

Diverse Perspectives on the July 1959 Sodium Reactor Experiment Accident

Glossary

activation products – radionuclides produced by the interaction of neutrons in a nuclear reactor with the steel or other components of a reactor vessel or with minerals in a reactor coolant; the half-lives vary from a few seconds to many years depending on what material interacted with the neutron.

alloy – A substance made by melting two or more elements together, at least one of them a metal. Examples: brass, bronze, 14k gold, sterling silver. In chemistry, atoms of one element replace or become integrated with the atoms of the other element.

barrier – A containment medium usually made of dense material, that reduces or prevents passage of materials from a contained area to the surroundings.

carbonaceous material – Substances that are rich in carbon.

cladding – In nuclear reactors, the protective outer layer of the fuel rods, between the coolant and the nuclear fuel. Cladding is one of several barriers that help

prevent radioactive fission fragments from escaping the fuel.

cladding failure (also breached cladding) – The weakening or compromise of the protective material around nuclear fuel, caused by any number of conditions such as an increase in or cycling of temperature, oxidation, or mechanical interaction with the fuel. When the stress is too great, a breach (or crack, opening, tear, or rupture) of the cladding can result. This can lead to the release of radioactive fission products to the coolant. In the SRE, the blockage of the sodium coolant flow caused the temperature to increase and fluctuate. The fuel swelled and the pressure caused a breach in the cladding.

containment – A gas-tight enclosure around a nuclear reactor to confine radioactive materials that otherwise might be released to the atmosphere in an accident.

coolant – A fluid circulated through the core of a nuclear power reactor to remove and

transfer heat energy. The SRE used liquid sodium as a coolant.

cooling system – The method through which a coolant fluid enters a reactor core at low temperature and leaves it at a higher temperature. This higher temperature fluid is then directed to components where the heat is converted into electrical power.

concrete plug – Component in the SRE nuclear reactor that contributed to the physical security of the fuel system and shielding from neutrons. The reactor core is protected on all sides by steel and reinforced concrete. The massive concrete plug was located at the top of the reactor and could be moved for access to the reactor core.

control rod – A device that absorbs neutrons. When inserted into a nuclear reactor core, the rods slow or stop the fission process, which can control or shut down the reactor.

core – The center of a nuclear reactor containing the fuel elements.

Core I Operations – The experiments conducted using the first fuel loading (Core I, using Uranium metal fuel) in the reactor, conducted between July 1957 and July 1959.

cover gas – A gas covering the nuclear reactor coolant that does not react with other materials, and where any gaseous activation or fission products released from the circulating coolant collect. The gaseous fission products are then removed from the cover gas in a cleanup system.

criticality – The condition in which a reactor is capable of sustaining a nuclear chain reaction.

curies (Ci) – A basic unit to describe an amount of radioactive material; a unit of radioactivity equal to that produced by 1 gram of radium-226 (i.e., 37 billion disintegrations per second).

excursion – A sudden, rapid rise in power level or temperature of a nuclear reactor.

expansion space – Space inside fuel cladding that allows the fuel to expand or contract to relieve stress caused by uneven heating.

eutectic temperature – with respect to the SRE, the temperature at which the fuel and the cladding inside the reactor formed a low-melting point alloy that caused local melting and cladding failure.

fission – The nuclear process in which a heavy atom such as uranium splits into fragments;

the splitting of a large atomic nucleus into smaller nuclei, often accompanied with the release of neutrons.

fission products – A general term for the complex mixture of nuclides produced as a result of nuclear fission. Fission products may be solid or gas and many are radioactive.

fission product collector – A material or mechanism that absorbs and removes fission products from a gas or liquid.

fuel – Fissionable material, such as uranium, which is “burned” in a nuclear reactor.

fuel handling cask – A machine used to remove a fuel assembly for examination or to insert another fuel assembly into the core when the reactor is shut down.

fuel recovery process – Separation of spent nuclear fuel components by segregating unused fissionable material from the waste material.

fuel rod – stainless steel tube 11 to 15-feet long that contains the nuclear fuel.

fuel rod jacket – See cladding

grid plate – Component that supports the reactor core region, providing flow distribution for

the coolant passing through fuel assemblies.

hanger rod – The support pole that holds the fuel element assembly in the core.

