NRR-7

(1)

REGULATORY ANALYSIS

OF

PROPOSED CHANGES TO 10 CFR 55

March 27, 1986

Prepared by Analysis & Technology, Inc.

under

NRC Contract No. RS-NRR-83-107

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Summary of Regulatory Analysis

The purpose of this regulatory analysis is to describe the values (benefits) and impacts (costs) of implementing the proposed changes to 10 CFR 55 (as described in Enclosures through). It should be realized that the accuracy of these estimates is limited by the lack of extensive data on human performance improvement associated with improved operator licensing examinations. Where possible, these quantitative measures are qualitatively compared to related information from other sources for verification.

The major regulatory alternatives considered for the regulatory analysis were the following:

Alternative A. Take no action and maintain the status quo (used as baseline case in the cost-benefit analysis).

Alternative B. Implement operator licensing examination changes through changes to 10 CFR 55.

In the cost-benefit analysis, the status quo alternative (Alternative A, no action) was used as the baseline case. The incremental costs (impacts) and benefits (values) associated with Alternative B were determined relative to this baseline. The practical benefit considered was the public exposure (person-rem) avoided that is associated with potential accidents. The principal costs were industry and NRC implementation and operating costs incurred. The value/impact ratio was calculated as a measure of the total net safety value of Alternative B in terms of public dose avoided (person-rem) in ratio to total NRC and industry costs.

The safety importance (reduction of public risk) is based on the expectation that improvements in the operator licensing examination process will result in improved operator performance (in terms of reduced personnel errors), resulting in reductions in accident frequencies. Probabilistic risk assessment (PRA) studies provide the best available methodology for linking human performance to reactor safety and, therefore, were used in quantifying the benefits of the expected improvements in human performance. The methodology used is described in NUREG/CR-2800 and was developed to calculate, using PRA information, the risk and cost impacts of implementing the resolutions to reactor safety issues (for both hardware and human performance areas).

This methodology involves: (1) estimating improvement in human performance as measured by a reduction in human error rates, (2) determining affected parameters of the risk equation for representative plants via a review of the minimal cut sets for the dominant accident sequences (i.e., the minimum number of component failures and operator errors that cause the accident sequences that dominate the risk associated with plant operation, based upon a combination frequency of occurrence and accident severity), (3) adjusting these risk equation parameters based upon the estimated reduction of the rate of human error, and (4) summing the resulting reduction of risk per facility across the estimated remaining lifetimes of affected facilities.

"Affected facilities" for the proposed written examination changes are all 125 power generating units that are now or are expected to be operational. For the proposed operating test changes, "affected facilities" are only the 35 units for which acquistion or upgrading of simulation facilities would be required.

Estimated costs to the industry for implementation include the efforts required to acquire simulation facilities for facilities not already having plans to acquire a simulator and for upgrades to older simulators to meet ANSI/ANS 3.5 (as endorsed by Reg Guide 1.149) requirements. Estimated industry operating costs include both simulator operating costs related to operating tests and cost savings due to both improved plant availability and changes in licensing examinations and renewals. NRC cost estimates include administrative implementation costs and operating cost savings due to changes in licensing examinations and renewals.

The quantitative decision factors determined in this analysis support the decision to implement the proposed changes to 10 CFR 55 on operators' licenses. These positive decision factors include the following:

(1) Public risk reduction estimated is significant (Alternative B best estimate = 13,000 person-rem);

(2) The estimated industry and NRC operating cost savings are greater than estimated implementation costs resulting in a best estimate of a net cost savings of $29.1 million (present value discounted at 10-percent);

(3) Value/impact ratio is high. The lower bound of the value/impact ratio is 3500 person-rem/$ million with the value impact ratio being negative (positive benefit and negative costs (e.g., net cost savings)) for best estimate and upper bound cases.

Other quantitative benefits and costs not included in the value/impact ratio are avoided occupational exposure and avoided property damage. All quantitative factors are summarized in Table 1.

Some of the qualitative decision factors cited in the regulatory analysis that support the decision to implement the proposed changed include:

- Increased confidence in examination and testing procedures due to consistency provided by simulation facilities.

- Increased concentration on performance indicators in training and drills.

- Increased management and employee commitment to performance-based training and practice due to simulator relevance and availability.

A full description of the regulatory analysis of the Operators' Licenses rule changes (10 CFR 55) is presented in the remainder of this enclosure.

TABLE 1

SUMMARY OF ALTERNATIVE B BENEFITS AND COSTS
(10-PERCENT DISCOUNT RATE ASSUMED)

	DOSE (person-rem)		
BENEFITS	BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Public Risk Reduction	13,000	25,000	7,000
Avoided Occupational Exposure (Accidental)	100	200	0
Avoided Occupational Exposure (Routine)	18,000	27,000	0
TOTAL BENEFITS	31,100	52,200	7,000

	COST ($ million)		
COSTS	BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Industry Implementation Costs			
- Simulators	36.8	69.1	33.1
Industry Operating Costs			
- Simulators	0.7	2.0	0.6
- Operating Cost Savings Due to Improved Plant Availability*	(46.1)	(69.2)	(23.0)
- Initial Licensing Exam Changes	(4.6)	(6.9)	(2.3)
- Extending License Expiration	(7.6)	(11.4)	(3.8)
- Requalification Exam Changes	(1.7)	(2.6)	(0.9)
NRC Costs			
- Implementation	1.0	1.5	0.5
- Operation	(4.3)	(6.5)	(2.2)
Avoided Public Property Damage	(1.9)	(10.5)	(0.9)
Avoided On-Site Property Damage	(1.4)	(2.1)	(0.7)
NET COSTS	(29.1)	(36.6)	0.4

*Parentheses indicate negative costs (i.e., cost savings).

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1. STATEMENT OF THE PROBLEM

1.1 Importance of Human Performance to Safety

Many studies have shown that in complex man-machine systems, operator error has often been the overriding contribution to actual or potential system failures (Shapero et al., 1960; Meister, 1962; Meister and Rabideau, 1965)[1-3]. All probabilistic risk assessment (PRA) studies completed to date, including WASH-1400,[4] indicated that operator error is a major contributor to risk from nuclear power plants (Potash et al., 1981)[5]. These study conclusions are supported by industry operating experience, which shows that 38 percent of precursors to potentially severe core damage accidents involved operator error[6].

Finally, major incidents, such as the fire at Browns Ferry and the Three Mile Island (TMI-2) accidents, clearly show that humans act not only as accident initiators and accident propagators, but also as accident mitigators. As the President's Commission on the accident at TMI reported[7], the fundamental problems are people-related problems, not equipment problems.

Given the direct relationship between the performance of nuclear power plant personnel and public health and safety, the need to subject operator licensing and related human performance issues to the same scrutiny and careful decision making processes used for structures, systems, and components important to safety is recognized.

1.2 Problem Background

Many factors contribute to errors in human performance (e.g., equipment design that does not account for human factors considerations; work shift schedules that induce fatigue and stress). Significant among these is the failure to ensure that personnel are prepared to perform their assigned duties and tasks. This is a consequence of training and qualification program inadequacies and, in the case of licensed operators and senior operators, also a consequence of licensing examinations that do not reliably predict that an individual will be a competent operator or senior operator. In the past there has been a general lack of demonstrated relationship between the requirements of licensed personnel jobs and the qualification and training programs provided to support individuals performing the jobs, as well as the licensing examinations used to evaluate candidates for the jobs.

In the absence of specific, objectively defined job performance criteria, the Nuclear Regulatory Commission (NRC) has been forced to specify quantitative training and qualification requirements, and generic training content and licensing examination requirements. As a result, current regulatory requirements do not reflect the fundamental interrelationships among the training, qualification, and examination processes. As noted by the President's Nuclear Safety Oversight Committee, these requirements provide little guidance to the industry, much less a firm basis for regulatory audits by the NRC.

