Environmental Impact Appraisal

for

University of Kansas
Nuclear Reactor

March/1980

Environmental Impact Appraisal

This section deals with the environmental effects which can be attributed to the operation of the University of Kansas (Lawrence) Training Reactor since its initial criticality in 1961. It will also address potential future environmental effects.

A. Facility, Environmental Effects of Construction

The KU Training Reactor is housed in the Nuclear Reactor Center which is located toward the west side of the KU campus. The nuclear reactor occupies the south end of the Center and the Radiation Biophysics Program now occupies the north end. There have been no significant effects on the terrain, vegetation, wildlife, nearby water or aquatic life due to the operation of the reactor.

There are no exterior conduits, pipelines, electrical or mechanical structures or transmission lines attached to the nuclear reactor facility other than utility service facilities which are similar to those required in other campus facilities, especially laboratories. Heat dissipation is accomplished by evaporation and conduction from the pool. There is no external cooling system on the KU Training Reactor.

Make-up water for the cooling system is readily available and is obtained from the City of Lawrence water supply. Radioactive gaseous effluents consist of very small quantities of Ar-41. There are minimal radioactive liquid effluents (less than a liter per year) associated with the production of isotopes in the KU reactor. These solid and liquid radioactive wastes are generated through the irradiation of samples to be used on campus for neutron activation analysis, classroom projects with radioactive materials, or for tracer studies. These radioactive samples are normally of such short half life that disposal is by decay. There is one Kansas Department of Health and Environment approved field study involving the use of small amounts of Tantalum.

The sanitary waste systems associated with the Nuclear Reactor facility are similar to those at other univeristy reactors. The design excludes the possibility of discharging un-monitored liquids into the sanitary waste system.

B. Environmental Effects of Facility Operation

The KU Nuclear Reactor has a maximum power output of 250 KWt limited to an average of 10 KWt and a maximum of three hours at 250 KWt. The environmental effects of thermal effluents of this order of magnitude are negligible. The waste heat is rejected to the atmosphere through the roof of the Nuclear Reactor building. Replacement water is equal to that lost by evaporation at the top of the 6000 gallon reactor tank with a top surface area of 45 ft^2 This amount of water loss by evaporation has minimum effects on the environment.

The room in which the reactor is located is continuously monitored for gamma-ray fields. The gamma detectors are Jordan ion chambers, three of which are mounted on the walls of the reactor bay and one of which is attached to the ceiling directly above the reactor tank.

At 10 KWt, none of the alarms have ever been unexpectedly triggered. The south wall and ceiling monitor do exceed five mR/hr at 250 KWt. The maximum rate has never exceeded 100 mR/hr.

The reactor has been used above 10 KWt an average of six hours per year for the past five years.

Air samples are obtained in and near the reactor building on a weekly basis during periods in which the reactor is being routinely used. (Samples are not normally taken when the reactor is not being operated.) A low volume air sampler is used to draw air through a filter with the volume determined by a flow meter. Gross beta activity is determined by 2 π gas flow counting and gross gamma activity with a NaI scintillation counting system.

Table I summarizes the data for the last five years and is representative of results throughout the life of the reactor.

The demineralizer regeneration effluent is held in a hold-up tank for a period of time to allow for decay. The gross beta and gamma activity in the effluent is determined before it is released to the sanitary sewer system.

Table 2 gives the total amount released to the sewer system in each of the past five years. The concentrations as the effluent enters the drain is less than 9×10^{-5} μCi/ml of beta plus gamma and less than 4×10^{-7} μCi/ml alpha. Thus the dilution factor obtained by averaging these concentrations with the normal sewage volume causes the disposal to be far below Appendix B, Table I, Column 2.

Water samples from the reactor tank are obtained on a periodic basis and analyzed for gross alpha, beta and gamma activity. The maximum activities recorded were $6.\underline{5} \times 10^{-7}$, 2×10^{-6}, and 1×10^{-6} μCi/ml respectively with averages of 7×10^{-8}, $1.\underline{6} \times 10^{-7}$, and $7.\underline{0} \times 10^{-7}$ μCi/ml. Of course, in this case, the sampling time relative to reactor operations does make a difference. It is seen that the values are extremely small.

