5 SUMMARY OF PROJECTED L-REACTOR RELEASES AND IMPACTS

Before L-Reactor was placed in standby status, its operation resulted in various impacts to its environment. During the period of reactor standby, the environment, principally the Steel Creek and delta system, has experienced a continuing successional recovery process. The resumption of L-Reactor operations is expected to affect predominantly those areas affected by past reactor operations. This chapter summarizes the environmental releases and impacts of pre-1968 and post-1984 L-Reactor operations.

5.1 SUMMARY OF PRE-1968 AND POST-1984 RELEASES

The resumption of L-Reactor operations will result in radioactive and nonradioactive releases to the environment. This section compares atmospheric, liquid, radiocesium, and other releases that occurred during previous operation to the releases expected after startup.

5.1.1 Nonradiological releases

5.1.1.1 Thermal discharge

Between 1954 and 1968, Steel Creek was subjected to varying amounts of thermal effluent discharges from P- and L-Reactors (Table 5-1). These discharges ranged in temperature from almost 80°C at the reactors to less than 50°C at the entrance to the Savannah River swamp.

Table 5-1. Reactor discharges to Steel Creek (cubic meters per second)[a]

Years	P-Reactor	L-Reactor	Total
1954-1958	5.6	5.7	11.3
1958-early 1961	9.3	9.3	18.6
Mid-1961	11.3	11.3	22.6
Late 1961-late 1963	9.3	11.3	20.6
Late 1963-February 1968	0.4[b]	11.3	11.7
February 1968-present	0.4[b]	0	0.4[b]

a. Source: du Pont, 1982.
b. Flow from P-Area process waste discharge at about ambient temperature.

From late 1963 (after P-Reactor discharges were diverted to Par Pond) until L-Reactor was placed in standby status, the maximum observed temperature increase in the Savannah River was 2.7°C (Table 5-2). This increase was due to the combined thermal discharges of K-, C-, and L-Reactors. The resumption of L-Reactor operation is expected to result in a similar thermal effluent discharge and a temperature increase in the Savannah River equivalent to that experienced during earlier operations.

Table 5-2. Maximum temperature increase of Savannah River caused by operations of the Savannah River Plant reactors[a]

Year ending May 31	Date of maximum temperature increase	Temperature increase (°C)
1959	May 4, 1959	2.4
1960	May 31, 1960	2.1
1961	Dec. 11, 1960	3.2
1962	June 11, 1961	3.2
1963	Mar. 4, 1963	3.2
1964	June 15, 1963	2.0
1965	June 22, 1964	2.0
1966	May 2, 1966	2.7
1967	May 28, 1967	2.2

a. Reactor history 1959-1968:

- R-Reactor discharged to Lower Three Runs Creek prior to 1959, and to Par Pond until placed on standby in 1964.
- P-Reactor discharged to Steel Creek until late 1963 when its discharge was diverted to Par Pond.
- L-Reactor discharged to Steel Creek until February 1968 when it was placed on standby.
- K-Reactor discharging to Pen Branch.
- C-Reactor discharging to Four Mile Creek.

5.1.1.2 Chemical releases

Before L-Reactor was placed in standby status in 1968, all sanitary waste was directed to a septic tank that discharged its liquid effluent directly to Steel Creek. When L-Reactor operations resume, all sanitary waste will be directed to a secondary wastewater-treatment plant. The output from this plant will be chlorinated and discharged through the process sewer along with the thermal effluent to Steel Creek.

During previous L-Reactor operations, bottom ash from a coal-fired steam boiler in the L-Reactor area was sluiced to an ash basin in that area. The L-Area powerhouse was dismantled after the reactor was placed in standby status. Process steam for the resumption of L-Reactor operations will be supplied by the steam plant in the K-Reactor area. Incrementally, this will increase the K-Reactor area ash discharge to the K-Reactor area ash basin by about 15 percent.

