



SAFETY OF RESEARCH REACTORS - SITING L.5.3.A

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FROM THE CODE

The operating organization should establish, implement and maintain appropriate procedures for:

- (a) evaluating all relevant site-related factors likely to affect the safety of the research reactor over its projected lifetime;
- (b) evaluating the potential safety impact of a planned research reactor on the public and the environment; and
- (c) re-evaluating the two preceding issues at appropriate times so as to ensure the continued safety acceptability of the research reactor.

SITING

OBJECTIVE

Protection of the public and the environment against the radiological impact of normal and accidental releases of radioactive material

To demonstrate how site characteristics will influence the facility design and operating criteria and to show the adequacy of the site characteristics from a safety viewpoint

INITIAL EVALUATION AND SELECTION

- **Low Power Research Reactor**
 - ✓ Minimal siting restraints

- **High Power Research Reactor**
 - ✓ More stringent siting requirements

Siting (continued)

- Site Evaluation
 - ✓ Establish the boundaries of the area which the operating organization controls, and its legal rights within the controlled area.

 - ✓ Establish activities unrelated to the operation of the research reactor that will be permitted in the controlled area

 - ✓ Determine the natural and man made factors in the region having a bearing on safety for a period covering the projected life of the research reactor.

Siting (continued)

- ✓ Determine the effects of natural and man made external influences

Natural

Meteorology (wind speed and direction, air temperature, precipitation, humidity, atmospheric stability parameters, prolonged inversions, hurricanes, tornadoes and waterspouts, thunderstorms, lightning, hail, freezing rain, snow, ice, and sandstorms)

Geology and seismology (establish the seismic design basis)

Hydrology and oceanography (surface and underground hydrology of the site and its environs including location, size, flow, water use and other characteristics of nearby freshwater sources, the location and characteristics of man-made structures including dams, diversion channels and flood control measures, the groundwater hydrology in the vicinity of the facility including the main characteristics of the water bearing formations, their interaction with surface waters, uses of groundwater in the region, oceanographic and hydrographic)

Siting (continued)

Man induced

Land and water use (land and waters supporting wildlife, agricultural use, commercial, residential and recreational purposes)

Nearby industrial, transport and military facilities and structures (present or projected industrial, transport, or military facilities, significant manufacturing or chemical plants, refineries, storage facilities, mining and quarrying operations, military bases or sites, transportation routes (air, land, water), transport facilities (rail lines, docks, anchorages, airports), oil and gas pipelines, drilling operations and wells, and underground storage facilities)

Population distribution and planning controls in the region (seasonal and daily variations, existing and projected population distributions)

Siting (continued)

✓ Establish radiological impact

Establish baseline radiological levels for assessing the future impact of the reactor at the site due to natural and artificial substances in air, water, in flora and fauna

Determine ecological and biological aspects of transfers of radioactive materials to man during all operational states and accident conditions

Determine a source term

Calculate atmospheric dispersion estimates based on representative meteorological data or conservative, worst weather assumptions

Determine if discharged radioactive materials could make their way into surface, ground or other bodies of water unintentionally

Determine effect of anticipated discharges of radioactive material from the facility on the population.

Assess the need for mitigation measures such as accident management or emergency measures which may be required in the event of accidents

Consideration shall be given to the storage and transportation of new and spent fuel and radioactive wastes

Siting (continued)

CONCLUSIONS

If the facility with all its safety features cannot withstand the above events without unacceptable risk of public exposure, the site shall be considered unsuitable

If the facility with all its safety features cannot withstand the radiological impacts determined above, the site shall be considered unsuitable

The radiological risk to the population from all operational states and accident conditions, including those which may lead to the implementation of mitigation measures, is acceptably low and in accordance with national requirements

Siting (continued)

ONGOING SITE EVALUATION

The operating organization, as necessary, shall evaluate the characteristics of the reactor site to determine changes which have occurred and which may affect the safety aspects of the research reactor such as changes in:

- (a) Nearby industrial, transport and military facilities
- (b) The site by the construction of new buildings and structures
- (c) The land area controlled by the operating organization
- (d) Nearby institutional, recreational or residential structures
- (e) The radiological impact because of increased population distribution surrounding the facility
- (f) The site meteorology because of new buildings or structures
- (g) The site seismology because of new information

ON GOING SITE EVALUATIONS (continued)

POSSIBLE SOLUTIONS

SHUTDOWN REACTOR

OPERATE AT LOWER POWER

PURCHASE ADDITIONAL LAND AROUND FACILITY

**CHANGE TO FUEL DESIGN WITH HIGHER MELT
TEMPERATURE**

**TAILOR OPERATING SCHEDULE WITH SURROUNDING
ACTIVITIES**

INSTALL ENGINEERED SAFETY FEATURES

EMERGENCY CORE COOLING

IMPROVE CONFINEMENT PROPERTIES OF BUILDING

**INCREASE STACK HEIGHT BY INCREASING AIR
VELOCITY USING UNCONTAMINATED AIR**

INCREASE FILTRATION

IMPROVE BUILDING LEAK RATE

SHADOW SHIELDING

RESEARCH REACTOR SITE EVALUATION

USING ANS/ANSI 15.7

IAEA PUBLICATIONS ARE INTERNATIONAL CONSENSUS DOCUMENTS AND DO NOT INCLUDE RECOMMENDED NUMBERS

ANS 15 PUBLICATIONS ARE CONSENSUS DOCUMENTS FOR US RESEARCH REACTORS AND DO RECOMMEND NUMBERS

EXAMPLES OF SITE EVALUATION FACTORS:

POPULATION (BASED ON TOTAL EFFECTIVE DOSE EQUIVALENT FROM DBA TO PERSONS WITHIN THE OPERATIONAL BOUNDARY, SITE BOUNDARY, RURAL ZONE AND AT THE URBAN BOUNDARY OVER DESIGN LIFETIME OF FACILITY)

WITHIN OPERATIONS BOUNDARY (25 REM MAXIMUM FOR TIMELY EVACUATION FOLLOWING THE DBA. TIMELY IS A FRACTION OF AN HOUR)

WITHIN SITE BOUNDARY (5 REM MAXIMUM FOR 2 HOUR EXPOSURE PERIOD)

WITHIN THE RURAL ZONE (0.5 REM MAXIMUM)

AT OR BEYOND THE URBAN BOUNDARY (0.5 REM MAXIMUM OVER 24 HOUR PERIOD)

RESEARCH REACTOR SITE EVALUATION USING ANS/ANSI 15.7 (CONTINUED)

GEOLOGY/SEISMOLOGY

FAULT PROXIMITY (NOT CLOSER THAN 400 METERS
FROM KNOWN CAPABLE FAULT)
SEISMIC DESIGN (SAFETY RELATED STRUCTURES AND
SYSTEMS DESIGNED SO THAT ANY SEISMIC EVENT
CANNOT CAUSE TEDE IN EXCESS OF THOSE ABOVE.
IF INTENSITY V OR GREATER IS POSSIBLE, SEISMIC
ALARM TO OPERATOR REQUIRED.)
LIQUEFACTION (SITE IN AREA KNOWN TO HAVE LOW
SOIL LIQUEFACTION POTENTIAL)
HYDROLOGY (EVALUATE ACCIDENTAL RELEASE
USING ABOVE GUIDELINES. EVALUATE SEISMIC
INDUCED RELEASE, TSUNAMI, SEA WAVES, ETC)

METEOROLOGY (EVALUATE EFFECTS OF ATMOSPHERIC
EXTREMES SUCH AS HURRICANES ON SAFETY RELATED
STRUCTURES SO AS TO REMAIN WITHIN ABOVE
GUIDELINES)

AIR TRAFFIC

8 KILOMETERS FROM EXISTING OR PROJECTED AIRPORT
EVALUATE FREQUENCY, TYPE OF AIRCRAFT FLIGHT
PATTERNS TOPOGRAPHY

8 TO 16 KILOMETERS

MAKE ABOVE EVALUATION IF AIRCRAFT
MOVEMENTS PER YEAR $\Rightarrow 200D^2$ WHERE D IS
DISTANCE IN KILOMETERS BETWEEN REACTOR SITE
AND AIRPORT

IF IN LINE WITH RUNWAY
DEMONSTRATE LOW PROBABILITY FOR ACCIDENT
TO LEAD TO TEDE ABOVE

**RESEARCH REACTOR SITE EVALUATION USING ANS/ANSI 15.7
(CONTINUED)**

ENVIRONMENTAL FACTORS (IMPACT STATEMENT NOT
REQUIRED FOR LOW AND INTERMEDIATE POWER LEVEL
REACTORS. PROVIDES A LIST OF FACTORS TO BE
CONSIDERED WHEN STATEMENT IS REQUIRED)

CRITERIA FOR DOWNWIND CONCENTRATIONS

FOR ELEVATED AND GROUND RELEASE
RECOMMENDS COMPUTER CODES

FOR INSTANTANEOUS RELEASE
PROVIDES TECHNIQUE AND RECOMMENDS
PARAMETERS (PASQUILL CONDITION, WIND SPEED,
ETC) TO COME TO INTEGRATED EXPOSURE.
INCLUDES EFFECTS OF EFFLUENT TEMPERATURE
AND VELOCITY IN STACK

DOWNWIND DIFFUSION FROM CONTINUOUS RELEASE
EQUATIONS FOR CONCENTRATION AND DOSE
FOR EXPOSURE TIME LESS THAN 2 HOURS
EQUATIONS FOR SHORT STACK (< 2.5 X BUILDING
HEIGHT)
EQUATIONS FOR CONCENTRATION AND DOSE FOR
EXPOSURE TIME OF 2-24 HOURS
EQUATIONS FOR CONCENTRATION AND DOSE FOR
EXPOSURE TIME MORE THAT 24 HOURS

SOURCE TERM PROVIDES ASSUMPTIONS WHICH MAY BE USED
FOR SITE EVALUATION PURPOSES ONLY WHEN NO DATA
ACTUALLY EXISTS.

ENGINEERED SAFETY FEATURES BUILDING LEAK RATE,
FILTRATION, RELEASE HEIGHT, ETC.

**RESEARCH REACTOR SITE EVALUATION USING ANS/ANSI 15.7
(CONTINUED)**

BIOLOGICAL FACTORS INHALATION RATES, IODINE
CONVERSION FACTORS, CLOUD DIMENSIONS, ETC