On March 20, 1985 the "Commission Policy Statement on Training and Qualification of Nuclear Power Plant Personnel" was published in the Federal Register. This Policy Statement endorses the Institute of Nuclear Power Operations (INPO) managed Training Accreditation Program as providing the basis to ensure that nuclear power plant (NPP) personnel have qualifications commensurate with the performance requirements of their jobs. The Policy Statement further indicated that the NRC considers the following five elements to be essential to acceptable training programs:

(1) Systematic analysis of the jobs to be performed,

(2) Learning objectives that are derived from the analysis and that describe desired performance after training,

(3) Training design and implementation based on the learning objectives,

(4) Evaluation of trainee mastery of the objectives during training, and

(5) Evaluation and revision of the training based on the performance of trained personnel in the job setting.

This Policy Statement is a partial response to the Nuclear Waste Policy Act, of 1982, Section 306, which directed that the NRC promulgate regulations or other regulatory guidance on the training and qualifications of nuclear power plant personnel, simulator training requirements for applicants for operator licenses and for operator requalification programs, requirements governing NRC administration of requalification examinations, requirements for operating tests at civilian nuclear power plant simulators, and instructional requirements for training programs of nuclear power plant licensees.

1.3 Proposed Solution

The solution proposed is based upon three considerations:

(1) To respond to the specific direction provided by Congress in Section 306 of the Nuclear Waste Policy Act of 1982,

(2) To be consistent with the Commission Policy Statement on Training and Qualification of Nuclear Power Plant Personnel and to be supportive of industry self-improvement initiatives, particularly INPO accreditation of training programs, and performance-based training, and

(3) To provide the NRC with an improved basis for administering the operator licensing process.

The following specific actions are proposed:

(1) Written Examinations. Examination content, in addition to being developed from sources currently used, would be based on the results of a systematic analysis that the facility licensee or license applicant will perform under the INPO accreditation program and the learning objectives derived from that analysis. The content of the examination would also be developed from information supplied by the facility licensee to the NRC and from information available within the NRC.

(2) Operating Tests. The purpose of this requirement is to provide a performance-based operating test. In addition to the required plant walkthrough, the proposed amendments would require the operating test to be partially administered in a simulation facility, which may include the plant, a plant-referenced simulator or another simulation device, alone or in combination. Information about one type of simulation facility acceptable for this purpose and a description of associated performance tests are contained in a proposed revision to Regulatory Guide 1.149[8]. This requirement would ensure that uniform examinations are conducted at all facilities.

(3) Medical Requirements. These proposed changes simplify the procedure for the review of the medical status of licensed operators and applicants for operator licenses. In usual cases, medical information for an applicant for an operator license would not be submitted to the NRC. Instead, a certification to the NRC about compliance with the health requirements of 10 CFR 55[9] would be made by the facility licensee. In the case of disability, before an operator could resume licensed duties, the facility licensee would be required to provide medical certification to the NRC that the individual again meets licensing health requirements. Guidance about one acceptable standard against which to conduct medical examination would be contained in proposed revisions to NRC Regulatory Guide 1.134.[10]

(4) Conditions of License. Guidance about interpretation of "actively performing the functions of an operator or senior operator" is contained in the proposed Section 55.57. This interpretation would require a licensed individual to function in a position requiring a license per the facility's technical specifications for a minimum of three eight-hour shifts every three months to be considered to be actively performing the functions of an operator or senior operator. To maintain/renew a license, individuals would not be required to be "actively performing the functions." However, any individual who is not actively "performing the functions" would be required to complete a retraining program before returning to licensed duties. The facility licensee would be required to certify to the NRC that this retraining has been successfully completed. An acceptable retraining program is described in proposed Regulatory Guide 1.8.[11]

(5) Integrity of Examinations and Tests. As proposed, a new paragraph 55.49 would provide that any applicant or licensee who engages in activities that compromise the integrity of an examination or test conducted under the regulations in this part may be guilty of a crime.

(6) Expiration. Unless renewed, each license would now expire after six years instead of the current two years. This change would reduce facility licensees' and NRC paperwork and streamline the renewal process.

(7) Renewal of Licenses/Requalification Programs. Renewal of licenses would require successful completion of a requalification program approved by the NRC. The type of requalification acceptable for license renewal could be either a program developed by the facility licensee using the systems approach to training under an INPO accreditation program or an alternative requalification program developed from the items listed in the proposed paragraph 55.59(c). Submittal of an INPO accreditation letter may be sufficient to obtain NRC approval of this requirement. Requalification examinations would include an annual performance-based operating test, which could include both a plant walkthrough and a simulator operating test as well as a biennial written examination. The proposed changes would also codify NRC's current practice of active participation in and/or audit of facility requalification programs.

2. OBJECTIVES

The overall objective of the proposed regulatory action is to improve plant safety by improving the performance of licensed operators. The following more specific objectives of this action support the overall objectives:

(1) Establish a rational, analytical process for determining performance criteria for licensed operators that is consistent with performance-based training programs being implemented by facility licensees for accreditation of these programs by INPO.

(2) Develop examinations for use in the operator licensing process that are derived from the associated job performance criteria and that provide an objective basis on which to judge an applicant with sufficient confidence to grant or deny a license.

(3) Provide the NRC with an improved basis for administering operator licensing examinations and conducting operating tests, including the use of simulation devices.

(4) Streamline the licensing process and reduce facility licensee and NRC administrative burdens where safety will not be jeopardized.

(5) Respond to the specific direction given by Congress in Section 306 of the Nuclear Waste Policy Act of 1982 to promulgate regulations and regulatory guidance in the area of operator licensing and examinations.

3. ALTERNATIVES

3.1 Alternative A - Take No Additional Action (Maintain Status Quo).

3.1.1 Training (Alternative A)

Current NRC practices relating to operator training programs can be categorized into two functional areas:

(1) Approval of training programs for initial appointees to the plant staff through reviews of Preliminary and Final Safety Analysis Reports (PSARs and FSARs), and

(2) Auditing of training practices for selected programs and special issues.

PSAR and FSAR reviews are based on program descriptions submitted by the plant that include the following:

(1) A commitment to conduct an on-site formal training program and on-the-job training before the initial fuel loading.

(2) The details of the on-site training program, including a syllabus or equivalent course description, the duration of the course (approximate number of weeks in full-time attendance), the organization teaching the course or supervising instruction, and the position titles for whom the course is designed.

(3) Reactor operations experience by training on a nuclear power plant simulator that complies with Regulatory Guide 1.149 or assignment to a similar plant, including length of time (weeks), and identity of simulator and plant.

(4) Any difference in the training programs for individuals who will be seeking licenses before criticality pursuant to existing Section 55.25 of 10 CFR 55[9] or any differences in the training programs for other individuals based on the extent of previous nuclear power plant experience.

(5) A detailed description of the proposed operator requalification training program.

(6) A description of training to satisfy specific requirements of the TMI Action Plan.[12]

Before issuance of a facility operating license, the NRC conducts an inspection of operating staff training. The objectives of this inspection as stated in the inspection procedure include the following:

(1) Confirm that the licensee has trained the operating staff.

(2) Confirm that a continuing program of training is being conducted.

(3) Verify that replacement personnel receive training or have experience equivalent to that required for originally selected personnel.

Following approval of the training programs in the FSAR, the NRC Regional Offices assume responsibility for periodic audits of training conducted at reactor sites. The objective of these audits is to verify that the requalification training program is conducted in accordance with regulatory requirements.

In addition to these periodic audits, the NRC may conduct special audits to address special issues related to training.

Current practices do not provide guidance or requirements for the design, development, conduct, maintenance, or evaluation methodologies the licensee is to use in its training program.

These are presently no NRC requirements for using control room simulators, or any other simulation devices, for nuclear power plant personnel training. There are, however, requirements for licensed operator and senior operator control manipulations (Denton Letter of March 28, 1980).[13] This letter lists required control room manipulations and states the following with respect to their performance:

> "Normal control manipulations, such as plant or reactor startups, must be performed. Control manipulations during abnormal or emergency operations must be walked through with, and evaluated by, a member of the training staff at a minimum. An appropriate simulator may be used to satisfy the requirements for control manipulations."

Utilities use simulators to satisfy these requirements for performing control manipulations. The NRC has not yet defined an "appropriate" simulator, in any regulations or regulatory guide, except for requalification training in 10 CFR 55 Appendix A which states:

> "A simulator may be used in meeting the requirements of 3a [control manipulations] and 3b [demonstrate understanding of operations] if the simulator reproduces the general operating characteristics of the facility involved, and the arrangement of the instrumentation and controls of the simulator is similar to that of the facility involved."

