TREND ANALYSIS OF COMMERCIAL U.S. NUCLEAR POWER PLANT RADIOLOGICAL EFFLUENTS

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***Abstract*-Commercial nuclear power plants release gaseous and liquid radiological effluents into the environment as a byproduct of electrical generation. These releases are monitored by federal agencies to ensure compliance of regulatory limits. The U.S. Nuclear Regulatory Commission (NRC) and U.S. Environmental Protection Agency (EPA) offer guidance and make recommendations for domestic power plants effluent operations.**

Although these federal agencies track effluent releases, they do not currently compile or analyze the entire industry data. Because of this, international organizations, like the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), have not had a reliable source of U.S. effluent data for the last several years. These organizations require the data for evaluating trends and determining population dose. Individual nuclear power plants also require data for benchmarking operations and work management. In 1997, the North American Technical Center (NATC) began compiling and analyzing the U.S. nuclear power plant effluent release data.

The purpose of this study was to identify trends, calculate average dose commitments, and benchmark U.S. nuclear power plant effluent releases over the last 8 years. Data was taken from the NATC U.S. Effluent Database developed by the authors.

The collection of radiological effluent data has sparked new interest and debate about reporting and studying nuclear power plant discharges. Many more studies will need to be performed to solve some of the effluent trend ambiguities. Evaluating effluent data will also become more important as plants extend their operating licenses, perform reactor power up-rates, or begin new power plant siting.

INTRODUCTION

Commercial nuclear power plants release small amounts of radiation into the environment under normal operating conditions. These radioactive effluent by-products are a result of the beneficial electric generation produced by these plants [2]. Many of the radioactive isotopes that are released are in the form of gaseous or liquid effluents. In the United States two types of commercial nuclear power reactors are operated by the nuclear utilities - boiling water reactors (BWRs) and pressurized water reactors (PWRs). These two design configurations are classified as light-water reactors (LWRs).

United States (U.S.) nuclear power plants are required to monitor the release of these effluents and make certain that they fall below government regulatory limits. The U.S. Nuclear Regulatory Commission (NRC) is the government agency that requires compliance and reporting of the effluent radioactivity levels. In the past, the U.S. NRC compiled the effluent data from all of the U.S. nuclear power plants for government, industry, and public inspection. The data was also made available to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for inclusion in their publication, *Sources and Effects of Ionizing Radiation*, published every five years. However, since 1994 the collection and compilation of the effluent data has ceased due to funding cuts. Compilation and analysis of this data is necessary for trending effluent releases, calculating doses to the public, for industry benchmarking, and comparing reporting standards among U.S. and international nuclear power plants. Accumulated data may also be used for analyzing reactor power up-rate consequences, protecting the nuclear power industry against litigation, and for assisting in new power plant siting. Most importantly, collecting and maintaining an effluent database is necessary in maintaining a favorable public perception in regards to the low environmental and biological impact of nuclear power.

After the cessation of government funding, the U.S. NRC requested the North American Technical Center (NATC) to compile and analyze the U.S. commercial nuclear power plant effluent data. The NATC is an independent scientific organization, located at the University of Illinois at Urbana-Champaign, which was originally formed to help coordinate the Information System on Occupational Exposure (ISOE) Program. The ISOE was created by the Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) in 1992, and subsequently co-sponsored by the IAEA for non-NEA members. The ISOE is a network of communications among participating utilities and regulatory authorities for the collection, analysis, and dissemination of occupational exposure data [6]. The ISOE program is coordinated through 3 regional technical centers located in North America, Asia, and Europe. The IAEA coordinates all non-OECD member countries located throughout the world. In 1996 the U.S. NRC, recognizing the technical expertise of the NATC, designated the NATC as the lead scientific organization to collect, tabulate, analyze and distribute the U.S. effluent database to other interested organizations [8].

The NATC initiated the program to develop a U.S. gaseous and liquid effluent database in 1997, starting with 1994 effluent data. In 2000, the program officially became known as the Public Radiation Safety Research Program. The goals of the program include: development of a U.S. gaseous and liquid effluent database for use by U.S. nuclear power plants, U.S. regulatory bodies, and scientific organizations, expanded trend analysis and discussion of the effluent data, development of a standardized electronic data entry form for licensee use, establishment of an effluent expert group, and establishment of an effluent website to provide database access to the general public [9]. The entire database with expanded trend analyses has been completed for data up to and including calendar year 2000 [4]. This expanded trend analysis of plant effluent releases is the focus of this study.

