

BRC AND THE CONCEPT AND ESTABLISHMENT OF A LOWER LIMIT FOR VERY LOW-LEVEL RADIOACTIVE WASTES

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ABSTRACT

Inherent in any discussion or consideration of low-level waste management is the concept of an established lower boundary: the radiometric value below which the waste is no longer considered to be hazardous in a regulatory sense. The most recent attempt to arrive at this value is embodied in a concept known as Below Regulatory Concern (BRC). It was mandated, established, reviewed, and revoked by the Congress through the Nuclear Regulatory Commission (NRC) in a series of actions extending from August 29, 1985, to August 24, 1993.

It actually makes absolutely no difference as to whether we refer to this waste as the politically unacceptable BRC, the older *de minimis* designation, or the informal, international term Exemptable Waste (EW); the concept is the same. We must establish this boundary. The withdrawal of BRC rule making on the federal level has created the potential for developing major problems in nuclear waste in the areas of economic evaluation, engineering design, and remediation. Additionally, it has left such major waste classification categories as Naturally Occurring Radioactive Material (NORM), Accelerator Produced Radioactive Material (NARM), and Class A Low-Level waste without basic foundations.

It is recommended that the International Atomic Energy Agency (IAEA) value for Exemptable Waste (1 mrem/yr or 10 microsieverts/yr) be adopted. This figure could be usefully applied for numerous wastes and waste streams, despite the fact that it is four times less than the Environmental Protection Agency (EPA) recommendation and ten times less than the maximum limit originally adopted by the NRC.

INTRODUCTION:

The most recent attempt to develop a regulatory framework to establish a boundary below which waste is no longer considered to be hazardous is embodied in the concept known as Below Regulatory Concern (BRC). Section 10 of the Low-Level Radioactive Waste Policy Amendments Act of 1985 required the NRC "...to develop standards and procedures for expeditious handling of petitions for rulemaking to exempt disposal of radioactive waste determined to be below regulatory concern." In its brief history this mandate has been instituted, established, reviewed, and revoked by the Congress in a series of actions that have taken place in a period of time extending from August 29, 1985, to August 24, 1993.

What impact has the revocation on the concept? We think none. It makes no difference as to whether we refer to this waste as the politically unacceptable BRC, the older *de minimis* designation, or the informal, international term Exemptable Waste (EW); the necessity for the concept is the same. *De minimis* is taken from the Latin maxim "*de minimis non jurat lex*" (the law does not concern itself with trifles)(1). It was adopted by the IAEA in 1979 to develop a clear legal distinction between low level and very low level wastes dumped at sea, which is an international problem, as opposed to dumping terrestrially, which is a national problem (2). Exemptable Waste (Waste Category 6) of the current solid waste classification (3) is informally individually taken as maximum annual effective dose equivalent from any exempted source or practice which should not exceed 1 mrem (10 microsieverts).

The withdrawal of the BRC rule making on the federal level has created the potential for developing major problems in

nuclear waste in the areas of economic evaluation, engineering design, and remediation. Additionally, it has left such major waste classification categories as Naturally Occurring Radioactive Material (NORM), Accelerator Produced Radioactive Material (NARM), and Class A Low-Level waste without the basic necessity of a lower limit. A lower limit is similarly an absolute requirement for any future applications to be developed in the areas of reuse and recycling of materials (e.g., steel, copper, etc.). Without a regulated lower limit it will be impossible to decontaminate, decommission, or remediate any licensed nuclear facility. The problem of the development of radiological criteria for decommissioning activities for NRC licensed facilities is underway [58 FR (Federal Register) 37760] (4). The IAEA has developed approaches to the problems encountered in classifying, identifying, and monitoring recyclable and reusable materials from decommissioned facilities (5,6,7,8,9). The problem of very low level waste should be examined on three levels: local, national, and international.

STATE-LEVEL BRC

On the state level Texas still retains the Below Regulatory Concern designation for selected medical, industrial, and research facilities wastes. It has an established limit of 1 mrem/yr (10 microsieverts/yr) for its short-lived waste. It has, through the Texas Department of Health, been active in radiological health activities since 1947. Today, it is a NRC Agreement State which allows the current responsible agency, the Texas Bureau of Radiation Control, to assume the responsibility for all licensing and regulation of radioactive material in Texas except that from nuclear reactors and weapons. E.P.A. has selected Texas as a Delegated State. This

designation allows it to regulate and handle its hazardous substances such as NORM (10).