In general, as a minimum, utilities have used a control room simulator for the same nuclear steam supply system (NSSS) vendor as the plant. Eighty-four percent of the facilities that either are currently licensed or are expected to be licensed either have or are acquiring control room simulators that are referenced to their plants (if not the individual facility).

In April 1981, Regulatory Guide 1.149[8] was issued endorsing ANSI/ANS 3.5-1981[14] for specifying the functional capability of a simulator and for comparing a simulator to its reference plant. Regulatory Guide 1.149 indicated that all simulators used for operator training should be in full compliance with ANSI/ANS 3.5, as modified by the guide, by August 1, 1984, or by the time the simulator is placed in operation for training, whichever is later.

3.1.2 Qualifications (Alternative A)

Current NRC practices relating to qualifications requirements for plant staff include reviews of PSARs and FSARs and periodic audits to verify that minimum qualifications requirements have been established in writing for plant personnel. Regulatory Guide 1.8, "Personnel Selection and Training,"[11] established the staff position on plant personnel qualifications and indicates that criteria contained in ANSI N18.1-1971, "Selection and Training of Nuclear Power Plant Personnel,"[15] are generally acceptable, except as noted in the guide. ANSI N18.1-1971 has been superseded by ANSI/ANS-3.1-1981, "Selection, Qualification and Training of Personnel for Nuclear Power Plants."[16]

3.1.3 Operator Licensing - Operating Examinations (Alternative A)

The present NRC policies with respect to operating examinations for initial replacements, and requalification for licensed operators and senior operators are stated in SECY 82-232[17] as follows:

> "For power reactors with a plant-specific (plant-referenced)* simulator, continue the requirements of a simulator licensing exam of all new and replacement candidates and require, for the NRC-administered requalification exam, only a simulator exam of a least 20% (per year) of the currently licensed operators. For power reactors without a plant-specific (plant-referenced) simulator, require an operating test (oral exam) in accordance with 10 CFR 55.23 as well as written exam of all new and replacement candidates and require, for the NRC-administered requalification exams, oral and written exams of at least 20% (per year) of the currently licensed operators."[11]

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*The term "plant-specific simulator," although commonly used in the industry, has not been uniquely defined, either in industry standards or in practice. To avoid any ambiguity, the terms "reference plant" (the specific nuclear power plant and unit from which the simulator control room configuration, system control arrangement and simulator data base are derived) from ANSI/AN 3.5 and the complement of "reference plant," "plant-referenced simulator" will be used in this analysis.

These NRC policies have been in effect since June 1982. During the period from October 1981 to June 1982, the NRC staff administered simulator examinations to all new, replacement, and requalification license candidates in response to SECY 79-330 E.[18] During the period, about 600 license candidates were examined on non-plant-referenced simulators, and approximately 200 candidates on plant-referenced simulators. This experience led to the conclusion (in SECY 82-232) that "the staff does not believe that the information gained from a non-plant-specific (non-plant-referenced) simulator provides the basis to accurately judge the ability or competence of an operator with sufficient confidence to justify denial of a license." This conclusion led directly to the present requirements described earlier in this section.

3.1.4 Operator Licensing - Written Examinations (Alternative A)

The present NRC policy with respect to written examination content is to regroup the topics identified in Sections 55.21 and 55.22 of 10 CFR 55 into examination categories listed below:

Reactor Operator Examination

(1) Principles of Nuclear Power Plant Operation, Thermodynamics, Heat Transfer and Fluid Flow

(2) Plant Design Including Safety and Emergency Systems

(3) Instruments and Controls

(4) Procedures - Normal, Abnormal, Emergency and Radiological Control

Senior Operator Examination

(5) Theory of Nuclear Power Plant Operation, Fluids and Thermodyamics

(6) Plant Systems Design, Control and Instrumentation

(7) Procedures - Normal, Abnormal, Emergency and Radiological Control

(8) Administrative Procedures, Conditions and Limitations.

The regrouping into these categories was practical because of the close interrelationships between the topics identified in Sections 55.21 and 55.22. However, these topics may not encompass all aspects of the operator/senior operator position that are necessary for satisfactory operation of a reactor facility. In addition, structured topics could lead to license candidate training programs that address only these topics and therefore only teach candidates to pass an examination. Accordingly, an examination that is based upon the required knowledge, skills, and abilities of licensed personnel, as identified in a job task analysis, will more appropriately assess a license candidate's relative weaknesses and strengths and will preclude teaching only examination topics.

3.1.5 Operator Licensing - Requalfication Examinations (Alternative A)

In response to SECY 79-330 E, "Qualifications of (Power) Reactor Operators," the Commission directed the staff to administer examinations as part of the requalification program for all licensees and applicants. This requirement was incorporated into TMI Task Action Plan (NUREG-0660)[19] Item I.A.3.1 and clarified in NUREG-0737.[12]

The implementation of this Commission directive is described in SECY 82-232, and involves the NRC preparation of an audit examination. The examination is administered to at least 20 percent of the licensed operators at every facility.

The requalification examinations are conducted in a manner similar to the original license examination, with emphasis on procedures and operating experience, If the facility has a plant-referenced simulator, the examinations are conducted on the simulator. Otherwise, a written examination and a practical test are conducted. Unsatisfactory peformance necessitates accelerated retraining in weak areas. Reexamination by the NRC may be required in unsatisfactory areas. Renewal licenses continue to be issued to licensed personnel who are enrolled in approved requalification programs, provided the NRC requalification examinations do not identify significant weaknesses in those programs. These current NRC policies and practices on requalification examinations have not been codified in 10 CFR 55.

3.2 Alternative B - Implement Licensing Examination Changes and Qualification Requirements through Regulation Changes to 10 CFR 55

3.2.1 Qualifications (Alternative B)

It is assumed that Regulatory Guide 1.8 will endorse ANSI/ANS 3.1-1981 (with exceptions) for licensed operator and senior operator positions, and will continue to endorse ANS N18.1-71 for other positions. It is expected that INPO accreditation will ensure that qualifications based upon job performance requirements will result from these performance-based training programs. Regulatory Guide 1.8 will indicate that these qualification requirements will be superseded by those requirements developed through INPO accreditation.

3.2.2 Operator Licensing - Operating Examinations (Alternative B)

If Alternative B were implemented, initial, replacement, and requalification operation examinations for all licensed operators and senior operators would include a demonstration of the candidate's ability to perform certain tasks as specified in 10 CFR 55.45, and would be conducted as follows:

(1) An examination on a plant-referenced simulator as defined in ANSI/ANS 3.5-1981 (as amended) that is referenced to the plant and unit for which the candidate is being examined. These examinations would be similar to those presently administered by the NRC for plants with

plant-referenced simulators. Such simulators would be certified for use in the conduct of examinations by the licensee and approved by the guidance in Regulatory Guide 1.149, as amended, or

(2) An examination on a plant-referenced simulator, not referenced to the plant and unit for which the candidate is being examined, has been certified by the licensee and approved by the NRC for use for such examinations in accordance with the guidance established in Regulatory Guide 1.149 as amended, or

(3) An examination on a licensee-proposed device, system or combination of devices that would enable the licensee to meet the requirements of 10 CFR 55.45. Such devices or systems would be certified by the licensee and approved by the NRC in accordance with the guidance established in Regulatory Guide 1.149 (as revised).

These simulator examinations would be similar to those presently administered by the NRC for plants with plant-referenced simulators. Therefore, this alternative would not affect those plants that either do have or plan to acquire a plant-referenced simulator as defined in ANSI/ANS 3.5 (as revised). Table 3-1 provides a list of plants already having or acquiring plant-referenced simulators. Some of the simulators shown in Category A of Table 3-1 may not fully meet the definition of a plant-referenced simulator as stated in ANSI/ANS 3.5 (as revised), and thus some upgrading might be required of these simulators by Alternative B (on a schedule proposed by the licensee and agreed to by the NRC). Those plants that do not acquire plant-refernced simulators (Table 3-2) would be maximally affected by Alternative B in that they would be required to have available a plant-referenced simulator or other device, system, or combination of devices for the conduct of operating examinations.