U.S. COMMERCIAL NUCLEAR POWER PLANTS

Currently in the U.S., there are 103 operating commercial nuclear power reactors [1]. Nuclear power plant sites may contain a single reactor unit or multiple reactor units. Each licensee must submit an annual effluent report to the U.S. NRC to reflect the discharges at each site. Since many of the multiple reactor unit sites share radwaste systems, an individual report may be submitted. Multiple unit sites with independent radwaste systems may also submit an individual report as long as the effluent data is reflected by each reactor unit's discharge. Nuclear power reactor sites with multiple licensees (e.g. Indian Point) must submit separate reports. Plants that are in cold shutdown or undergoing decommissioning must also submit the required annual report if they are still releasing radioactive material into the environment (e.g. Rancho Seco). Figure 1 shows the location of nuclear power reactors in the U.S. (as of 12/2000).

The U.S. NRC uses the annual effluent reports to measure, monitor, and evaluate the radioactive releases of nuclear power plants. Up until 1994, the U.S. NRC also compiled all of the radioactive materials released by nuclear power plants into a yearly publication (NUREG-2907) [14]. This program was coordinated by Brookhaven National Laboratory (BNL). The project, however, was terminated due to the cessation of funding. Currently the U.S. NRC does not trend or analyze the collective nuclear power industry effluent releases.

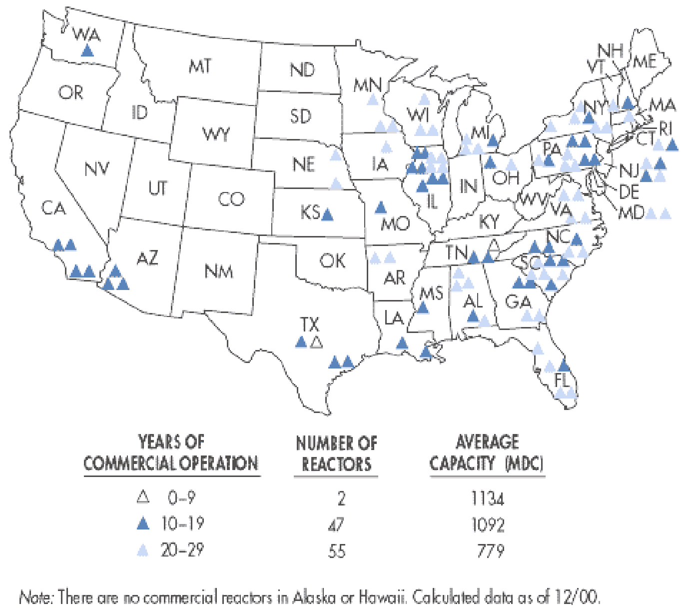

Figure 1: Map of U.S. commercial nuclear power reactor sites [16]

PURPOSE

The purpose of this study was to evaluate the significance, if any, of the nuclear power plant effluent releases in terms of trends, dose commitments and benchmarking. This study was performed at the request of many radiation protection organizations, managers, and regulators. The data used was taken from the NATC effluent database [4]. Analyses were performed using the effluent data from 1994 to 2000 or 2001. Completed studies of all 2001 and 2002 releases will not be available until August, 2003. A brief description of the database and its key qualities will now be discussed.

U.S. EFFLUENT DATABASE

The NATC U.S. commercial nuclear power plant gaseous and liquid effluent database was developed to specifically satisfy the needs of interested U.S. and international organizations. The format in particular was designed to match U.S. NRC and UNSCEAR reports. The database was provided in a Microsoft Excel© format to give annual effluent values. The Excel© files were listed separately by plant type (BWR or PWR) and year. Each sheet was broken down into several effluent categories. These categories were further divided into three separate sections: reactor unit data, reactor site data, and normalized data. Individual isotope categories, besides tritium and iodine, were not defined in this research due to reporting differences by the nuclear power plants.

In keeping with U.S. nuclear power effluent report formatting, the effluent database used the same categories as those listed in U.S. NRC Regulatory Guide 1.21 [12]. The four gaseous effluent categories used in the database are: fission/noble gas (fission/activation gas), iodines (iodine-131), particulates, and tritium. The three liquid effluent categories used are: fission and activation products (fission products), dissolved and entrained gases (dissolved gases), and tritium. Gross alpha radioactivity was not included in this database because it replicates values used in other categories. Those categories listed in parentheses above indicate the titles used in the NATC database. The NATC also decided to add an additional category of liquid effluents called "others". This category takes the sum of the liquid fission and activation products, and the dissolved and entrained gases. This category was created to replicate the reporting done by UNSCEAR

The reactor unit data section of each category gives the raw, unnormalized data provided in the U.S. NRC Regulatory Guide 1.21 reports. The nuclear reactor unit was listed along with the radioactivity values in GBq and Ci. A comment section was also included to indicate if the reported value is for the reactor unit or site. If data was given for the site (usually done for shared radwaste systems), reactor unit values were obtained by dividing the radioactivity by the number of reactor units on site. Although this method of determining reactor unit effluent radioactivity was not entirely correct, it was the only way to obtain reactor unit values. Every effort was made to correctly divide the data if it was known that one or more of the reactor units were not discharging effluents.