Texas uses its BRC equivalent for selected medical, industrial, and research facilities wastes. NORM wastes present major state and national problems in specific reference to: oil and gas scale and sludge, rare earth production, water purification, phosphogypsum mining, and coal fired plants. None of these materials can be regulated without serious to disastrous financial consequences. Decommissioning pipelines will destroy the domestic petroleum industry. Water purification in areas of South Texas with high radionuclide content is not feasible; the sediments in which the water is extracted contains the uranium. Phosphogypsum, waste from the fifth largest mining industry in the U.S., has now been regulated by the EPA under the Clean Air Act at radium-226 10 picocuries/g [58 FR 23305; 40 CFR Part 61]. Its impact on the industry is unknown. Texas has an established limit of 1 mrem/yr (10 microsieverts/yr) for its short-lived waste (11). This figure will probably be equivalent or below that formally adopted by the International Atomic Energy Agency (IAEA) for their Exemptable Waste (EW) classification. We are of the opinion that this figure is both conservative and reasonable.

BELOW REGULATORY CONTROL CONCEPT

The national problem is to determine what follows BRC. BRC was specifically instituted by Congress in 1985 to take care of very low radioactive wastes by establishing a specific safe value for BRC. The NRC was to act as the regulatory agency for petitioners wishing to have specific waste streams classified as BRC. The NRC was further given the mandate to issue timely, generic, industry-wide decisions on specific waste streams which would eliminate the need for duplicate petitions from a series of producers with the same waste streams.

The basic rules were issued by the Nuclear Regulatory Commission (NRC) in a policy statement given in the Federal Register [51 FR 30639] on August 29, 1986. The concepts and requirements as originally set out by the NRC were reasonable and appropriate. If we are looking to once again establish a lower limit to selected nuclear waste streams, it is worthwhile to reanalyze the original intent and framework of the BRC policy to see where it proved to be defective and what, if any part, can be resurrected to establish a new lower radioactive waste limit, regardless of what name we call it.

The NRC, among its other functions, was to act as judge on BRC petitions. To qualify for consideration for exemption, the operator needed to file a specified set of data, answer 14 basic commission decision criteria, and adhere closely to a detailed set of administrative procedures. A partial list of the NRC general information requirements (10 CFR Part 2) would include such items as: waste characterization, management options, analyses, record keeping and reporting, specifics of the proposed rule, administrative handling, and responses to the decision criteria.

The five general data requirements of the petition included: 1) identification of the problem with the reason for interest and the proposed solution; 2) documentation supporting the fact that there would be no significant impact on the quality of the human environment; 3) the proposed action must not have any adverse impact on small entities; 4) the NRC IMPACTS-BRC (NUREG/CR-3585) computer program was preferred; other programs or parts of programs would require extensive documentation; and, lastly, 5) geo-

graphical area (e.g., states, compacts) involved in the exemption.

The requirements for waste characterization include: the identification of the radionuclides present, in addition to their half-lives; concentration levels; and total quantity present. The components of the nonradiological portion of the stream also must be documented (e.g., origin, chemical composition, physical state, stability, etc.). The implication is that models will require actual data as these exemptions cannot be considered to be simply a theoretical mathematical exercise. As the decisions of the Commission would have had the potential to develop into generic ones, an estimate of the number of other similar waste streams needed to be made; variation in concentrations in these streams and estimates of total annual quantities produced also were required. Lastly, the waste stream must follow the Commission's ALARA (as low as is reasonably achievable) requirement in 10 CFR 20.1(c). The petition should designate waste management options. If onsite, will it be burial or incineration? If offsite, will it be some municipal waste disposal facility such as a sanitary landfill or, perhaps, sent to a hazardous waste disposal facility or incinerator? The operator must select a favorite option as well as what will be required to prepare the material for disposal (e.g., shredding, compacting).

Analyses were and are required to justify every petition. Radiological impacts as those specified in NUREG/CR 3585 and the computer program IMPACTS-BRC should be addressed. On May 18, 1992, NUREG/CR - 5797, IMPACTS - BRC, VERSION 2.1 was listed in the Federal Register [57 FR 21139]. Impacts Version 2.1 contains the last iteration of the program's code and data verification as well as another revised version of the input files. The NUREG document describes code history, quality assurance work, and summarizes all literature reviews up to version 2. This program was developed to support review of petitions to exempt specific waste streams. The original code was known as IMPACTS-DE MINIMIS (NUREG/CR-3585 Vol. 1). *De minimis* Waste Impacts Analysis Methodology was developed by O.I. Oztunali (Dames and Moore) and G.W. Roles (NRC) in late 1983 and published in February of the following year. IMPACTS - BRC version 1.0 (NUREG/CR 3585 Vol. 2) was a modified version of the original impact-*De minimis* code. The code was developed to the point to where it could be used on personal computers. IMPACTS-BRC version 2.0 (NUREG/CR 5517) was a modification and revision of version 1.0. This includes such factors as current dose conversion factors, peer review accountability, validation, and verification. Further independent review produced version 2.1. This document recommends that models be limited to site screening applications and advises the use of alternate models for groundwater and surface water transport calculations to quantify site specific impacts and exposures. Since this iteration and the enactment of *The National Energy Policy Act* of 1992, no further versions have been made available.

