereof.

THIS PERMIT SHALL BECOME EFFECTIVE ON September 1, 2005

THIS PERMIT SHALL EXPIRE AT MIDNIGHT ON August 31, 2010

The authority granted by this permit is subject to the following further qualifications:

1. If there is a conflict between the application, its supporting documents and/or amendments and the terms and conditions of this permit, the terms and conditions shall apply.

2. Failure to comply with the terms, conditions, or effluent limitations of this permit is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

3. A complete application for reissuance of this permit, or notice of intent to cease discharging by the expiration date, must be submitted to DEP at least 180 days prior to the above expiration date (unless permission has been granted by DEP for submission at a later date), using the appropriate NPDES permit application form.

   In the event that a timely and complete application for reissuance has been submitted and DEP is unable, through no fault of the permittee, to reissue the permit before the above expiration date, the terms and conditions of this permit, including submission of the Discharge Monitoring Reports (DMRs), will be automatically continued and will remain fully effective and enforceable against the discharger until DEP takes final action on the pending permit application.

4. This NPDES permit does not constitute authorization to construct or make modifications to wastewater treatment facilities necessary to meet the terms and conditions of this permit.

DATE PERMIT ISSUED August 5, 2005

ISSUED BY Kate Crowley
Water Management Program Manager

DATE PERMIT AMENDMENT ISSUED ____________