Plants that are not the referenced plant for a simulator would have three choices under this alternative:

(1) Acquire a plant-referenced simulator as defined in ANSI/ANS 3.5 (as revised) and in accordance with the guidance in Regulatory Guide 1.149 (as revised), or

(2) Demonstrate to the NRC's satisfaction that a simulator chosen by the licensee that meets the ANSI/ANS 3.5 definition of a plant-referenced simulator is suitable for simulator examination because there are no significant differences between the plant and the ANSI/ANS 3.5 simulator chosen. The utility would use the Appendix of ANSI/ANS 3.5 (Procedure for Documenting Simulator Performance) to certify the licensee's analysis of suitability and would submit that certification to the NRC. The NRC would make the final acceptance (or rejection) decision of the licensee's certification. Once a year (as a maximum) this analysis and NRC review would be repeated.

(3) Substitute any device, system, or combination of devices that would enable the licensee to demonstrate applicant "understanding" of all terms identified in Section 55.45, as well as an ability to perform on those items as a minimum, that:

TABLE 3-1

REACTORS HAVING OR ACQUIRING PLANT-REFERENCED SIMULATORS

A. Seventy-one reactors with forty existing simulators that purport to meet, at least in part, ANSI/ANS 3.5-1981 standards:

Beaver Valley 1 & 2	Indian Point 2	River Bend 1
Bellefonte 1 & 2	Kewaunee	Salem 1 & 2
Braidwood 1 & 2	LaSalle 1 & 2	San Onofre 2 & 3
Browns Ferry 1,2 & 3	Limerick 1 & 2	Seabrook 1 & 2
Calvert Cliffs 1 & 2	McGuire 1 & 2	Sequoyah 1 & 2
Clinton 1	Millstone 2	Shearon Harris 1 & 2
Commanche Peak 1 & 2	Millstone 3	Surry 1 & 2
Diablo Canyon 1 & 2	Monticello	Susquehanna 1 & 2
Dresden 2 & 3	North Anna 1 & 2	Vogtle 1 & 2
Farley 1 & 2	Oconee 1, 2, & 3	WNP 2
Fermi 2	Palisades	Wolf Creek
Grand Gulf 1 & 2	Palo Verde 1, 2, & 3	Zion 1 & 2
Hatch 1 & 2	Perry 1 & 2	
Hope Creek 1	Prairie Island 1 & 2	

B. Forty-one reactors acquiring plant-referenced simulators:

1. Thirty-three reactors with twenty-five simulators under construction:

ANO 1	Millstone 1	Summer 1
ANO 2	Nine Mile Point 1	TMI 1
Brunswick 1 & 2	Nine Mile Point 2	Turkey Point 3 & 4
Callaway 1	Peach Bottom 2 & 3	Vermont Yankee
Catauba 1 & 2	Pilgrim 1	Waterford 3
Connecticut Yankee	Robinson 2	Watts Bar 1 & 2
Cook 1 & 2	Shoreham	WNP 3
Ginna	St. Lucie 1 & 2	
Maine Yankee	South Texas 1 & 2	

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2. Eight reactors that have under consideration or have stated an intent to build eight plant-referenced simulators regardless of new regulations:

Crystal River 3	Indian Point 3	Oyster Creek
Davis Besse	Rancho Seco	Trojan
Fitzpatrick	San Onofre 1	

TABLE 3-2

REACTORS NOT ACQUIRING PLANT-REFERENCED SIMULATORS

A. PWRs

Six operating reactors:

Byron 1 & 2	Point Beach 1 & 2
Fort Calhoun 1	Yankee Rowe

B. BWRs, Six operating reactors:

Big Rock Point	Duane Arnold	Quad Cities 1 & 2
Cooper	LaCrosse	

C. HTGR

1. One operating reactor:

Fort St. Vrain

(a) Require team performance,
(b) Have an associated time criticality, or
(c) Are important to safety. Such devices may include written and/or oral tests, part task and/or concept simulators, etc.

This alternative would include a provision for a request for an exemption of this requirement for plants where the cost/benefit may not justify the requirement based upon size (source term), plant life remaining, or operating characteristics.

Once every year (as a maximum) the licensee would be required to re-certify the simulator, device(s), or system to the NRC, and the NRC would perform a re-analysis against the requirements of 10 CFR 55.45.

3.2.3 Operator Licensing - Written Examinations (Alternative B)

If Alternative B were implemented, the content of operator written examinations described in Sections 55.21 and 55.22 of 10 CFR 55 will be a representative sample of the knowledge, skills, and abilities the operator needs to perform his job duties. The knowledge, skills, and abilities will be identified in part from information in the Final Safety Analysis Report, operating manuals, license for the facility and license amendments, Licensee Event Reports, and the job task analysis performed by each facility to comply with INPO accreditation and the Commission Policy Statement on Nuclear Power Plant Personnel Training and Qualification."

The changes described above, along with associated implementation changes to the Operator Licensing Standards, would have the following advantages over the present content of the written examination:

(1) Improved standardization in examination development, administration, and grading,

(2) Better delineation of appropriate areas/levels of knowledge, and

(3) Better assurance that the test as a whole is a balanced sample of important skills and knowledge.

The results of this alternative would be:

(1) Maximum assurance that the written examinations are performance based [based upon what the operator (senior operator) must know to protect the health and safety of the public].

(2) An improvement in the ability of examiners to use written examination results to justify denial (or issuance) of an reactor operator (RO) or senior reactor operator (SRO) license.

This alternative could not be completely implemented until performance-based training programs have been implemented for licensed operators (estimated to be January 1987); however, in the interim, the content of written examinations would be made more performance based by using the best available information, including the Institute of Nuclear Power Operations (INPO) job and task analyses, to revise the examination question bank.

3.2.4 Operator Licensing - Requalification Examinations (Alternative B)

The NRC staff would request each facility's schedule for its requalification program, including classroom, in-plant, and simulator training dates and written, oral, and simulator examination dates (same as Alternative A). Based on the input of the Regional Administrator, LER history, Systematic Assessment of License Performance (SALP) evaluations, recent operator licensing and requalification examination results, and training program accreditation, the staff would select facilities to visit. During these visits, the staff would have several options available to evaluate the strengths and weaknesses of the facility requalification program. Among these options are: (1) substitute an NRC-developed examination or section of the examination for the facility-developed examination;
(2) conduct NRC oral/simulator examinations of the candidates; and/or
(3) observe facility-administered oral/simulator examinations on subject areas determined by the NRC. The base program would have the NRC visit all the facilities in the first two-year period and administer written examinations to approximately 50 percent of the facilities visited. Adjustments to this base could be made as resources and results dictate. Effectiveness of training programs would be determined by the overall results of the examination; individual weaknesses would be addressed by retraining programs that the facility would administer. Any NRC-administered portions of requalification examinations would be of the same type and format as facility requalification examinations.

Other alternatives for NRC administration of requalification examinations were considered, but a preliminary screening of these alternatives indicated they were more costly to the industry and would require greater NRC resources, while not offering greater benefits. The primary alternative in this group was relicensing on a periodic basis. For this approach, NRC licenses would be valid for a period of six years, and complete NRC re-examination would be required for relicensing. Operators with licenses due to expire the following year would be examined in conjunction with the scheduled replacement examinations to a given facility. NRC would reexamine people who scored poorly in the examinations. This approach would cost the industry more money because the industry would have to prepare for and conduct these relicensing examinations in addition to the facility requalification programs. Greater NRC resources would be required because a complete re-examination requires more time to prepare and administer than does the recommended approach.

3.2.5 Operator Licensing - Other Changes

For purposes of the regulatory analysis, codification of existing practices now contained in NRC Regulatory Guides, NUREGs, or generic letters to facility licensees are assumed to have neither cost nor benefit impact. The proposed regulations include revisions to the medical requirements described in NRC Regulatory Guide 1.134, "Medical Evaluation of Nuclear Security Personnel Requiring Operator Licenses", 55.31, How to Apply, and 55.51(b), Issuance of Licenses.