The reactor unit data lists all operating PWR and BWR reactors. The data also lists shutdown reactors that are still discharging radiological effluents. These reactors were included to realistically calculate the total amount of radioactivity released by U.S. commercial nuclear power plants. The reactor site data is obtained by summing the values from the reactor unit data for the applicable nuclear power plants. If the site values are initially reported, then these are used to avoid rounding errors. Totals are also obtained for the entire category of release.

Using the values in the reactor site section, the effluent data was normalized. This was achieved by taking the amount of radionuclides released per unit of electrical energy generated each year. This method is the most common way to normalize effluent data and is used by UNSCEAR. The electrical energy generated per year was obtained by multiplying the net electrical energy generated by the capacity factor. Capacity factor is defined as the gross electricity generated divided by the product of the licensed capacity and reference time. The capacity factor and energy generation data were obtained from the U.S. NRC [15, 17]. Normalizing data in this manner takes into account the operational performance of the nuclear power plant. However, it also assumes that effluent release amounts are a direct consequence of operation time. Variations in numbers, sometimes by orders of magnitude, show that this is not necessarily the case.

Using the normalized totals, the collective effective dose was calculated. This effective dose was obtained using an average collective dose developed by UNSCEAR. To avoid skewing trending and benchmarking studies, abnormal values were withheld until verification is completed by nuclear plant personnel. Observation of the data shows that on average, radioactivity levels were less then 1% of the regulatory limits set forth in 40 CFR 190.

The existence of the NATC U.S. nuclear power plant database provides interested organizations with easily accessible data. In addition to the hardcopy version, the database is available on the NATC Public Radiation Safety Research Program website for public use. The database clearly shows the radioactive effluent values for each reactor unit and site. Nuclear power plant personnel have expressed approval for both the format and content of the database.

EFFLUENT RELEASE TRENDS

As commercial nuclear power electrical generation steadily increases in the U.S. and the rest of the world, it has become even more important to evaluate the release of radioactive materials into the environment. An easy way to track industry wide effluent releases is by performing trend analyses. The 1994-2001 PWR and BWR, unnormalized and normalized data, were used to trend the nuclear power industry discharges.

Traditionally, only normalized releases are compiled for trend analyses. Average normalized releases better reflect particular operating conditions (i.e. amount of electrical energy generated, etc.). Also, atypical releases by one or more plants tend to skew unnormalized data more then normalized data. However, at the request of the nuclear power industry, U.S. NRC and the general public, unnormalized data was also trended. The public in particular, is only concerned with the raw release values, since that data determines the population dose around the vicinity of the nuclear power plant.

Overall the releases have stayed constant during the analyzed 8-year period (Figures 2 and 3). The advantage of using 8 years of data is that operation anomalies, such as long shutdown times for maintenance, are averaged out. The gaseous releases of fission/noble gases have slightly declined for both BWRs and PWRs. Gaseous iodines, particulates, and tritium have showed only slight variations. Liquid releases have stayed very constant over the 8-year period. The generally larger releases of tritium in PWRs, and iodines and particulates in BWRs (taken from the raw effluent data) support other published observations [5, 3].

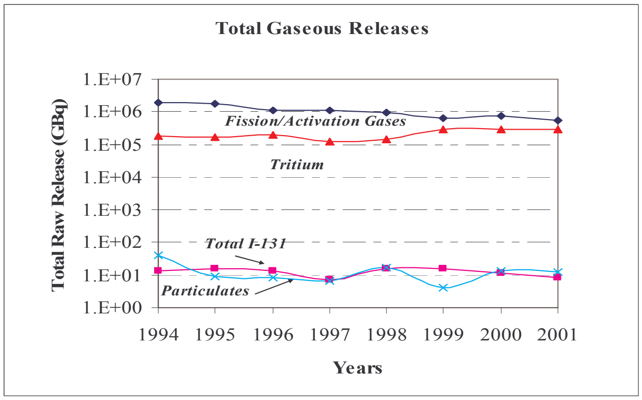

Figure 2: Unnormalized total gaseous effluents released (1994-2001)