Developed analyses in the petitions must clearly address maximum individual exposure, critical group exposure, and cumulative population exposure. Analytical documentation of the nonradioactive waste material in the exempted waste stream must be provided. The regulatory analysis, if the petition is granted, must respond to the questions developed in NUREG/BR-0058, Rev. 1, Regulatory Guidelines of the U.S. Nuclear Regulatory Commission. The basics include: statement of the problem (i.e., determination of which wastes do not require disposal in a licensed low-level waste site), a listing

of all reasonable alternatives plus the status quo, consequences of this action, what decision rationale was used, and an implementation schedule. The NRC considered that a cost/benefit discussion was an essential part of the evaluation of the proposed exemption.

Record keeping (survey) requirements were developed by utilization of the existing regulations in 10 CFR 20.201 which established the general NRC requirements. A typical survey might include: a fairly comprehensive initial sampling; establishment of a periodic analysis to confirm the initial finding; quality control; and routine survey to monitor the system. Reports should be made on at least an annual basis.

The proposed rule sent to NRC should include the quantity and/or concentration for each radionuclide, with trace radionuclides lumped together as a total limit. A proposed method to deal with the radionuclide mixtures of the stream needs to be defined as well as adequately documenting the nonradioactive component of the waste stream. A specific method or methods for the disposal of the exempted BRC material needs to be made.

CHRONOLOGY

The chronology of some 47 events involved in the concept of Below Regulatory Concern can document it from its inception to its demise. The great bulk of the data comes from three fundamental sources: the Federal Register and two selected hearings given before the Subcommittee on Energy and Environment of the Committee on Interior and Insular Affairs of House of Representatives of the United States Congress (Serial Nos. 101-29 and 102-25)(12)(13). The following brief summary is not intended to be anything more than a general pattern of events that reflects the sequence of problems encountered in the implementation of the concept by the Nuclear Regulatory Commission.

On January 15, 1986, the Low-Level Radioactive Waste Policy Amendments Act of 1985 was signed into law. The Commission was directed to establish standards and procedures to consider deregulating certain low-level wastes; specifically to develop criteria and procedures to act on petitions "To exempt specific radioactive waste streams from regulation. ...due to the presence of radionuclides in sufficiently low concentration or quantities to be below regulatory concern (B.R.C.)." NRC on August 29, 1986, in response to a provision of the Low-Level Radioactive Waste Act of 1985 [51 FR 30839] set the criteria for the evaluation of petitions as set forth in 10 (Code of Federal Regulations) CFR, Part 2, Appendix B of the Commission's regulations. The Commission requested public comment on their August 29th policy [51 FR 43367] with its generic rulemaking capability and its 14 decision criteria.

The NRC started to prepare a comprehensive BRC statement in late 1987. Concurrently with this task a problem arose concerning the practice of irradiation of gemstones, which was clearly prohibited under the Atomic Energy Agency (AEC) policy statement on the use of radiation in consumer products [30 FR 3462]. The BRC base limit fluctuated between 1 and 10 mrem/yr within the NRC. The internal difficulties concerning these two points, recorded by memos, etc. (12), continued within the Commission through the published advance notice [53 FR 49866] until the issuance of the final notice on June 27, 1990. The individual dose limit was set at 10 mrem/yr and allowed an unlimited number of deregulated practices with a 100 mrem/yr limit. Two months later (2/2/89) the EPA severely criticized the advance notice of the NRC's

BRC policy statement. They noted that the policy does not adequately protect public health, quality of man's environment, has an individual dose limit too high, and the 100 mrem per year limit is totally inappropriate.