5.1.1.3 Atmospheric releases

The resumption of L-Reactor operations will increase the amount of air pollutants emitted from the K-Reactor area steam-generating plant, and the continuously operating emergency diesels in the L-Reactor area. The emergency diesel generators are expected to have atmospheric releases similar to those emitted before 1968. Reductions in atmospheric emissions are expected to occur because the K-Reactor steam-generating plant will be used to supply process steam for the resumption of L-Reactor operations rather than the L-Reactor coal-fired plant that was used prior to 1968. With the higher loading on the K-Reactor area coal-fired boilers, which are equipped with particulate control devices, the coal-fired boilers would operate more efficiently. The L-Reactor coal-fired plant was not equipped with particulate control devices.

5.1.1.4 Solid waste

Until 1968, all nonsalvageable L-Reactor trash was burned. The Savannah River Plant discontinued this practice in 1973. All nonsalvageable trash generated by L-Reactor after it begins operations will be disposed of in a sanitary landfill or rubble pits on the Savannah River Plant that are licensed by the South Carolina Department of Health and Environmental Control.

Until 1968, hazardous solid wastes were disposed of in an oil and chemical basin near the L-Reactor area. As an interim measure, hazardous wastes generated after L-Reactor resumes operations will be stored temporarily in a building near SRP Roads 2 and C; an engineered hazardous-waste storage building is being constructed in the Central Shops area to handle waste for L-Reactor and other reactors.

5.1.2 Radiological releases

5.1.2.1 Atmospheric releases

Table 5-3 lists both the L-Reactor atmospheric releases expected after startup and the measured or estimated releases before standby status. The listed isotopes account for about 98 percent of the total atmospheric releases from L-Reactor. Overall, about 16,800 total curies less are expected to be released to the atmosphere than during earlier operations.

Atmospheric releases from the chemical separations and fuel fabrication areas are expected to be similar for both the pre-1968 and post-1984 periods of L-Reactor operation.

5.1.2.2 Liquid releases

A major source of radioactive liquid discharges to the environment from L-Reactor before 1968 was the purge of water from the reactor disassembly basin to surface streams. This purge was necessary to maintain the tritium concentration in the basin water at a level to maintain safe working conditions and to maintain water quality.

Table 5-3. L-Reactor atmospheric releases (curies/year)

Isotope	Pre-1968	Expected post-1984
H-3	52,900	54,900[a]
Ar-41	36,000[b]	19,500
Xe-133	4,000[b]	1,700
Xe-135	1,400[b]	1,400
TOTAL	94,300	77,500

a. The expected value for tritium atmospheric releases after L-Reactor restart represents an annual average after many years of operation. Years of operation will be required to build the tritium content to an equilibrium level; the releases for years following restart until the equilibrium level is reached will be lower because the D_2O moderator in the system is new. The increase in tritium levels after equilibrium is reached in the post-1984 period can be related to a change in operating conditions and power levels that SRP is using in its current and expected operations.

b. No pre-1969 data are available; the number shown is the average for P-, K-, and C-Reactors for 1971 to 1978 (Ashley and Zeigler, 1980).

A recirculating filter deionizer system has been added to the disassembly basin; in addition, disassembly basin water will be discharged to the seepage basin in the L-Reactor area and not directly to Steel Creek. The treatment system will reduce the amount of nuclides other than tritium being discharged to the seepage basin, and will reduce the total release of radionuclides to surface streams. Table 5-4 lists the L-Reactor liquid releases to surface streams before 1968 and those expected to occur after startup.

Liquid releases from the chemical separations and fuel fabrication areas are expected to be similar for both the pre-1968 and post-1984 periods of operation.

5.1.2.3 Radiocesium transport in Steel Creek

From 1955 through 1968, a total of approximately 232 curies of radiocesium from the P-Reactor area and 23 curies from L-Reactor area were released to Steel Creek. From 1960 to 1968 an average of 15.8 curies of radiocesium per year was transported down Steel Creek. Concentrations in the river averaged 1.8 picocuries per liter from 1963 to 1968.