Radioactive samples made in the reactor are normally allowed to decay to extremely small values following which they may be disposed of via the sewer in the case of liquid samples. Indium foils and other such materials are kept and reused.

The number of samples of radioactive materials produced in the reactor over the past five years are given in Table 3. This table also gives the total activity produced.

C. Environmental Effects of Accidents

Accidents ranging from failure of experiments to the insertion of 1.5% excess reactivity result in doses of only a small fraction of 10 CFR Part 100 guidelines and are considered negligible with respect to the environment.

D. Effects of Facility Operation

No adverse impact on the environment is expected from the operation of the reactor based on the analysis given above.

E. Alternatives to Operation of the Facility

There are no suitable or more economical alternatives which can accomplish both the educational and the research objectives of this facility. These objectives include the training of students in radiation protection aspects of nuclear reactors, the production of radioisotopes, its use as a source of neutrons for neutron activation analysis, and also its use as a demonstration tool to familiarize the general public with nuclear reactor operations.

F. Long-Term Effects of Facility Construction and Operation

The long-term effects of a research facility such as the KU Nuclear Training Reactor are considered to be beneficial as a result of the contribution to scientific knowledge and training. This is especially true in view of the relatively low capital costs ($147,000) involved and the minimal impact on the environment associated with a facility such as the KU Training Reactor.

G. Costs and Benefits of Facility and Alternatives

The annual operating cost for a facility such as the KU Training Reactor is approximatley $29,000 with negligible environmental impact. The benefits include, but are not limited to: training of radiation protection students, performance of activation analysis; production of short-lived radioisotopes; and education of students and public. Some of these activities could be conducted using particle accelerators or radioactive sources, but these alternatives are at once more costly and less efficient. There is no reasonable alternative to a nuclear training reactor of the type presently used of the University of Kansas - Lawrence Campus for conducting the broad spectrum of activities previously mentioned.

Approximately an average of five graduate degrees a year have been awarded in Radiation Biophysics with emphasis on radiation protection. In addition, two to three undergraduate degrees are completed per year. All of these students receive training involving the reactor.

It is possible to have a Radiation Biophysics degree program without a Nuclear Reactor Facility. However, past experience for most disciplines show a much better understanding when experiments and experience accompany a lecture/problem learning system.

Another example of the benefits recovered from a facility of this type is the visitors tours. Approximately 2000 people have visited the facility in the last five years and have either been shown by demonstration or by lecture/tour, the purpose of nuclear reactors in our society.

Table I.

AIR SAMPLES
(Vicinity of Nuclear Reactor Center)

Year	# Samples	Average Beta Activity (μCi/ml)	# Samples	Average Gamma Activity (μCi/ml)
7/1/73 - 6/30/74	32	$<4.0 \times 10^{-12}$*	32	$<1.8 \times 10^{-11}$*
7/1/74 - 6/30/75	37	$<3.4 \times 10^{-12}$*	37	$<2.2 \times 10^{-11}$*
7/1/75 - 6/30/76	84	$<3.4 \times 10^{-12}$*	84	$<2.2 \times 10^{-11}$*
7/1/76 - 6/30/77	45	$<3.4 \times 10^{-12}$*	45	$<2.2 \times 10^{-11}$*
7/1/77 - 6/30/78	23	$<2.0 \times 10^{-12}$*	27	$<2.0 \times 10^{-11}$*
7/1/77 - 6/30/78	5	1.2×10^{-11}	1	4.1×10^{-11}
7/1/78 - 6/30/79	46	$<2.8 \times 10^{-12}$*	46	$<3.2 \times 10^{-11}$*
7/1/78 - 6/30/79	5	2.4×10^{-12}	5	4.0×10^{-11}

*Represents the average minimum detectable activity for the samples collected.

Table 2.