On April 6, 1989, the EPA submitted a draft low-level waste rule to the Office of Management and Budget (OMB) which contains a BRC regulation of 4 mrem per year for all BRC waste practices. This rule was stalled at the OMB through July 26, 1990, in part due to objections from both the NRC and the DOE that the permissible exposure levels were too low. The 1965 policy statement on consumer products was revoked in the final NRC BRC notice of June 27, 1990. The limits were set for individual dose criteria at 1 to 10 mrem/yr (0.01 to 0.1 millisieverts/yr) and 1000 person rem collective dose level (10 person sieverts/yr). Simultaneously the EPA Office of Radiation Programs (ORP) reacted to the BRC statement and indicated by memo some seven major problems in the policy. Internal memos (12) also revealed some concern over the "usurpation of EPA jurisdiction."

The NRC issued a general statement on BRC(55 FR 27522) July 3, 1990. They prepared a unified framework for exemption decisions for very low radioactive wastes. Specific areas addressed include: decommissioning and decontamination, distribution of consumer products, reuse and recycling of slightly contaminated material, and management of very low radioactive wastes. The major point was to determine: "How clean is clean enough [House Armed Service Committee HAS 129160 lines 667-702]?" The number was to be based upon safety limits and objectives utilizing data obtained from: the International Commission of Radiation Protection (ICRP) and the National Council on Radiation Protection and Measurements and other authorities. Safety limits refer to an annual dosage not to be exceeded while in the process of optimally utilizing the principle of As Low As Reasonably Achievable (ALARA).

On July 26, 1990, a congressional oversight hearing was held on The Nuclear Regulatory Commission's Below Regulatory Concern (BRC) policy before the Subcommittee on Energy and Environment of the Committee on Interior and Insular Affairs (12). The 10 mrem/yr level established resulted in major negative reactions from: Congress, States (standards set below NRC), Public (various environmental groups), and other governmental agencies (specifically E.P.A.), and it created interagency turf problems. Another major objection lodged against the NRC proposal was that it was developed in a virtually isolated manner. In essence, no one was invited to participate. In June, 1991, in response to the major objections that were placed upon it, an indefinite moratorium was placed on BRC by the NRC.

On September 12, 1991, a congressional hearing on H.R. 645 was held before the Subcommittee on Energy and Environment of the Committee on Interior and Insular Affairs, House of Representatives (13). After five months the NRC terminated the BRC participatory program as it was unable to attract a valid representation from the environmental community. As a result of this, they reaffirmed and indefinitely extended the BRC moratorium. On October 24, 1992, state authority to regulate lower level radiation Sec. 276 was added by Public Law 102-486 Act of October 24, 1992. No provision of this Act or the Low-Level Radioactive Waste Policy Act can either restrict or prohibit appointed State Radioactive Waste authorities from regulating the disposal or off-site incineration of low-level radioactive waste if the NRC exempts such waste from regulation. This does not give the state

authorities the right to regulate those activities licensed by the NRC.

In October, 1992, the National Energy Policy Act of 1992 (H.R. 776) Section 2901 revoked the Commission's 1986 and 1990 Below Regulatory Concern (BRC) policy statements. In December NRC permitted on-site incineration of waste oil [57 FR 57649]. This was with full compliance to the Commission's current regulations and all other applicable federal, state, and local laws. Under Radiation Protection of the Public and the Environment [58 FR 16268], the EPA sets standards for dose limits. It then places itself in authority to require an Environmental Radiological Protection Program (ERPP) for all DOE activities. No estimates of public cost of this action have been made. On June 3 [53 FR 23305] the EPA under the Clean Air Act places limits on NORM phosphogypsum stacks (piles of waste from wet acid phosphorous production) for use in agriculture. They may be acceptable as long as the certified average concentration of radium - 226 does not exceed 10 pCi/g (40 CFR Part 61). The NRC on June 18 developed the Radiological Criteria for Decommissioning of NRC Licensed Facilities [58 FR 33570]. This notice indicates the Commissioner's intent to have the NRC develop a Generic Environmental Impact Statement (GEIS) for the safe and timely decommissioning of the nuclear facilities it licenses.

On August 24, 1993, the Nuclear Regulatory Commission formally withdrew the BRC statements of 29 August, 1986, and July 3, 1990 (58 FR 44010). It should be noted that H.R.776 did not explicitly remove the Commission's responsibilities under either Section 10 of the Low-Level Radioactive Policy Amendments Act of 1985 (evaluation of exemption requests for specific waste streams on an expedited basis) or the Atomic Energy Act (ability to exempt classes of materials from licensing). The NRC is currently handling exemptions on a case-by-case basis using the earlier criteria developed prior to the July 3, 1990, BRC statement. The Commission is using its existing authority under the Atomic Energy Act and the existing general procedures for the expedited processing of petitions for rulemaking.