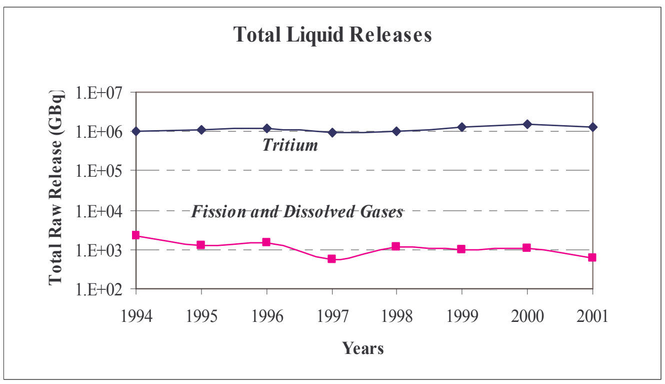

Figure 3: Unnormalized total liquid effluents released (1994-2001)

Trending effluent releases with normalized data is the preferred method used by UNSCEAR. Normalization by electrical energy generated has been used to show overall industry trends. However, like unnormalized data, atypical releases may dominate the normalized release values. In this case, the normalized releases reflect only the prevailing operating experience, and cannot be taken as representative of the releases from a particular reactor type [11].

The evaluation of the normalized data over the 8-year period partly eliminates variations in annual values. Similar to the unnormalized data trends, the normalized releases are fairly constant or slightly decreasing (Figures 4 and 5). The normalized releases of BWR fission/noble gases have shown the greatest decrease (>1 order of magnitude). Gaseous iodines, tritium, and particulates have stayed fairly constant. Liquid tritium has stayed the most stable while liquid fission products and dissolved gases have shown a slight decline. The combined total liquid and gaseous releases follow the same patterns.

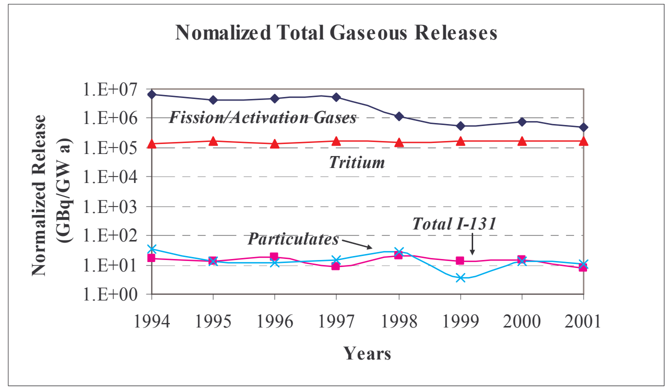

Figure 4: Normalized total gaseous effluents released (1994-2001)

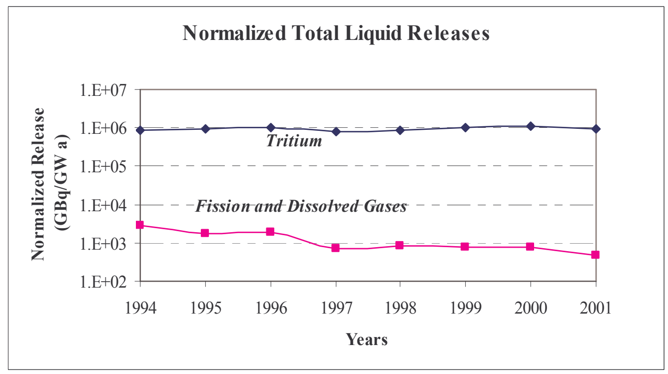

Figure 5: Normalized total liquid effluents released (1994-2001)

Declines in effluent releases may be due to improved operations (i.e. early leak detection), better fuel, and improved radwaste systems. The decrease in BWR fission/noble gases is probably a direct result of longer holdup times for radioactive decay. More research needs to be performed in these areas to evaluate their significance in decreased effluent trends.

DOSE DETERMINATION

Tracking effluent release quantities is important in determining radioactive levels in the environment. However, dose determination of the effluents must be performed to evaluate the human effects of these radiation sources. Commercial nuclear power plants use the guidelines set forth in U.S. NRC Regulatory Guide 1.109 to calculate annual doses to the public from routine releases of radiological effluents using different exposure pathways [13]. This guide bases its calculations on the geographical, meteorological, and population characteristics of the specific nuclear power plant site.

Over the last several years, nuclear power plants have even developed site-specific computer programs for determining population doses. Although site-specific models and programs are necessary for regulatory compliance of dose determination, it is impractical and burdensome to use them for large amounts of effluent data from multiple reactor sites. Instead, a wide-ranging model should be used to obtain a generalized measure of reactor operating experience and serve as a standardized parameter for analyzing long term trends.