HEPA filter (High Efficiency Particulate Air filter) – A device for removing small pollutants and particles.

inert gas – A gas that is not reactive with other elements. Also known as noble gas. Use of an inert gas in the reactor can prevent undesirable chemical reactions.

kilowatt thermal (kWt) – A standard unit of measure for thermal or heat power produced. The rating of a reactor is usually given in kilowatts, representing the heat generation rate.

light water cooled reactor – A nuclear reactor cooled and moderated by water. This is the most common type of nuclear reactor in the U.S.

liquid metal reactor – A nuclear reactor where the primary coolant is a liquid metal, such as sodium. The SRE was such a reactor.

liquefied fuel – Reactor fuel (uranium metal for the SRE Core I) heated to melting temperature during the SRE accident

megawatt (MW) – The unit of measure used to describe the electrical output of, or amount of power, produced by a generator. It is equal to 1 million watts. Watts are a unit of electric energy.

moderator – A material, such as water or graphite, that is used in a nuclear reactor to slow neutrons to facilitate a nuclear chain reaction. Once the neutrons given off during fission move at a slower speed, other uranium atoms are more likely to be hit by the neutrons and sustain the fission chain reaction. The **moderator assembly**, also called a **moderator can**, contains the moderator material.

noble gas, also – A group of chemical elements that tend to be odorless, colorless gases, with a very low chemical reactivity. The six noble gases that occur naturally are helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), and the radioactive radon (Rn).

noble gas radionuclides – unstable isotopes of inert noble gases

nonvolatile – A substance that does not readily vaporize or go into the gaseous phase at temperatures experienced in the reactor.

nuclear chain reaction – A self-sustaining, reoccurring process, such as fission or fusion, which uses the products of one reaction to stimulate another.

oxygen contamination in sodium – The accidental mixing of oxygen in liquid sodium, which automatically leads to a chemical reaction. Any oxygen that accidentally gets into the sodium can be considered contamination.

plenum – A space or enclosure into which a gas or liquid flows based on a difference of pressure from one side to an other. In the SRE reactor, the plenum allowed the sodium to flow to the cooling channels in the reactor core.

radioactive decay – The process by which unstable atoms become more stable by emitting energetic particles from their nucleus. This decay, or loss of energy and mass, results in an atom of one type, called the parent nuclide transforming to an atom of a different type, called the daughter nuclide.

radioactivity – Spontaneous disintegration of an unstable nucleus by emission of energetic particles.

radionuclide, also **radioisotope** – An atom with an unstable nucleus that will eventually undergo radioactive decay.

release mechanisms – The ways in which radionuclides may escape from the fuel elements to the surrounding environment (e.g. sodium coolant or cover gas).

run – A specific period of operation of a nuclear research reactor. Each run has a set of planned experiments with defined objectives.

safety rod – A component used when performing a protective shutdown of a reactor.

shielding – A material, usually lead or concrete, used around a nuclear reactor to prevent the exposure of personnel and equipment to radiation.

sodium-potassium bonding – Solid sodium-potassium that is used in the interior of a fuel rod to enhance conduction of heat from the fuel to the coolant. Also known as NaK bonding.

sodium cooled reactor – A nuclear reactor that uses a liquid state of sodium as coolant instead of water.

Sodium exit temperature – The temperature of sodium coolant at the exit of a reactor core coolant channel.

Tetralin – An organic, clear liquid, with a high boiling point.

Tetralin was used to cool the primary pump used to pump sodium coolant between the SRE reactor core and the heat exchanger.

thermal cycling – A temperature modulation process where materials are alternately cooled or heated. In the SRE, this repeated process resulted in the failure of the metal cladding around the nuclear fuel due to overheating of the fuel.

thermal shield – Material that removes heat energy generated by the neutron and gamma radiation, which is transferred to the reactor coolant – that is, the sodium, in the SRE).

thermocouple temperature – Temperature as recorded by thermocouples located at various locations in the reactor.

uncertainty – A state of having limited knowledge, making it difficult or impossible to describe existing conditions or future outcomes exactly. Scientists use the term to describe limits on the confidence in a measurement or their knowledge about a subject. For example, if scientists have a thorough knowledge about a past or future event, it would be described as one with “low uncertainty.” If there is little known about a past or future event, scientists would describe it as one with “high uncertainty.”

vent system – The mechanism to remove gases generated in a nuclear reactor. Because cover gases are potentially radioactive, these gases are collected in a tank, compressed, held until enough radioactive decay has occurred to allow their release to the environment. The vent system also includes piping, filters, and a stack.

vent tube – Components that enable gases and pressure generated inside a moderator can to move to the cover gas region, preventing the moderator can from being damaged.

vessel – Structure housing the nuclear reactor core, which includes the fuel assemblies, control rods, moderator, coolant, and cover gas.

volatile – A substance that easily vaporizes or changes from a liquid to a gas at elevated temperatures.

zirconium can – The housing that surrounded the graphite moderator in the SRE reactor. The can was fabricated from a zirconium alloy, also called zircaloy.