4.0 CONSEQUENCES

In the cost-benefit analysis, Alternative A (no action) is used as the baseline case. The incremental costs (impacts) and benefits (values) associated with Alternative B (regulation changes) are determined relative to this baseline. Benefits are terms that support the NRC goals of provision of safety. The principal benefit to be considered will be the public exposure (person-rem) avoided that is associated with potential accidents. The principal costs will be industry and NRC implementation and operating costs incurred. Other benefits and costs (e.g., routine and accidental occupational exposure avoided, property loss avoided) will be considered. Benefits and costs can have either positive or negative algebraic signs. For benefits (values), improvements in meeting NRC goals are positive; for impacts, increases in costs are positive. A value/impact ratio is calculated for Alternative B following the guidance of Office of Nuclear Reactor Regulation (NRR) Office Letter No. 16 (Revision 1).[20] This ratio is a measure of the total net safety value of each alternative in terms of public dose avoided (person-rem) ratioed to total NRC and industry costs ($ million). Summary tables of all benefits and costs are provided.

4.1 Benefits and Costs

4.1.1 Safety Importance (Public Risk Reduction)

All probabilistic risk assessment (PRA) studies completed to date, including WASH-1400 (NUREG-75/014), indicate that human error is a major contributor to risk from nuclear power plants. This conclusion is supported by industry operating experience, which shows that 38 percent of precursors to potential severe core damage accidents involved human error. However, these PRA studies (Potash et al., 1981) have also identified that:

(1) Human reliability is more difficult to model and quantify than equipment reliability, and

(2) Data on human errors are difficult to obtain because errors are usually associated with disciplinary action and job security.

Given these limitations, PRA studies still prove the best available way to link human performance to reactor safety and, therefore, were used in quantifying the benefits of the improved human performance expected through implementing Alternative B. The methodology used was developed by Pacific Northwest Laboratory (PNL) for the NRC to quantify benefits associated with specific safety issues and is described in NUREG/CR-2800.[21]

For issues related to personnel performance, the methodology involves the following steps:

(1) Estimate the improvement in human performance, as measured by a reduction in error rates, resulting from the safety issue.

(2) For representative plants, determine the parameters of the risk equation that can be affected by the safety issue by means of a review of the minimal cut sets for the dominant accident sequences.

(3) Adjust the parameters in the risk equation identified in step 2 based upon the error rate reduction in step 1. The difference in public risk before and after the safety issue implementation (accidental exposure avoided) is the benefit of the issue.

The paragraphs that follow describe how the proposed changes of Alternative B are expected to affect reactor safety:

(1) Written and Operating Examination Changes. The proposed changes to the operator licensing examination process should contribute to reducing the rate of human error in that these examination changes are designed to improve the ability of NRC examiners to discriminate between acceptable and unacceptable operator performance. Two types of errors can be made when using any examination instrument to discriminate between acceptable and unacceptable performance. The first type of error is to reject (fail) an individual when that person's actual performance is acceptable (a Type I error). The second type of error is to accept (pass) an individual when that person's actual performance is, in fact, unacceptable (a Type II error). Type I errors do not have an impact on safety, but Type II errors have a safety impact. The proposed operator written and operating examination changes (NUREG/CR-1750[22] and PNL-4682, Rev. 3[23]) should provide greater test validity and, therefore, help reduce Type I and Type II errors. By reducing Type II errors, an overall improvement in licensed operator performance can be expected, hence, contributing to overall human error rate reductions. The magnitude of these reductions was estimated as follows:

(a) Written examinations. To estimate the improvement in discrimination provided by Alternative B with respect to written examinations, an expert panel of experienced OLB examiners was utilized. The consensus of this panel was that Alternative B would reduce Type I errors by 2 percent (i.e., a 2-percent decrease in the failure rate) and would reduce Type II errors by 1 percent (i.e., a 1-percent increase in the failure rate). If the baseline failure rate of written examinations were 20 percent (with Alternative A), then implementing Alternative B would reduce the failure rate to 19 percent (a 2-percent decrease due to a reduction in Type I errors and a 1-percent increase due to a reduction in Type II errors). With respect to Type II errors (passing individuals who should have failed), it is assumed

that these individuals are not failed on the basis of the oral or operating tests (e.g., they are issued a license). It is further assumed that there is a direct relationship between the reduction in Type II errors and a reduction in operator performance as measured by operator error rates (e.g., a 1-percent reduction in Type II errors will result in a 1-percent reduction in operator error rates). The lower bound estimate of error reduction is 0.5 percent, with an upper bound of 2.0 percent.

(b) Operating Tests. Operating tests administered as provided by Alternative B should reduce the number of Type II errors because "a simulator examination is a type of work sample examination, and work sample examinations have been shown to have more test validity than other examination types for purposes of selecting candidates who have already acquired the job performance requirements[23] In developing an estimate of the percentage of Type II errors for simulator examinations, examination failure rates for the period from July 1, 1982 to December 31, 1982 (which includes only plant-referenced simulator examinations) were reviewed. The average percentage failure rates for the three examination types are shown below:

Written examination	18.9 percent
Oral examination	7.9 percent
Simulator examination	5.3 percent.

The 5.3-percent plant-referenced simulator examination failure rate shown above can be used as the upper bound for the Type II error percentage for licensing examinations given without a simulator examination since some individuals who failed the plant-referenced simulator examinations also failed the written and/or oral examinations. A best estimate of the percentage of Type II errors for licensing examinations without plant-referenced simulator examinations is assumed to be 2 percent with a lower bound of 1 percent.

In order to use these Type II error percentages to quantify safety improvements, it is first necessary to convert these percentages to operator error percentage reductions. It was assumed that there is a one-to-one relationship (e.g., a 1-percent Type II error percentage decrease results in a 1-percent decrease in operator errors). Through the procedure described below, the operator error reductions are translated to reductions in public risk through PRA consequence models.

(2) Requalification Examination Changes. Alternative B provides, on a continuing basis, the same opportunity as Alternative A for the NRC to review the products of each facility's training and requalification programs and to identify and improve any weak individuals or weak facility programs. For this reason, it is expected that the benefits from both alternatives will be equal.

(3) Other Proposed Changes. It is assumed that the safety effects of the other changes that are a part of this package are either included in the safety effects discussed above (e.g., associated Regulatory Guides) or that their safety effects are relatively small compared to the effects above and thus they can be ignored for purposes of the analysis.

As indicated earlier in this section, there are few quantitative data concerning improvements in performance (reductions in error rates) resulting from training or qualifications programs; however, the only data identified support the estimates presented earlier in this section. An EPRI (1982) research project to evaluate an automated performance measurement system for control room simulators[24] used two test groups (experienced requalification operators and inexperienced cold license trainees). The error rate of the experienced requalification group was 42 percent less than that of the inexperienced, cold-license trainee group. In a similar manner, Oak Ridge National Laboratory conducted a study[25] to provide a data base to support development of criteria for safety-related actions by nuclear power plant operators. The results of this study indicated an error of omission rate for licensed operators 29 percent lower than the error of omission rates of trainees. In Table 3-8 of NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications - Final Report,"[26] Swain and Guttmann estimate a 50 percent to 90 percent decrease in human error probabilities (HEPs) as a result of frequent practice of the appropriate responses to potential emergencies or other abnormal situations.