Table 5-4. L-Reactor liquid releases to surface streams and seepage basins (curies/year)[a]

Isotope	Pre-1968	Expected post-1984
	Releases to streams	
H-3	8,500	3,600
Co-60	1.1	0.045
Sr-90	1.5	0.00016
Cs-137	1.6	0.00041
	Releases to seepage basins	
H-3	860	10,500[b]
Co-60	0.2	0.00037
Sr-90	0.2	0.0002
Cs-137	0.1	0.044
Ru-106	0.1	0.00034
Pm-147	0.05	0.003

a. Sources: Ashley and Zeigler, 1980; du Pont, 1982.

b. Disassembly basin purges will be discharged into the seepage basin rather than to Steel Creek.

Approximately 67 curies of radiocesium are presently in Steel Creek. The resumption of L-Reactor cooling-water discharges to Steel Creek is anticipated to result in a remobilization and discharge of about 9.8 curies to the Savannah River during the first year of operation. After the first year, the radiocesium discharge from Steel Creek is expected to decrease to about 7.2 curies. A 20-percent annual decrease in radiocesium is anticipated in the third and subsequent years of operation (du Pont, 1982). Given normal river flow during the first year of operation, concentrations of radiocesium would be about 1.0 picocurie per liter in the Savannah River.

5.2 SUMMARY OF PRE-1968 AND POST-1984 IMPACTS

Table 5-5 summarizes the expected environmental impacts from the resumption of L-Reactor operations. Based on the impact projection techniques and available data, Table 5-5 also indicates the similarity of impacts due to pre-1968 L-Reactor operations. The following sections describe some of the more important impacts associated with the restart of L-Reactor.

5.2.1 Thermal discharge

Prior to 1968, thermal effluent discharged to Steel Creek caused pronounced vegetative mortality in the creek channel, floodplain, and swamp. On an average, the delta growth rate for one reactor during the period of prior L-Reactor operations was about 3 acres per year.

By 1968 a 220-acre tree-kill zone had developed in the swamp. Stands of lowland hardwoods composed of cypress and gum tupelo were eliminated as the result of previous thermal discharges to Steel Creek. About 1000 acres of wetlands, including habitat of the American alligator, were lost. Steel Creek and the associated Savannah River swamp were not suitable as a fish spawning area.

When L-Reactor operation resumes, thermal discharges to Steel Creek will eliminate previously impacted portions of the creek and swamp. Delta growth will resume at a rate of about 3 acres per year. Approximately 1000 acres of wetlands will again be lost as habitat for wildlife including the American alligator. Steel Creek and the associated Savannah River swamp will not be suitable as spawning areas for fish.

Thermal plumes in the Savannah River are expected to be similar to those experienced during previous L-Reactor operations. The Academy of Natural Sciences of Philadelphia conducted several studies (ANSP, 1953, 1957, 1961, 1970, 1974, 1977) to monitor the effects of SRP operations on the aquatic communities of the Savannah River (Matthews, 1982). The Academy found no direct evidence that would indicate major changes in species composition caused by the addition of heat, either from Four Mile Creek (C-Reactor) or from Steel Creek (K- and L-Reactors). The operation of L-Reactor, therefore, did not produce discernible effects on the structure of the aquatic communities at the locations monitored, although the downstream monitoring stations were below (8 kilometers or more) the area of the direct effects of the thermal plumes (ANSP, 1981).

5.2.2 Cooling-water withdrawal

During previous and projected L-Reactor operations, about 10 percent of river flow under low-flow conditions is pumped to L-Reactor, resulting in the impingement of approximately 5 fish per day, the entrainment of less than 5 percent of the fish eggs (primarily American shad) passing the Savannah River Plant, and about 4 percent of the fish larvae in the Savannah River near the SRP pumphouses.

Table 5-5. Summary of projected impacts from L-Reactor operations

Issues	Post-1984 impacts	Pre-1968 impacts
Nonradiological impacts		
• Land use and socioeconomics	No additional land will be required for L-Reactor restart and operation; workforce for L-Reactor operations will increase by a total of 350. Direct and composite impacts are expected to be minor compared to indigenous population growth.	About the same.
• Archeology	Only one site which could be eligible for nomination to the National Register has been identified that might be affected by proposed operation. A monitoring and mitigative plan for protecting the site has been developed for approval by the State Historic Preservation Officer.	Very limited pre-1968 data available on archeological sites.
• Cooling-water system		
- Withdrawal	About 4% of the average annual flow and less than 7% of the 7-day, 10-year low-flow will be pumped to L-Reactor causing impingement of an additional 5 fish per day and entrainment of less than 5 percent of the fish eggs passing SRP intake, and 4 percent of the fish larvae in the Savannah River passing the intake.	About the same.

