Waste Types and Volumes Generated from a Pressurized Water Reactor and a Comparably-Sized Coal-Fired Plant

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INTRODUCTION

In the United States (U.S.), approximately 56% of the electricity generated from commercial utilities is from coal, while 21% is generated from nuclear power (1). Although both forms of energy production produce waste, it is the generation of low-level radioactive waste that attracts a great deal of attention and scrutiny by concerned parties, such as the media, the public, or political interests. This paper presents a unique comparison of waste types and volumes generated from a typical 1,150 MWe pressurized water reactor (PWR) to that of a comparably-sized coal-fired plant (2).

NUCLEAR WASTE GENERATION

There are four types of waste generated from a PWR: spent nuclear fuel; low-level radioactive waste (e.g., personal protective equipment, spent resins and filters); gaseous waste discharged to the atmosphere; and liquid waste discharged to the oceans, lakes, or rivers. For a typical PWR, the total annual amount of waste discharged, averaged over outage and non-outage years, is 38.6 U.S. tons (35.0 t) of spent nuclear fuel, 47.5 U.S. tons (43.1 t) of low-level radioactive waste, 630 curies (2.3E13 Bq) of gaseous waste, and 570 curies (2.1E13 Bq) of liquid waste. For the gaseous and liquid wastes, the primary constituent is tritium.

COAL-FIRED WASTE GENERATION

A typical U.S. coal-fired plant burning 2.5% sulfur and 10% ash coal burns approximately 4,494,000 U.S. tons (4.1E6 t) of coal per year. The total annual amount of ash produced is 449,400 U.S. tons (4.1E5 t), and is deposited in a landfill. With an average coal ash density of 35 pounds per cubic foot (561 kg/m^3), this equates to 25,680,000 cubic feet (7.3E5 m^3) of waste. The total annual amount of sulfur dioxide emitted up the stack, contributing to acid rain, is 187,400 U.S. tons (1.7E5 t) if uncontrolled. To control the sulfur dioxide emissions, U.S. coal plants are fitted with flue gas desulfurization systems (i.e., scrubbers) spraying a mixture of pulverized limestone and water through the flue gas before it enters the stack and is discharged to the atmosphere. Using scrubbers, the total annual amount of sulfur dioxide is reduced to 18,100 U.S. tons (1.6E4 t), but generates 503,700 U.S. tons (4.6E5 t) of sludge. During combustion, the nitrogen in the air oxidizes to form nitrous oxides. The total annual amount of nitrous oxides emitted up the stack, and possibly leading to respiratory problems, is 58,400 U.S. tons (5.3E4 t) if uncontrolled. Oxygen in the air combines with carbon in the coal to form carbon dioxide. The total annual amount carbon dioxide emitted up the stack, adding to greenhouse gases, is 9,771,800 U.S. tons (8.9E6 t). There are currently no systems used by U.S. power plants to control this gas. In addition, U.S. coal plants emit up to 82 curies (3.0E12 Bq) of noble gases, halogens, and particulates each year.

COMPARISON AND CONCLUSION

In a single year of operation, the total amount of waste generated from a typical 1,150 MWe PWR (e.g., spent nuclear fuel, low-level radioactive waste) is only 1/125,000 when compared to the total amount of waste generated from an equivalent 1,150 MWe coal-fired plant using scrubber technology (e.g., ash, sulfur dioxide, sludge, nitrous oxides, and carbon dioxide). When comparing the 129,464 U.S. tons (1.2E5 t) of PWR decommissioning waste to the 953,100 U.S. tons (8.6E5 t) of ash and flue gas desulfurization sludge, the decommissioning of a PWR generates 1/7 of the total amount. Over a 40-year operating period, the total amount of waste generated from the PWR is 132,908 U.S. tons (1.2E5 t), consisting of spent nuclear fuel, low-level radioactive waste, and decommissioning waste. This compares to the 432,056,000 U.S. tons (3.9E8 t) of waste generated by the coal-fired plant. Still, the PWR generates only 1/3200 of the total amount. This comparison puts the total amount of waste generated from nuclear power into perspective relative to more common forms of energy production.

REFERENCES

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