The public risk reduction potentially achievable through Alternative B is estimated using the procedure developed in NUREG/CR-2800 and further refined in "Estimating the Public Risk Reduction Affected by Human Factors Improvements"[27]. This procedure advocates the use of existing risk/reliability assessments for specific nuclear power plants to estimate the public risk reduction potentially achievable. The procedure has been used in estimating the public risk reduction for human factors related issues as part of the "Prioritization of Safety Issues Project" conducted by PNL for NUREG-0933.[28] A detailed description of this procedure is presented in NUREG/CR-2800 and is not reproduced here. As part of its efforts, PNL has developed curves of estimated changes in major core-melt frequency (ΔF) versus percent human error rate reduction and estimated reduction in public risk (ΔW) versus human error rate reduction. In these

calculations, Oconee 3 and Calvert Cliffs 2 were chosen to represent pressurized water reactors (PWRs) and Grand Gulf 1 to represent boiling water reactors (BWRs).*

The "PWR Average" values shown in Tables 4-1 and 4-2 were developed from Supplement 1 to NUREG/CR-2800, page 2.189, by taking the average base core melt probability (F) for the 10 PWRs for which risk/reliability studies are currently available. This value is 1.8×10^{-4} core melts/ry. The base case risk value for (W) for the PWR average category was determined by using the average dose factor for Oconee and Calvert Cliffs** (3.2×10^{6}) and multiplying this times F (1.8×10^{-4} to obtain a total "PWR Average" baseline risk value of 576 person-rems/ry. The ΔW and ΔF values for the "PWR Average" were determined by taking the average rate of change for Oconee and Calvert Cliffs (from Tables 4-1 and 4-2) times the baseline W and F values.

The Grand Gulf baseline core melt probability per reactor year (3.7×10^{-5}) was considered sufficiently representative of the average BWR value of F in Supplement 1 to NUREG/CR-2800 (6×10^{-5}ry) that the Grand Gulf ΔW and ΔF values of the PNL report of September 1983[27] were used without modification to represent BWRs.

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*In NUREG/CR-2800, Oconee was the "representative plant" selected. Subsequently, in PNL's Draft Report "Estimating the Public Risk Reduction Affected by Human Factors Improvements," September 1983, the Oconee results were compared with Calvert Cliffs (PWR) and Grand Gulf (BWR) results to confirm that the Oconee results were representative. It has been suggested that more recent PRA studies (e.g., NRC Interim Reliability Program (IREP) PRA studies such as Arkansas Nuclear 1) should be utilized for this analysis. However, the human factors contributions to the IREP PRAs have not been quantified as PNL has quantified the RSSMAP studies for Oconee, Calvert Cliffs and Grand Gulf, and the effort to conduct such an analysis is substantial. Therefore, the RSSMAP PRA results represent the best currently available data.

**The dose factor is the ratio W/F. From Oconee the dose factor (from Tables 4-1 and 4-2) is $207/8.2 \times 10^{-5} = 2.5 \times 10^{6}$. For Calvert Cliffs, the dose factor is $7620/2.0 \times 10^{-3} = 3.8 \times 10^{6}$. The average of these dose factors is 3.2×10^{6}.

Alternative B Public Risk Reduction

To determine the ΔW_{PWR} and ΔW_{BWR} values to be used for the analysis, curves were fit through the PWR average and BWR (Grand Gulf) ΔW values for 10%, 20% and 50% reductions in operator error rates of Table 4-1 (it should be noted that the base case value of W shown in Table 4-1 cannot be used for these calculations because component failures and maintenance actions also contribute to the total per plant risk which these W numbers represent).

To determine the public risk reduction (ΔW_{total}) in person-rems, the PWR and BWR per-reactor-year estimates must be multiplied by the number of affected facilities and by the average time that the operator licensing improvements will be implemented at the facilities. Shown algebraically, the result is :

$$\Delta W_{Total} = N_{PWR} \times T_{PWR} \times \Delta W_{PWR} + N_{BWR} \times T_{BWR} \times \Delta W_{BWR}$$

where

ΔW_{Total} = Total public risk reduction in person-rems,
N = Number of affected reactors,
T = Average reactor lifetime after implementation of proposed changes, and
ΔW = Per-plant public risk reduction in person-rems per reactor year.

T was calculated assuming a 4-year implementation period (see Section 6.1 for a discussion of the implementation schedule) and the average remaining reactor lifetime calculations of NUREG/CR-2800. T_{PWR} was calculated to be 24.5 years and T_{BWR} 23 years. Per-plant public risk reductions for PWRs and BWRs were obtained from the Table 4-1 results of the PNL model.

TABLE 4-1

CHANGE IN PUBLIC RISK REDUCTION (ΔW)
VERSUS OPERATOR ERROR RATES*

PLANT	BASE CASE VALUE OF W (person-rem/yr)	ΔW (person-rem/ry) REDUCTION IN OPERATOR ERROR RATES 10%	20%	50%
Oconee	207	9.2 (4.4)**	19.1 (9.1)	48.1 (23.2)
Calvert Cliffs	7620	230 (3.0)	460 (6.0)	1370 (18.0)
PWR Average	576	21.3 (3.7)	43.8 (7.6)	118.7 (20.6)
Grand Gulf (BWR)	250	18.3 (7.3)	22.4 (8.9)	38.8 (15.5)

*Based upon NUREG/CR-2800 and PNL, September 1983.[27]

**Values in parentheses ( ) are the percent change from the base case.

TABLE 4-2

CHANGE IN MAJOR CORE-MELT FREQUENCY (ΔF)
VERSUS OPERATOR ERROR RATES*

PLANT	BASE CASE VALUE OF F (core melt probability/ry)	ΔF (core melt probability/ry) REDUCTION IN OPERATOR ERROR RATES 10%	20%	50%
Oconee	8.2×10^{-5}	3.7×10^{-6} (4.5)**	1.1×10^{-5} (13.4)	1.9×10^{-5} (23.7)
Calvert Cliffs	2.0×10^{-3}	6.1×10^{-5} (3.0)	1.2×10^{-4} (6.0)	3.7×10^{-4} (18.1)
PWR Average	1.8×10^{-4}	6.8×10^{-6} (3.8)	1.9×10^{-5} (9.7)	3.8×10^{-5} (20.9)
Grand Gulf (BWR)	3.7×10^{-5}	2.7×10^{-6} (7.2)	4.1×10^{-6} (10.9)	5.8×10^{-6} (15.6)

*Based on NUREG/CR-2800 and PNL, September 1983.[27]

**Values in parentheses ( ) are percent change from the base case.

Shown below are the ΔW and N values that apply for the calculation of ΔW_{TOTAL}.

Written examinations (1-percent error reduction for all plant units)

ΔW_{PWR} = 2.3 person-rem/ry

ΔW_{BWR} = 3.8 person-rem/ry

N_{PWR} = 84 units

N_{BWR} = 41 units

$\Delta W_{Written\ Tests}$ = 8316 person-rem

Operating Tests (2-percent error reduction for affected plants)

ΔW_{PWR} = 4.3 person-rem/ry

ΔW_{BWR} = 6.7 person-rem/ry

N_{PWR} = 22
N_{BWR} = 13
(See Section 4.1.2.1 for the basis for these numbers)

$\Delta W_{Operating\ Tests}$ = 4320 person-rem

Therefore, ΔW_{TOTAL} = 12,636 man-rem or 13,000 man-rem, rounded to the nearest thousand.

Using the upper and lower bound estimates on page 21 (2-percent and 0.5-percent for written examinations and 5.3-percent and 1.0-percent for operating tests) the upper and lower bounds for ΔW_{TOTAL} are 25,000 and 7,000 man-rem, respectively.*

The ΔF values for Alternative B are calculated both for those plant units that are maximally affected (both written examinations and operating tests) and for those plant units that are only affected by written examination changes.

*The confidence bounds calculated address uncertainty only in the estimates of human error rate reductions, not the uncertainty in the risk equation parameters. If the procedures of Section 3.5.1 of NUREG/CR-2800 are used to estimated the total uncertainty in ΔW_{total}, the 90-percent confidence interval lower bound is about 0 person-rem and the upper bound is equal to the total risk.

Maximally Affected Plants (affected by both written examination and operating test changes)

For these plants the expected reduction in operator error rates is 3-percent (1-percent for written examinations and 2-percent for operating tests). Using Table 4-2, estimates of values of ΔF for PWR's and BWR's can be made for a 3-percent reduction in operator error rates. These estimates are shown below.

$$\Delta F_{PWR} = 2.8 \times 10^{-6} \text{ core melts/ry}$$

$$\Delta F_{BWR} = 1.1 \times 10^{-6} \text{ core melts/ry}$$

Plants Affected by Written Exam Changes Only

For these plants the expected reduction in operator error rates is 1-percent. ΔF estimates for these plants are:

$$\Delta F_{PWR} = 1.2 \times 10^{-6} \text{ core melts/ry}$$

$$\Delta F_{BWR} = 5.2 \times 10^{-7} \text{ core melts/ry}$$

As was done for ΔW_{TOTAL}, a value of ΔF_{TOTAL} (core melts per year)can be calculated by combining the ΔF values above and using the same values for N and T as were used in calculating ΔW_{TOTAL}. Therefore the best estimate of $\Delta F_{TOTAL} = 1.7 \times 10^{-4}$ core melts per year.