For the U.S. effluent database, the UNSCEAR effluent dose assessment model was used. The dose assessment procedures are applied to a model site with representative environmental conditions. The average population density used is 20 km^{-2} within 2,000 km of the site. Within 50 km of the site, the population density is taken to be 400 km^{-2} [11]. Using this model site, the collective effective dose per unit release was obtained for the different release categories.

The collective effective dose per unit of electrical energy generated (man Sv $(GW\ a)^{-1}$) is obtained by multiplying the normalized releases (unnormalized release divided by electrical energy generated) by UNSCEAR calculated collective doses per unit release (man Sv PBq^{-1}). The collective doses per release were calculated using appropriate UNSCEAR dose pathway models. For example, an ingestion dose pathway was used for both liquid and gaseous tritium. From these values, the collective effective doses for each nuclear power plant in each release category were obtained (gaseous fission/noble gases, gaseous iodine, gaseous particulates, gaseous tritium, liquid tritium, and liquid others).

The collective effective doses show exactly how insignificant the radiological releases are to man. The doses are so low in fact, they only represent up to a few percent of the regulatory limits. For example, in the year 2000 the highest collective dose calculated was attributed to the gaseous fission/noble gases discharged by Cooper Nuclear Station. The collective effective dose was 44.55 man mSv/GW a (4.455 man rem/GW a). Using the electrical energy generated that year, the total collective effective dose was 24.03 man mSv or 2.4 man rem. This represents the dose given to the entire population within the vicinity of the power plant. Using the UNSCEAR number of 20,000 people per 50 km^2 around the site gives a dose commitment of 0.0012 mSv or 0.12 mrem. This value is 0.12% of the annual limit set forth in 10 CFR 20 (1 mSv or 0.1 rem).

Figures 6 and 7 display the total BWR and PWR effluent collective effective doses (1994-2000). It is not surprising that the doses follow similar trends as the release amounts since both are determined using the same data. For gaseous releases, the highest collective doses are from the fission/noble gases and tritium. This is partially due to the fact that these are released in highest quantities. Both of these categories however, have the lowest collective doses per unit release. Gaseous particulates and iodines, which have higher collective doses per unit release, actually contribute to a smaller total collective effective population dose. Recall that site-specific models may provide different results.

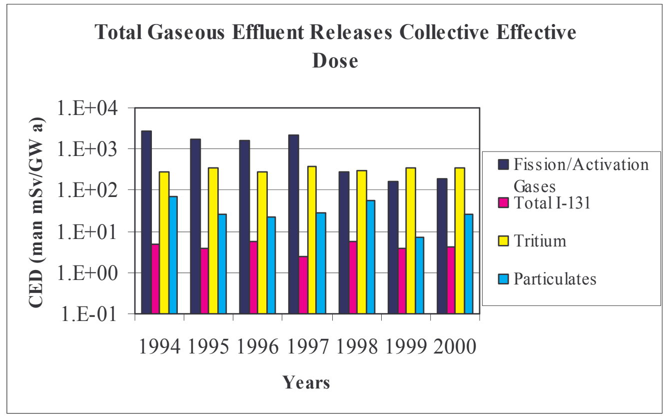

Figure 6: Total gaseous effluent release collective effective doses for PWR and BWR plants (1994-2000)

For liquid effluents, doses from PWR tritium and particulates are similar. Tritium is released in much larger quantities, but particulates have a much higher collective dose per unit release (330 man Sv PBq^{-1} or 33 man krem PBq^{-1} versus 0.65 man Sv PBq^{-1} or 65 man rem Sv PBq^{-1}). In BWRs the particulate doses are higher, as the tritium releases are smaller. The total (PWRs and BWRs combined) liquid effluent releases doses have stayed very constant over the 7-year period. The total gaseous effluent releases doses are more variable.

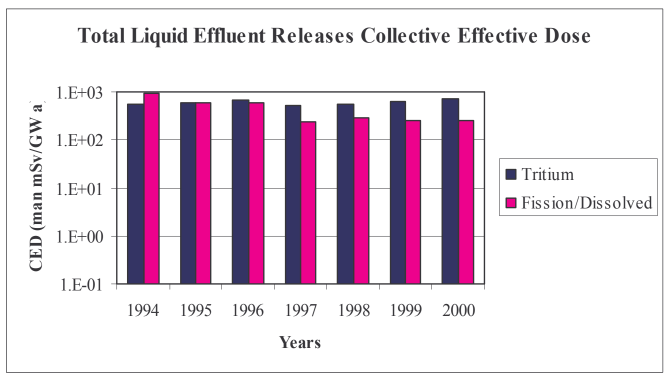

Figure 7: Total liquid effluent release collective effective doses for PWR and BWR plants (1994-2000)

Overall, the collective effective doses have remained constant over the last several years for the entire commercial nuclear power industry. The use of a general dose model allows for analysis of these trends. Nuclear power plant effluent personnel can take advantage of the database and dose model for conducting general comparisons of their effluent release doses to those of other plants. Comparisons among similar designed plants can also be made.