There are a number of studies on BRC that will prove to be useful in the future. The BRC as an economic concept has been reviewed by the power industry and generally found to be cost-effective (14). Some authors (15) indicate that estimates as large as a third of the waste now consigned to licensed disposal facilities could be assigned to BRC.

INTERNATIONAL CONCEPTS

Exemptable Waste (EW), also referred to as *de minimis*, contains so little radiation that it cannot be considered to be radioactive and is, therefore, exempted from regulatory control. It may be safely disposed of by conventional means. The IAEA recommends this level to be set at less than 1 mrem/yr (10 microsieverts/yr)(16). Exemption classification is intended for practices that are inherently safe and represent a trivial level of risk, or dose. The three basic principles that comprise dose limitation are: justification of the practice, optimization of radiation protection, and the limitation of individual risks. Justification of practice requires, among other things, that it not be frivolous (e.g., irradiation of gems). Optimization of radiation protection is the zealous application of ALARA. Limitation of risk is carried out by controlling the radiation doses in the group most likely to receive the highest doses from the practice (17).

Linsley (18) further subdivides the EW into exclusion and exemption categories. Excluded materials are those over which control is not a feasible alternative (e.g., cosmic radiation, outdoor radon, black shale, etc.). Exemption is established at 1 mrem/yr (10 microsieverts/yr) for a single practice. It is necessary to develop a series of possible events to test limitation of risk in exempt waste which includes site trench operation, trench fires, contaminated groundwater, and residential scenarios involving pathways by inhalation of resuspended radionuclides, ingestion of garden crops, fish, drinking water, and external radiation (19).

The management of radioactive wastes from medicine, research and industry, as with other regulatory areas, is concerned with the basic problem of the disposal of exempted material (normal sewage system, municipal landfill, and atmosphere). The IAEA (20) recommends the ALI (annual limit on intake) concept to set secondary limits for internal exposure (inhaled ALI and ingested ALI) in developing exempt scenarios.

The problem of decontamination and decommissioning of nuclear facilities along with the evaluation of reuse and recycling of materials has long been of interest to the IAEA (7,8,9). The first coordinated research program (CRP) on decommissioning was held in a series of meetings extending from 1984 to 1987 (7). The term unrestricted release is now utilized in the process of decommissioning to differentiate it from exempt waste. Unrestricted release material is that material which may contain reusable or recyclable material as well as disposable material. A large (1000 MW) PWR or BWR contains 10,000 metric tons of steel, half of which is good for unrestricted release. The Advanced Gas Cooled reactor also has 10,000 tons, fifty percent recoverable (8). The Magnox reactor contains 13,000 tons of steel, a third of which is recyclable (6). Specific separate limits are set for categories of radionuclides (e.g., alpha emitters like Plutonium - 239 and beta - gamma emitters like Cobalt - 60) (8). Radionuclide multiple pathways include external direct exposure to radiation (Sv/hr/Bq/cm), inhalation of airborne waste (Sv/Bq), and ingestion of contaminated dust from hands to mouth (Sv/Bq) (9). Major recyclable materials include steel, aluminum, and concrete (e.g., 1971 reactor, 180,000 tons/1000 MW PWR). Reutilization is normally for either contaminated rooms or tools and equipment.

CONCLUSIONS

The Nuclear Regulatory Commission continues to work on the issue of a lower limit, but in a somewhat restricted position. We must come to an acceptable governmental consensus. This nation simply has neither the time nor the financial ability to waste on interagency turf battles. The now politically incorrect term "BRC" is not critical; however, the basic concept of a very low threshold limit for radioactive waste must be established. This situation affects all that is being done with respect to the problems of NARM, NORM, and uranium mill tailings. Decommissioning and recycling cannot be addressed until an Exemptable Waste level (or unrestricted release document) is set. We advocate serious consideration of the broad adoption of the IAEA classification. The environmental concepts, the engineering procedures, and the cost accounting analyses for decommissioning and decontamination of reactors will come to a standstill without a BRC equivalent to work with.

We are of the opinion that the IAEA Exemptable Waste Classification (less than 1 mrem/yr or 10 microsieverts/yr), as

well as its other five categories of radioactive waste, are reasonable, internationally translatable, and well documented. BRC, exemption status, or whatever you may choose to call it must be established as soon as possible. Radioactive waste needs to be classified according to its radioactivity, not according to its origin or its historical regulatory patterns.

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