4.1.2 Cost Estimates

This section addresses the industry and NRC implementation and operating costs associated with the proposed operator licensing changes described in Section 3. These costs are discussed individually in this section and include the following:

(1) Industry implementation costs associated with the acquisition of simulation devices.

(2) Industry operating costs

   (a) Simulation device operation (required for operating test administration)

(b) Operating cost savings due to some assumed improved plant availability due to reductions in operator error rates

(c) Operating cost savings due to fewer licensing examination failures

(d) Operating cost savings due to extending the length of licenses (from two to six years)

(e) Operating cost savings due to changes in requalification examinations

(3) NRC costs

(a) Implementation costs

(b) Operating costs.

All costs in this analysis are expressed in 1985 constant dollars; that is, no real increase in costs are assumed over time (i.e., nothing above inflation). Thus, the discount factors used in the cost analysis are to discount future costs for expected inflation.

4.1.2.1 Industry Implementation Costs

As discussed in Section 3.2 (description of Alternative B), plants that are not the reference plant for a simulator would have three choices for satisfactorily fulfilling the plant simulation device requirements for operating examinations:

(1) Acquire a plant-referenced simulator that meets Regulatory Guide 1.149 intent, or

(2) Use a simulator that conforms with Regulatory Guide 1.149 guidance and has been demonstrated to be suitable for use by the plant in accordance with the Appendix of ANSI/ANS 3.5, or

(3) Substitute any device, system, or combination of devices that would enable the licensee to meet the requirements of 10 CFR 55.45(b) and that would be approved by the NRC.

The first choice (acquire a Regulatory Guide 1.149 plant-referenced simulator) represents the upper bound for simulator acquisition costs associated with Alternative B if all affected plants elect to acquire Regulatory Guide 1.149 plant-referenced simulators. The second choice (either acquire Regulatory Guide 1.149 plant-referenced simulator or use another ANSI/ANS 3.5 simulator referenced to a different plant, but demonstrated to be an adequate alternative examination device) represents the best estimate for Alternative B simulator acquisition costs since a subset of the affected plants can avoid costs of acquiring a plant-referenced simulator through this option. The third choice (substitute any device, system, or combination of devices shown to be an adequate alternative) represents the lower bound for simulator acquisition costs if

it is assumed for the purpose of this regulatory analysis that the cost of procuring these alternative training and examination devices would not exceed the cost for a plant-referenced simulator.

The industry costs to acquire these simulators, including construction of a training facility and simulator course development, have been calculated by PNL for the NRC as part of a "Draft Regulatory Analysis of a Proposed Requirement for Plant-Referenced Simulators".[29] The capital cost estimates of major simulator vendors for a simulator that will meet the ANSI/ANS 3.5 Appendix criteria ranged from $7.5 to $10 million. The best estimate of the cost of a simulator was $8.5 million. In addition to obtaining a simulator from a vendor, a utility must also construct a facility. Utility feasibility studies on the purchase of simulators showed that the size of this facility varied from 5,500 square feet to 20,000 square feet with 10,000 square feet as the best estimate for the calculations shown in Table 4-3.

In addition to direct costs, there are a number of indirect costs that are usually a percentage of the direct costs. These percentages were obtained from a plant design handbook,[30] and from utility feasibility studies, and include considerations for utility project mangagement support during the simulator construction process. Because of the short construction time for the simulator (approximately three years), the interest during construction was assumed to be only 6 percent of direct costs.

Table 4-3 contains a summary of the best estimate implementation costs per simulator, which sum to $10.75 million.

The upper bound of total industry implementation costs for these simulators is based on the assumption that all affected plants elect to acquire Regulatory Guide 1.149 plant-referenced simulators and all existing simulators that need modifications to satisfy Regulatory Guide 1.149 criteria are upgraded.

With respect to acquiring new simulators, there are potentially 13 nuclear power plant units affected (see Table 3-2), but it is estimated that only 6 simulators will be needed because some of the facilities are co-located and have nearly identical operating characteristics and control rooms (e.g., Point Beach 1 and 2) or because of probable waivers in consideration of plant age, size and/or operating characteristics. Assuming that the implementation costs were uniformly distributed over the 4 years beginning in 1985 (1986 was used as the reference year for discounting purposes), the present value of these 6 simulators is $48.4 million (discounted at 10 percent: discount factor = 0.751). If a 5-percent discount rate is assumed (discount factor = 0.864), the present value of these simulators is $52.2 million.

The costs for upgrading the existing simulators that need modifications to meet the guidance provided in Regulatory Guide 1.149 were estimated by first determining the number of the simulators that would require upgrading/modification to meet ANSI/ANS 3.5-1981. It was determined that 11 simulators (serving 22 units) were operational before the latest revision of ANSI/ANS 3.5-1981. It was further assumed that these

TABLE 4-3

COST OF INDUSTRY IMPLEMENTATION PER SIMULATOR

COST COMPONENTS	BEST ESTIMATE ($)
DIRECT COSTS	
Simulator Equipment	8,500,000
Facility Construction (10,000 square feet @ $70/square foot)	700,000
Facility Furnishings (10-percent of Facility Cost)	70,000
Total Direct Costs	9,270,000
INDIRECT COSTS	
Interest During Construction (6-percent of Direct Costs)	556,000
Engineering & Construction Management (10-percent of Direct Costs)	927,000
Total Indirect Costs	1,483,000
TOTAL IMPLEMENTATION COST (in 1984 dollars)	10,753,000

11 simulators would require upgrade/modification to meet ANSI/AHS 3.5-1981. Vendor estimates of the average cost of these upgrades/ modifications for the oldest of these simulators is $2 million to $4 million in 1984 dollars. An estimate of $2.5 million per simulator was used for calculating the costs of upgrading these 11 simulators. Assuming these costs are uniformly distributed over the four years beginning in 1985, the present value of total industry costs for these simulator upgrades is $20.7 million (discounted at 10 percent; discount factor = 0.751). For a 5-percent discount rate, these present value costs would be $23.8 million (discount factor = 0.864).

Combining these acquisition costs for 6 simulators and the upgrading cost for 11 simulators, the upper bound of total industry implementation costs for simulators, is $69.1 million (10-percent discount rate). For a 5-percent discount rate, these total upper-bound costs are $76.0 million.

For determining the best estimate of industry implementation costs for simulators, it is assumed that some utilities would exercise the option to demonstrate that a simulator that meets Regulatory Guide 1.149 requirements that was not initially referenced to the utility's plant(s) is suitable for use by the plant(s) in accordance with the Appendix of ANSI/ANS 3.5. Based upon industry input, it is expected that 6 facilities would be likely to propose alternative simulators that might be suitable. This would reduce the upper-bound number of new simulators from 6 to 2. The costs for upgrading existing simulators to Regulatory Guide 1.149 requirements would remain the same; hence, the best estimate for industry implementation costs for simulators is determined by reducing the upper bound total cost estimate by the costs associated with four fewer new simulators. The best estimate of total industry implementation costs for simulators is $36.8 million (10-percent discount rate). The 5 percent discount rate costs would be $38.8 million).

Specific cost estimates for the case when some utilities would acquire satisfactory alternative training and examination devices in lieu of using acceptable ANSI/ANS 3.5 simulators or acquiring plant-referenced simulators are more difficult to develop because the utility response and technological improvements are not known today. However, it can be assumed for purposes of this regulatory analysis that the costs of procuring these Alternative B training and examination devices would not exceed the costs of a plant-referenced simulator. It will be further assumed that the additional capability for utility flexibility and initiatives provided by this option may result in a 10-percent reduction in the best-estimate expected industry implementation costs (this 10-percent figure is arbitrary). This assumption results in lower bound industry implementation cost estimates of $33.1 million (10-percent discount rate) and $34.9 million (5-percent discount rate).

