February 1974

U.S. ATOMIC ENERGY COMMISSION

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 3.20

PROCESS OFFGAS SYSTEMS FOR FUEL REPROCESSING PLANTS

A. INTRODUCTION

Section 50.34 of 10 CFR Part 50, "Licensing of Production and Utilization Facilities" requires, among other things, that each applicant for a construction permit for a production or utilization facility, including fuel reprocessing plants, include the principal design criteria for the facility. Paragraph (f) "Environmental Report," of §50.30, "Filing of Applications for Licenses; Oath or Affirmation," requires that an application for a construction permit or operating license for a fuel reprocessing plant be accompanied by an Environmental Report. Appendix D, "Interim Statement of General Policy and Procedure: Implementation of the National Environmental Policy Act of 1969 (Public Law 91-190)"[1] to 10 CFR Part 50 requires, among other things, that the Environmental Report include a discussion of the status of compliance of the facility with applicable environmental quality standards and requirements. This regulatory guide provides information relative to establishing principal design criteria for equipment associated with process offgas treatment systems for fuel reprocessing plants.

B. DISCUSSION

Process offgas systems, i.e., vessel and dissolver offgas systems are designed to confine hazardous chemical or radioactive materials evolved during process operations and radioactive waste storage and to reduce their concentrations in gaseous process effluents to levels as low as practicable.[2] Usual constituents of process offgas systems are gas collection systems, condensate removal systems, sampling and chemical monitoring systems, and control and instrumentation systems.

Process offgas systems are generally located within building structures designed to prevent uncontrolled release of radioactive materials under postulated accident conditions. Although those portions of offgas systems so located do not require designs which duplicate this capability to withstand postulated accidents, offgas systems should be designed to work with building structures (confinement systems) and building ventilation systems to prevent uncontrolled releases of radioactive material. Those portions of offgas systems not enclosed in protective structures should themselves be designed against failures which could cause uncontrolled release of radioactive materials under all normal operating loads plus those loads attributable to natural phenomena such as earthquakes and tornadoes postulated in the design criteria. Accident conditions postulated should also include equipment and utility failures and failures due to engineering or operating errors.

To meet reliability needs during postulated accident conditions, offgas systems are generally equipped with duplicate equipment items designed to maintain critical functions, e.g., installed spare exhaust blowers and equipment that will automatically switch to emergency utility systems upon loss of prime utility source to assure offgas flow.

Collection lines and offgas treating equipment are exposed to cell atmospheres and decontamination solutions as well as the collected fluids. To assure system reliability, the materials used in lines and equipment must be nonflammable, resistant to heat and the corrosive effects of the collected gases and the strong chemicals used for equipment decontamination.

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[1] On November 1, 1973, the Atomic Energy Commission published in the Federal Register (38 FR 30203) proposed amendments to its regulations which would place the provisions of Appendix D. to 10 CFR Part 50 into a new Part 51 to be entitled "Licensing and Regulatory Policy and Procedures for Environmental Protection."

[2] Guidance on "As Low As Practicable" as stated in 10 CFR Part 20 is being developed. This may include examination of krypton and tritium levels in process effluents.

Stainless steel is usually employed for process lines and vessels, rather than plastics, which may be subject to radiation, fire, or thermal damage, or carbon steel, which may be subject to corrosive attack by process materials or decontamination solutions.

Offgas systems function to handle both condensable and noncondensable gases generated in process operations and waste storage. The condensable component of the offgas consists primarily of steam and water vapor. To minimize the load on the offgas system and to increase the effectiveness of offgas cleanup operations, condensables are generally removed from the offgas stream by condensers and stack drains and then recycled to the process as water. Amounts of condensate in excess of process needs may be discharged as liquid waste to surface waters or revaporized and discharged to the atmosphere. The choice of discharge mode for excess condensables is generally determined by site factors such as meteorology, hydrology, and demography. Regardless of the mode of discharge, sampling and monitoring of all effluents is necessary to assure effective process operation and compliance with regulations concerning release of these effluents.

Offgases are further treated by one or more mass transfer devices, as necessary, to meet release limits for both radioactive and noxious materials. Devices used often include caustic scrubbers, acid scrubbers, activated carbon adsorbers, and zeolite adsorbers to remove iodine, and water scrubbers to remove oxides of nitrogen. Performance data for these devices have been published.[3]

Particulate removal equipment with high collection efficiency is needed to satisfactorily clean gases prior to discharge to the environs. Various types of filters are usually used in this service. To assure reliable process operation, such filters should be resistant to fire or be preceded in the process train by fire-suppressing equipment. Filters and adsorbents such as zeolites can be damaged by liquids in the offgas. To prevent such damage, filters and adsorbers may be preceded by heaters or by electrical or steam traced lines which maintain the offgas above its dewpoint. ORNL-NSIC-65, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Application,"[4] offers a comprehensive review of air filtration systems. This document is not a standard but a guide which suggests several design alternatives.