HOLD UP TANK
(Demineralizer Regeneration Effluents)

Year	Gross Beta Activity	Gross Gamma Activity
7/1/73 - 6/30/74	0.9 μCi	22.1 μCi
7/1/74 - 6/30/75	8.0 μCi	19.9
7/1/75 - 6/30/76	2×10^{-7}	1×10^{-7}
7/1/76 - 6/30/77	Less than Minimum Detectable	0.34
7/1/77 - 6/30/78	1.7	3.8
7/1/78 - 6/30/79	0.012	0.079

Table 3.

PRODUCTION OF RADIOISOTOPES

Years	No. of Samples	Activity (μCi)
7/1/73 - 6/30/74	12	$< 44 + 630\ ^{182}Ta$
7/1/[illegible] - 6/30/75	23	< 456 (of which ~ 200 ^{80}Br)
7/1/75 - 6/30/76	30	< 460 (of which ~ 300 ^{80}Br) + 4300 ^{66}Cu
7/1/76 - 6/30/77	22	$< 133 + 690\ ^{182}Ta + 6200\ ^{69}Zn$
7/1/77 - 6/30/78	10	$< 25 + 1370\ ^{182}Ta$
7/1/78 - 6/30/79	11	< 62

Isotopes produced included ^{60}Co (calibration foils), ^{24}Na, ^{116m}In (foils reused), ^{38}Cl, ^{64}Cu, ^{66}Cu, ^{50}Fe, ^{198}Au, ^{69}Zn, ^{122}Sb, ^{124}Sb, ^{80}Br, ^{80m}Br, ^{82}Br, ^{42}K, ^{32}P(traces) and traces of other isotopes.

Financial Considerations

University of Kansas - School of Engineering (R-78)

February 27, 1980

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FINANCIAL CONSIDERATIONS

1. Annual Statement

The accompanying page is reproduced from the Annual Financial Report of the University of Kansas for the fiscal year ended June 30, 1979. It shows the expenditures of the Department of Chemical and Petroleum Engineering and included in these were funds for operation of the nuclear reactor.

2. Annual Operating Cost

The estimated cost for operating the reactor for 1979-80 is $29,000. Funds for operation of the University come from appropriations by the Legislature of the State of Kansas. A statement concerning future funds for operation of the reactor is signed by the Dean of Engineering.

3. Cost of Permanent Shutdown

The cost for shutdown and dismantling the facility are as follows. All costs are in 1979 dollars. As per Regulatory Guide 1.89, the facility would be dismantled and returned to unrestricted use by the campus.

Five years cooling time after removal of the fuel is desirable before dismantling the core structure and portions of the pool wall. During that time the reactor bay would be maintained as a restricted area under NRC possession only license.

Security would continue as is currently provided during the cooling period. Appropriate monitoring would continue to insure the health and safety of the public. A facility radiation survey and an administrative procedure will be established for the notification and reporting of any hazard that might develop.

Dismantle Cost

Removal and Disposal of Fuel $2,000/element x 18	$ 36,000
Removal and Disposal of Core Support Plate	30,000
Removal and Disposal of Beamports and Thermal Column	100,000
Removal and Disposal of Activated Portion of Pool Wall	200,000
Contingency @ 25%	92,000
TOTAL	$458,000

4. Annual Cost to Maintain Shutdown Facility

Estimated cost in 1979 dollars to maintain the shutdown facility in a safe shutdown condition are:

Personnel	
Radiological survey, maintenance and administration	$10,000
Expense and Equipment	
Supplies	1,000
Annual Total	$11,000
Total for 5 years	$55,000