Table 5-5. Summary of projected impacts from L-Reactor operations (continued)

Issues	Post-1984 impacts	Pre-1968 impacts
– Thermal discharge to Steel Creek system	L-Reactor will discharge about 11 cubic meters per second of cooling water to Steel Creek at 70° to 80°C. Approximately 1000 acres (3% of SRP wetlands habitat) of previously impacted wetlands which are being revegetated will be eliminated and an additional 7 to 10 acres per year will be lost due to the thermal discharges. Delta growth will resume at a rate of about 3 acres per year. Habitat for the American alligator, waterfowl, fish spawning, and a variety of species similar to those in nonthermal streams at SRP will be eliminated in Steel Creek and the adjacent delta area.	Steel Creek received thermal discharges from P- and L-Reactors from 1954 through 1963, and from L-Reactor only from 1963 through 1968. Thermal stress, flooding, and sedimentation eliminated about 1000 acres of aquatic and semiaquatic habitat. A delta was formed in the swamp. Lowland tree stands and other vegetation were eliminated. Fish essentially were eliminated from the creek.
– Thermal discharge to Savannah River	In the summer, thermal discharges from L-Reactor will increase overall river temperature by as much as 0.8°C about 2.4 km downstream from the creek mouth. The thermal plume is expected to allow sufficient passage for fish. The average monthly temperature between Steel Creek and its confluence with the Savannah River will be 8.8°C during warmer months; the maximum difference is expected to be 14°C.	Thermal discharge about the same. No detectable impacts on the biological structure of the Savannah River.
• Water quality	Liquid effluents discharged to Savannah River via Steel Creek will have chemical characteristics similar to those of the river. The ash basin in the L-Reactor area will not be utilized.	About the same for surface water. Leachate and chemicals migrated to shallow ground water from the L-Reactor area coal ash basin.

Table 5-5. Summary of projected impacts from L-Reactor operations (continued)

Issues	Post-1984 impacts	Pre-1968 impacts
• Air quality	Operational emissions will consist primarily of NO_x, SOx, and particulate matter. Emissions from K-Area will increase by 15% to supply steam to L-Reactor.	Emissions from the diesel generators will be the same. Emissions from the L-Reactor area were higher due to the lack of particulate control devices for the coal-fired boilers.
• Solid waste	All unsalvageable domestic trash will be packaged and disposed of in a State-approved sanitary landfill at the SRP. Sanitary waste sludge will be disposed of at the SRP sludge pit. Bottom ash sluiced to the K-Area ash basin will increase by 15%.	All unsalvageable domestic trash was burned, emitting pollutants. Sanitary waste was handled by septic tank. Fly and bottom ash from the L-Reactor area power plant was sluiced to the L-Reactor ash basin.
• Endangered species	Habitat for about 25 American alligators in the Steel Creek system will be eliminated. However, no critical habitat as designated by the U.S. Fish and Wildlife Service is on the SRP. Adult alligators could migrate to avoid thermal stress. Smaller alligators might have difficulty migrating and could be more subject to predation.	About the same.

Table 5-5. Summary of projected impacts from L-Reactor operations (continued)

Issues	Post-1984 impacts	Pre-1968 impacts
Radiological impacts		
• Radiation dose to work force		
– Routine operations	Operating personnel will work in controlled radiation exposure areas. All high-level radioactivity operations will be remotely controlled; systems have been upgraded to provide increased control over radioactive releases; occupational doses will be monitored and controlled to be as low as reasonably achievable. Projected dose commitment is 69 man-rem/year.	Occupational dose commitment was approximately 200 man-rem/reactor-year.
• Radiation risks to public		
– Routine operations	The maximum individual dose will be about 1.3 millirem per year; the maximum population dose to the population within 80 kilometers of the SRP will be about 56 man-rem per year.	Due to the smaller population size and slightly higher release rates for radionuclides, the calculated health effects should be about the same.
– Accidents	Accidents are highly unlikely; safety systems have been improved to further reduce the chance of an accident.	No reactor accidents occurred that resulted in the release of radioactivity to the public.