UNITED STATES COMMERCIAL NUCLEAR POWER PLANT BENCHMARKING

The commercial nuclear power industry has long used benchmarking studies to promote excellence in plant work management and operation practices. The U.S. NRC benchmarks plant performance in order to revise regulations and operational recommendations. American Nuclear Insurers (ANI) also benchmarks several components of nuclear power plant operations to determine insurance premiums. Other organizations, such as the NATC, have performed benchmarking studies of interest to nuclear power plants. Each year the NATC ranks plants based on outage and normal operation occupational dose.

Recently, many nuclear power plants have reduced their effluent and environmental monitoring (RETS and REMP) programs because of cost-reduction initiatives. Both the U.S. NRC and ANI have expressed concern over these practices. It has now become necessary to further monitor and compare effluent releases by plants to help minimize a public relations incident. One method to compare radiological releases is by ranking the nuclear power plants based on reactor type. Performance ranks are very important to the nuclear power industry. Poor performance often leads to increased scrutiny by the public and heightened surveillance by the U.S. NRC. Because of these consequences, a plant will usually attempt to make improvements in its rank by changing management or operation practices.

A simple method of ranking nuclear reactor radiological category releases is by plant design. Specifically, the categories are broken down by sister plants (e.g. General Electric BWR-4). This method is currently used for occupational exposure data and has received approval by nuclear power plant personnel. One problem with this method for radiological effluents is that sister plants from the same site will have identical rankings if they share radwaste systems. Recall that release data is broken down by dividing the reported release of the site by the number of reactor units on the site. For example, if the releases are reported by site, abnormal releases by one of the reactors will be masked by taking the average of all the reactors (to get an individual reactor value). However, because of current reporting practices, sister plant breakdowns must be performed this way.

To accomplish the task of ranking discharges, separate sister plant databases were created using the PWR and BWR effluent data. Sister plants were verified using U.S. NRC information [17].

BWR Sister Plants

For effluent benchmarking, the BWR plants were broken down into their respective sister plant design categories. The sister plant designs used in this study were: BWR-2, BWR-3, BWR-4, BWR-5, and BWR-6. General Electric (GE) developed all these BWR designs. Only operating reactors as of 1994 were included in the database. The 1994 to 2000 raw (unnormalized) and normalized (with the collective effective doses) data were also included in the database. With this information, the total and average values were calculated for the 7-year period.

Unnormalized releases were used because the U.S. nuclear power plant industry is not concerned with normalized releases at this time (i.e. they are not used for regulatory compliance). Average raw releases were obtained by taking the discharges of each category divided by the number of years of data. This method averages out variabilities in yearly releases, long shutdowns (>6 months), and missing data. For most plants, 7 years of data are included (1994-2000).

The radiological release values are very wide ranging for the sister plant groupings. For example, in the BWR-4 sister plant group, Peach Bottom Units 2 and 3 have the highest average gaseous fission/noble gas release at 115,482 GBq. Susquehanna Units 1 and 2 have the lowest values (180 GBq). In other instances the average releases are very similar. Average gaseous particulate releases are nearly identical for the BWR-5 sister plant group. The release amounts as a whole show no obvious trends.

Several plants achieved very low average release amounts for the 7-year period. Clinton 1 had the lowest average gaseous fission/noble gas release at 7.66 GBq. Clinton Unit 1 and Susquehanna Units 1 and 2 recorded no measurable activity for gaseous iodine in this period. Cooper Unit 1 and Grand Gulf Unit 1 released no measurable activity of gaseous tritium and particulates, respectively. Several plants including Clinton Unit 1, Vermont Yankee Unit 1, and Duane Arnold Unit 1, have zero release policies for their liquid effluents.

In addition to comparing individual plants to their sister plants, entire sister plant grouping can be compared. The advantage of this comparison is to see if one design incorporates some “advantage” in terms of effluent release quantities. Figure 8 shows the BWR sister plant grouping comparisons for all effluent categories. Averaging over 7 years for all the plants, it is not clear if one design is “better’ then another. The newest plants (BWR-6) seem to release larger quantities of liquid effluents. The older plants (BWR-2) release slightly larger quantities of gaseous effluents.