[3] "Aqueous Processing of LMFBR Fuels–Technical Assessment and Experimental Program Definition," pp. 167-186, USAEC report ORNL-4436, Oak Ridge National Laboratory, June 1970.

[4] C. A. Burchsted and A. B. Fuller, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Application," ORNL-NSIC-65, Oak Ridge National Laboratory, January 1970.

Coordination of designs for the offgas systems with the designs for the confinement systems and building ventilation systems is important to assure complementary functioning of these systems. These systems work together to keep process vessel pressures lower than pressures in surrounding process areas thereby limiting leakage of contaminated gases into process cells and thence into potentially inhabited plant areas.

C. REGULATORY POSITION

1. All parts of the process offgas system should be designed:

a. To limit the release of radioactive materials during normal operation to the levels stated in 10 CFR Part 20.

b. To limit the release of noxious materials to comply with Federal and State statutes and implementing regulations imposed by Federal, State, and regional agencies.

c. To withstand postulated accident conditions to the extent that uncontrolled release of radioactive material to the environs is prevented or to be enclosed within a structure designed to withstand postulated accident conditions to the same extent. Accident conditions postulated should include earthquake, tornado, equipment and utility failure, and engineering or operating error. The pertinent quality assurance requirements of Appendix B to 10 CFR Part 50 should be applied to all activities affecting the safety-related functions of these structures, systems, and components.

d With adequate duplicate process and support equipment to maintain system safety functions in the event of any single failure or during maintenance operations.

e. To resist fire, thermal, effects, and the corrosive effects of cell atmospheres, decontamination solutions, and collected gases to the extent necessary to maintain safety-related functions.

f. To permit inspection, maintenance, and testing of systems and components that have safety-related functions to assure their continued functioning for the life of the facility.

2. The gas collection equipment should be designed to:

a. Collect gases near points of generation and conduct them in closed piping systems to treatment systems for the removal of hazardous chemical or radioactive materials.

b. Operate at negative pressures relative to surrounding cells where practical.

c. Prevent header flooding and unsafe accumulation of fissionable materials by sloping collection piping to drain to appropriate process vessels, by use of condensers and knockout pots, and by use of vessel overflow lines.

d. Minimize entrainment into collection headers, thereby preventing unsafe accumulation of fissionable materials, by sizing vessel offgas lines to provide low gas velocities, by providing deentrainment devices, and by separating vessel offgas lines from other vessel lines such as those receiving jet or pump discharge streams.

e. Limit spread of contamination by preventing backflows from radioactive to less radioactive areas by use of liquid seals on cold chemical addition lines, by providing top entry of offgas branch lines into headers, and by providing pressure-relief devices to guard against pressure increases due to flow blockages or gas flows in excess of design specifications.

f. Minimize radiation exposure to plant personnel by locating process piping containing radioactive material away from areas frequently occupied by plant personnel or by providing local biological shielding.

3. The chemical treatment equipment should be designed to:

a. Remove both radioactive and noxious gaseous contaminants predictably and effectively from process offgases. These contaminants include iodine, organic and inorganic iodine species, and other hazardous materials.

b. Provide protection to zeolite adsorbers against moisture damage.

4. The particulate removal equipment should be designed to:

a. Remove radioactive particulate contaminants predictably and effectively from process offgas.

b. Resist fire and be located downstream from fire-suppressing process devices or be equipped with fire detection and extinguishing devices. Fire-suppressing devices may consist of other process units, such as wet scrubbers used for chemical treatment, or may be systems designed specifically for fire protection.

c. Resist or be protected from condensate damage by maintaining system temperatures above the dewpoint of the gas and by providing low-point traps and drains on supply headers.

5. The exhaust equipment should be designed:

a. To provide motive power adequate to overcome offgas system head and maintain prescribed offgas system pressures to prevent backflow of contaminated gases into potentially inhabited areas.

b. With emergency utilities provided automatically on failure of prime utility source.

6. The sampling and chemical monitoring equipment should provide:

a. Sampling points for offgas on each chemical removal device and at the process offgas system inlet and discharge points.

b. Ports for testing filter efficiency on each safety-related stage of filtration.

c. Redundant continuous monitoring devices adequate to measure and record overall effluent radioactivity and system performance at point of process offgas system discharge to the environs. These devices may be stack monitors which monitor combined plant discharges.

d. Alarms in a continuously occupied control room to indicate safety-related abnormal conditions.

7. Control and instrumentation systems should be designed to:

a. Control automatically or facilitate manual control of all safety-related process parameters.

b. Indicate or record all safety-related process parameters in a regularly occupied control room. Parameters include such items as fluid levels, pressures, temperatures, and radiation levels.

c. Alarm all abnormal safety-related parameters in a continuously occupied control room.

d. Switch in safety-related standby process devices automatically when needed.

e. Switch safety-related process devices to standby power supplies automatically when needed.