Table 5-5. Summary of projected impacts from L-Reactor operations (continued)

Issues	Post-1984 impacts	Pre-1968 impacts
• Radiocesium transport	About 9.8 Ci of radiocesium could be resuspended and transported from Steel Creek to the swamp and to the Savannah River and its floodplain during the first year and about 20-25% less each year thereafter. During the first year, radiocesium concentrations in the river will be about 1.0 pCi/liter, 2.4 km below the creek mouth assuming average flow conditions. The maximum individual dose from this release is calculated to be about 5 millirem per year. Of the 9.8 Ci of radiocesium remobilized, 2.3 Ci could be deposited over 1235 acres of previously contaminated offsite swamp. Deposition rate will decrease to about 0.3 Ci in the tenth year.	From 1960-1968, an average of 15.8 Ci of radiocesium per year were transported down Steel Creek to the river. Concentrations in the Savannah River averaged 1.8 pCi/liter from 1963-1968. Due to previous deposition from Savannah River flooding, there is currently about 21 Ci of radiocesium on a 1235-acre offsite swamp.

5.2.3 Chemical releases

Liquid effluents discharged to the Savannah River via Steel Creek will have chemical characteristics similar to those in the river. A comparison of the chemical analyses of Savannah River water samples for the 5-year period before 1968 to the 5-year period after 1968 indicates no detectable differences in water quality (Table 5-6). The conclusion drawn from this comparison is that the resumption of L-Reactor operations, like previous operations, will have no detectable impact on the water quality of the Savannah River.

Table 5-6. Comparisons of water quality parameters above and below SRP in the Savannah River before and after L-Reactor was placed on standby status

Chemical parameter	Units	1965-1969 average value[a]		1971-1975 average value[b]	
		Above SRP	Below SRP	Above SRP	Below SRP
pH	--	7.1	7.1	6.8	6.7
Dissolved oxygen	mg/liter	9	9	8.9	8.5
BOD	mg/liter	2	2	1.3	1.1
Conductivity	micromhos/cm	63	64	67	67
Chloride	mg/liter	2.6	2.6	4.4	4.2
Nitrite	mg/liter	0.05	0.03	0.07	0.03
Hardness as $CaCO_3$	mg/liter	17	18	20	20
Sulfate	mg/liter	3.9	3.5	4.8	4.9
Total iron	mg/liter	0.5	0.6	0.4	0.3
Total phosphate	mg/liter	0.3	0.4	0.4	0.4
Surfactant	mg/liter	0.05	0.06	0.03	0.03
Total dissolved solids	mg/liter	47	46	43	42

a. Marter, 1970.
b. du Pont, 1972, 1973, 1974, 1975, 1976.

5.2.4 Radiological impacts

The maximum individual total-body dose from atmospheric and process liquid radioactive releases resulting from the resumption of L-Reactor operations will be about 1.3 millirem in the tenth year of operation; the dose to the population within 80 kilometers of the Savannah River Plant will be about 56 man-rem. Calculated doses as a result of the total radionuclides released by these pathways after the restart are estimated to be lower than those released before 1968 due to installed treatment systems.

The maximum individual total-body dose from the release of radiocesium from Steel Creek to the Savannah River averaged about 8 millirem per year between 1963 and 1968. The maximum individual total-body dose from the remobilization and transport of radiocesium from Steel Creek to the Savannah River is calculated to be about 5 millirem during the first year of L-Reactor operations or 0.6 millirem during the tenth year of resumed L-Reactor operations. During the first year of operation, about 2.3 curies of the remobilized radiocesium will be deposited on 1235 previously contaminated acres of an offsite swamp (current contamination level of 21 curies).

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