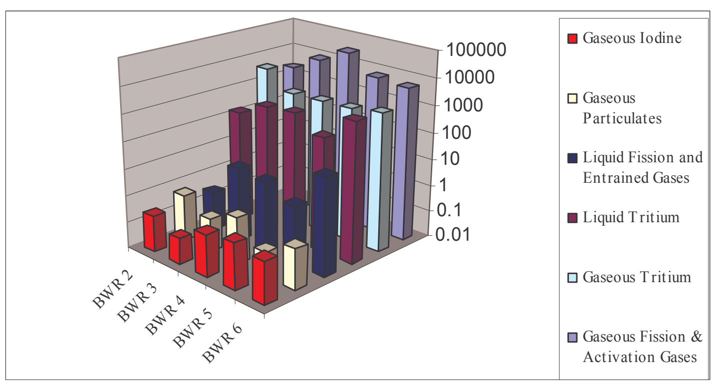

Figure 8: BWR sister plant grouping average effluent release (GBq) categories (1994-2000)

Figure 9 shows the average collective effective doses for the sister plant groupings. Trends are similar to the raw release values, except that variabilities or outliers can seriously affect the results. This is clear for the liquid fission and entrained gas category.

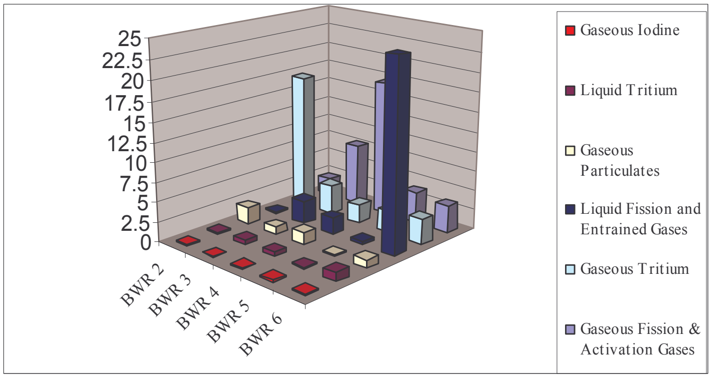

Figure 9: BWR sister plant grouping average collective effective doses (man mSv/GWa) for all effluent release categories (1994-2000)

PWR Sister Plants

The PWR plants were broken down into their respective sister plant design categories in the same manner as BWRs. The sister plant designs used in this study were: B&W 2 Loop, CE 2 Loop, Westinghouse 2 Loop, Westinghouse 3 Loop (Generation 0), Westinghouse 3 Loop (Generation 1), Westinghouse 4 Loop (Generation 0), and Westinghouse 4 Loop (Generation 1). The CE 2 Loop, Generation 1 reactors were not included in this study. Only the Palo Verde reactors fall into this group and since that site uses one radwaste system, no comparisons can be made. Also, the Westinghouse 2 Loop designed plants were grouped together because the design differences are not enough to affect effluent releases [10]. Only the 1994 to 2000 raw (unnormalized) and normalized (with the collective effective doses) data for operating reactors were included in the database. With this information, the total and average values were calculated for the 7-year period.

The graphical values are very wide ranging for the liquid releases and follow no particular pattern. The gaseous tritium and fission/noble gas release categories are extremely variable. The ranges span several orders of magnitude. However, the sister plant groups release very small amounts of gaseous particulates and iodine. The variation in values is also small (0-0.37 GBq for iodines and 0-0.10 GBq for particulates). Indian Point Unit 2 has an abnormally high particulate release average due to a steam generator tube leak [7].

Several plants achieved low average release amounts for the 7-year period. Releases of gaseous iodines and particulates were undetectable at several plants. Kewaunee 1 had the lowest average gaseous fission/noble gas release at 3.93 GBq. Indian Point Unit 2 recorded the lowest measurable activity for gaseous tritium in this period (90.52 GBq). Palisades Unit 1 achieved the lowest release average for liquid tritium and fission products/dissolved gases.

Figure 10 shows the PWR sister plant grouping comparisons for all effluent categories. Averaging over 7 years for all the plants, it is evident that the PWR designs are much more consistent with each other, especially compared with the BWR plants. Age also does not seem to affect effluent release quantities.