STATEMENT OF CURRENT EXPENDITURES
FOR THE FISCAL YEAR ENDED JUNE 30, 1979

EXHIBIT [illegible]-2

PCS DESCRIPTION	TOTAL	SALARIES	GENERAL EXPENSE	EQUIPMENT AND IMPROVEMENTS	SOURCE OF FUNDS UNRESTRICTED GENERAL USE	UNRESTRICTED DESIGNATED USE	RESTRICTED
UNASSIGNED FACULTY	22,493.53	18,047.44	4,446.09		22,493.53		
DRAMATICS	74,837.94	13,825.30	60,917.73	54.91	10,320.73	64,517.21	
TOTAL PCS 11B	20,312,524.32	18,444,808.67	1,899,637.97	568,077.68	20,120,327.46	149,975.41	42,221.45
11C EDUCATION INSTRUCTION							
ADMIN, FOUNDATIONS & HIGHER ED	343,454.73	328,235.69	13,009.59	2,205.25	343,035.03	415.70	
ECONOMIC EDUCATION	12,540.99	9,821.14	1,909.79	810.06		12,204.97	336.02
VISUAL ARTS EDUCATION	84,545.40	81,672.12	2,651.29	221.99	84,545.40		
CURRICULUM LABORATORY-EDUC	13,814.81	3,683.55	9,785.26	346.00		13,814.81	
COUNSELING	156,731.70	149,680.94	5,987.16	1,063.60	156,193.22		538.48
EDUCATIONAL PSYCHOLOGY & RES	301,814.09	268,435.33	31,743.64	1,635.12	300,157.33	1,164.92	491.84
CURRICULUM & INSTRUCT	667,110.73	627,769.02	27,763.52	11,578.39	664,501.11	493.00	2,116.62
SPECIAL EDUCATION	430,290.05	358,479.65	53,960.03	17,850.37	373,698.30	56,184.71	407.04
MUSIC ED & THERAPY	267,411.03	226,956.94	23,440.87	17,013.22	264,870.23	861.76	1,679.04
HEALTH, PHYS ED & REC	484,215.54	450,990.22	28,412.41	4,812.91	474,926.60	6,817.81	2,471.13
TOTAL PCS 11C	2,761,929.27	2,505,728.80	198,663.56	57,536.91	2,661,927.22	91,961.68	8,040.37
11C ENGINEERING INSTRUCTION							
AEROSPACE ENGINEERING	218,383.14	181,915.75	26,554.80	9,912.59	211,145.50	6,440.52	797.12
CHEMICAL & PETROLEUM ENG	490,633.02	353,977.95	99,583.63	37,271.44	482,668.89	6,734.53	1,229.60
CIVIL ENGINEERING	775,316.69	601,032.85	56,028.11	118,255.73	760,706.40	14,610.29	
ELECTRICAL ENGINEERING	825,958.03	568,369.13	149,722.80	107,866.10	820,963.78	4,058.27	935.98
MECHANICAL ENGINEERING	428,668.18	362,473.00	14,848.66	51,346.52	426,695.32	1,732.24	240.62
TOTAL PCS 11C	2,739,159.06	2,067,768.68	346,738.00	324,652.38	2,702,379.89	33,575.85	3,203.32
11E FINE ARTS INSTRUCTION							
DESIGN	630,729.69	581,258.20	25,983.16	23,488.33	626,306.34	1,075.87	3,347.48
OCCUPATIONAL THERAPY	235,641.64	224,299.52	9,351.08	1,991.04	235,417.57	224.07	
PAINTING & SCULPTURE	480,578.54	435,319.87	27,859.58	17,399.09	479,254.60		1,323.94
MUSIC ENSEMBLES	225,961.37	170,412.43	43,097.33	12,451.61	220,517.46	3,453.76	1,990.15
MUSIC HISTORY	94,334.62	83,239.01	4,795.26	6,300.35	93,238.22	167.84	928.56
MUSIC THEORY	178,554.65	176,976.70	1,286.70	291.25	178,554.65		
MUSIC PERFORMANCE	684,054.02	631,174.81	22,870.59	30,008.62	681,764.22	378.62	1,911.18
TOTAL PCS 11E	2,529,854.53	2,302,680.54	135,243.70	91,930.29	2,515,053.06	5,300.16	9,501.31
11F JOURNALISM INSTRUCTION							
SCHOOL OF JOURNALISM	751,624.97	594,137.85	24,725.17	132,761.95	743,129.82	5,633.15	2,862.00
RADIO-TV FILM LABORATORIES	79,600.48	35,473.94	31,344.19	12,782.35	69,980.09	9,620.39	
TOTAL PCS 11F	831,225.45	629,611.79	56,069.36	145,544.30	813,109.91	15,253.54	2,862.00

POOR ORIGINAL