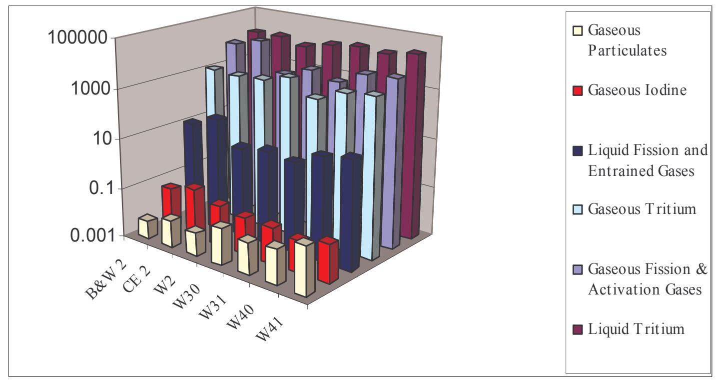

Figure 10: PWR sister plant grouping average effluent release (GBq) categories (1994-2000)

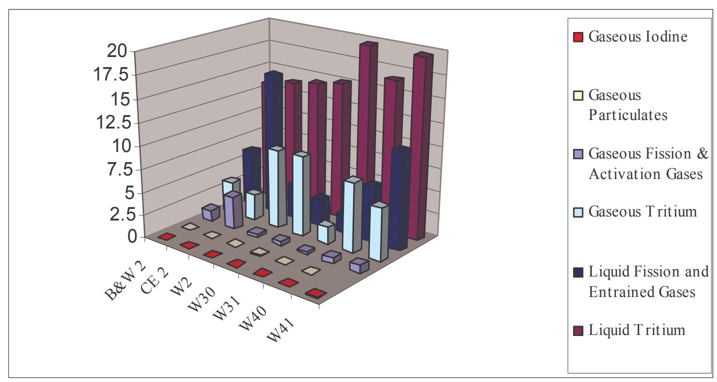

Figure 11: PWR sister plant grouping average collective effective doses (man mSv/GWa) for all effluent release categories (1994-2000)

Figure 11 shows the average collective effective doses for the PWR sister plant groupings. Trends are similar to the raw release values. Some variabilities exist, but no outliers significantly affect the groupings.

Data for U.S. nuclear power plant effluent release benchmarking were never presented in this way and have proved beneficial in promoting conversation about investigating nuclear power plant effluent releases more thoroughly. However, more studies need to be performed to better evaluate the average releases for all nuclear power plants.

CONCLUSION

Many of the items presented in this paper reflect the analytical potential of the NATC Public Radiation Safety Research Program's U.S. commercial nuclear power plant gaseous and liquid database for regulatory, industrial, and scientific benefit. The development of the comprehensive effluent database has already been used to provide data to several nuclear power plants, UNSCEAR, and the U.S. NRC. Trends were identified to show long-term U.S. nuclear industry effluent release patterns. Using a standard model, the average effluent collective effective doses were also calculated. This component of the research helped to show how low normal operation effluent doses are, compared to regulatory limits. Sister plant effluent breakdowns were performed to identify design trends, and provided benchmarking tools for the U.S. industry.

Although this research provided important insight into commercial nuclear power plant discharges, more studies are needed to truly understand effluent trends and nuclear power plant radioactivity. Radioactive releases are dictated not only by electrical generation, but also by the design of radwaste systems, the age of the plant, and the method of release. A total inventory of radioactive materials released needs to be accounted for to understand what factors contribute to effluent releases. The NATC has started a database to collect the solid radioactive waste data from power plants. This should provide a better understanding of the total radioactivity released by plants. The development of a more comprehensive database that identifies the actual isotopes released is also underway. A study concerning the radwaste systems at each plant would also be helpful in understanding discharge amounts.

Identifying trends and benchmarking releases would be much easier and more accurate if the U.S. industry utilized a standard report. Although many plants use U.S. NRC Regulatory Guide 1.21 or a similar template for reporting their effluents, others use very different formats. This creates the problem of inconsistent categorization of effluents. For example, some plants only report iodine-131 in their gaseous iodine category. Others use all the iodine isotopes found. This results in comparisons that are not truly accurate. To confront reporting differences and other concerns, the NATC has organized an effluent expert advisory committee. The committee is made up of experts from the nuclear power industry and academia. A primary goal of the advisory group is to develop a standardized effluent report that can be used by nuclear power plants to report their releases electronically to the NATC and U.S. NRC.

Effluent tracking and reporting will continue to be important for the future of the commercial nuclear power industry. As plants conduct reactor power up-rates, effluent releases will need to be observed to determine if there are any effects from this design enhancement. Effluent trending may also reveal insight into the effect of increased reactor lifetime operation on radioactivity releases. Currently, many plants have been approved for, or are applying for, operating license extensions. Tracking data for siting of new nuclear power plants may also be used to determine environmental radionuclide buildup and long-term nuclear power health effects.

Finally, effluent tracking and analysis is important in maintaining favorable public opinion about nuclear power. The more accurate, scientifically based information that citizens can be provided with, the more likely they are to make informed, non-emotional judgments about nuclear power.

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