The Alternative B total industry implementation costs for simulators are summarized in Table 4-4.

4.1.2.2 Industry Operating Costs

Increased industry operating costs as a result of implementing Alternative B include the following components:

(1) Simulator operations. Includes increased training staff for operation of the simulator as well as costs for simulator facility operation and maintenance.

(2) Operating cost savings. Includes cost savings due to some assumed improved plant availability due to reductions in personnel error rates.

Each of these components is discussed separately. Total industry operating costs are then developed for Alternative B.

TABLE 4-4

ALTERNATIVE B SIMULATOR IMPLEMENTATION COSTS ($ MILLION)

COSTS	10-PERCENT DISCOUNT RATE	5-PERCENT DISCOUNT RATE
BEST ESTIMATE		
(Acquire plant-referenced simulator or use acceptable alternative Regulatory Guide 1.149 simulator.)	36.8	38.8
UPPER BOUND		
(Acquire plant-referenced simulator.)	69.1	76.0
LOWER BOUND		
(Acquire plant-referenced simulator; use acceptable alternative Regulatory Guide 1.149 simulator or use acceptable alternative training devices.)	33.1	34.9

Simulator Operations

These increased operating costs for simulators apply to the additional plants that would need to acquire plant-referenced simulators (or acceptable alternative devices). In its draft simulator analysis for the NRC,[29] PNL estimated these costs, which include additional instructors, a simulator manager, software and hardware technicians, and facility operation and maintenance costs. The best estimates of these annual simulator operating costs are provided in Table 4-5. These costs are an industry average, which considers that some simulators are used for single units/plants and others by multiple units/plants. Because the proposed changes require the use of simulators for examinations not training, only 10 percent of these annual simulator operating costs were assumed to be associated with the proposed changes. This ratio of training to examination time is expected to be constant irrespective of whether the simulator is used by one unit/plant or multiple units/plants.

As discussed earlier under industry implementations costs (Section 4.1.2.1), implementation of Alternative B is expected to result in an additional 6 simulators for the upper-bound case (i.e., all affected plants acquire plant-referenced simulators). These total upper-bound simulator operation costs are discounted over the average plant lifetime with these simulators in operation (24 years starting in 1988). Therefore, the present value upper-bound industry operating cost for simulators (discounted at 10 percent; discount factor = 6.96) is $2.0 million (6 simulators x 49,600 annual costs x 6.96). For a 5-percent discount rate (discount factor = 12.18), these upper-bound costs are $3.6 million.

TABLE 4-5

ANNUAL OPERATING COST PER SIMULATOR

COST BREAKDOWN	BEST ESTIMATE ($)
SALARIES AND BENEFITS	
Simulator Supervisor	40,000
Simulator Instructors (3)	105,000
Hardware Technician	27,000
Programmer/Software Technician (2)	58,000
Total Direct Salaries	230,000
Allowance for Overhead (60% of Direct Salaries)	138,000
Total Salaries and Overhead	368,000
FACILITY COSTS	
Cleaning Expenses	10,000
Building and Equipment Maintenance	32,000
Telephone Service	4,000
Reproduction Expense	6,000
Expendable Supplies	3,000
Simulator Maintenance	19,000
Simulator Upgrading	54,000
Total Facility/Operating Costs	128,000
TOTAL ANNUAL OPERATING COSTS	$496,000

For the best-estimate case discussed in Section 4.1.2.1 (i.e., acquire a plant-referenced simulator or use another ANSI/ANS 3.5 simulator shown to be adequate), only two simulators are required. The present value operating costs for the best-estimate case discounted at 10 percent are $0.7 million. For a 5-percent discount rate, these best-estimate costs are $1.2 million.

Specific operating cost estimates for the lower-bound case discussed in Section 4.1.2.1 where some utilities might acquire satisfactory alternative training and examination devices in lieu of using acceptable ANSI/ANS 3.5 simulators or acquiring plant-referenced simulators are more difficult to develop because the utility response and technological improvements are not known today. However, for the purpose of this regulatory analysis, it can be assumed that the costs of operating these alternative devices would not exceed the costs of operating a simulator. As was done for estimating acquisition costs for this lower-bound case (Section 4.1.2.1), an arbitrary 10-percent reduction in the best-estimate industry operating costs was assumed to account for potential cost efficiencies of the additional utility flexibility and initiatives associated with this option. This assumption results in a lower bound for industry simulator operating costs of $0.6 million (10-percent discount rate) and $1.1 million (5-percent discount rate).

Operating Cost Savings with Improved Plant Availability

A reduction in human errors associated with plant operations and maintenance can logically be assumed to affect plant availability in addition to the influence on core-melt frequency developed in Section 4.1.1 of this regulatory analysis (e.g., an error that results in a reactor and turbine trip can not only cause a transient that requires operation of the reactor protective system and other systems important to safety, but can also cause an unscheduled outage). In fact, the connection between human errors and day-to-day plant availability is easier to conceptualize than the tie to core-melt frequency. Errors in the daily operation and maintenance of the plant that lead to less serious results such as plant shutdown can be expected to occur much more frequently than accidents that lead to core damage or core melt.

Three separate, and essentially independent, data sources were used to quantify these cost savings (improved plant availability) that would result from fewer human errors. They are:

(1) Utility outage data provided to the NRC,

(2) Licensee Event Report (LER) analysis, and

(3) Industry estimates of availability improvements due to improved personnel performance.

With respect to the utility outage data, a computer printout of all reported outages during 1980 and 1981 grouped by facility was reviewed. This review determined that the average total duration of forced outages attributed to "operational error" was 22.2 hours per facility per year. However, a review of the descriptions of the outage causes and discussions with cognizant NRC personnel indicated that only forced outages, where there was a close linkage in time and cause between "operational error" and the outage, were categorized in this operational error category by the facility. The most common categorization of forced outages was "equipment failure"; however, for many of these "equipment failure" forced outages, the equipment failure many have been due to personnel error. (For example, "Reactor scrammed when main steam line high radiation trip was reset improperly," or, "Scram due to high water level indication which caused the main turbine and reactor feedwater pumps to trip. Equalizing valve on level indicator was open.")

In general, the description of the outage cause was not sufficiently detailed to allow an accurate categorization through review of the computer printout. However, such a categorization of LERs related to the operation, testing, and maintenance of reactor safety system pumps and valves was conducted by the Brookhaven National Laboratory (BNL) and reported in NUREG/CR-2417, "Identification and Analysis of Human Error Underlying Pump and Valve Related Events Reported by Nuclear Power Plant Licensees."[31] The following quotes from NUREG/CR-2417 report BNL results with respect to LER categorization:

> "Although licensees do attribute certain events to personnel error in the LERs, such attributions were used only as alerting signals during the analysis. While it is true that the cause assignment - 'personnel error' - is usually supported by the LER text, the converse is frequently not the case. That is, it is not uncommon to find LERs in which the event cause is presented as 'component failure' but which, in reality, more accurately reflect human error. To illustrate by an actual example, a remotely actuated valve failed to operate in response to a signal. On investigation, it was found that the valve stem was binding because the packing had been excessively compressed through overtightening of the packing adjustment nut. In this case, the licensee's attribution of the event to component failure in the LER was considered invalid because the valve had not really failed in the true sense, as through normal wear, for example. When the packing compression was properly adjusted, the valve functioned perfectly. This event was, therefore, considered to be the consequence of human error and not of component failure."

The overall result of this LER analysis of over 3000 LERs was "a human error data base six times larger than indicated by the LERs themselves."

Assuming that the utility categorization of LERs and outages is consistent, a correction factor of 6 can be applied to the outage data to get a more accurate estimate of outage time caused by operational error. Hence, the estimated actual average total duration of forced outages attributable

to personnel error is 133.2 hours per facility per year [22.2 hours x 6 (LER correction factor)].

The average total forced outage duration per year of 133.2 hours per year per facility due to personnel error does not include TMI-2 in the statistics. If TMI-2 is included (assuming a 65-percent capacity factor if TMI-2 were operational), the average total forced outage duration per year per facility due to personnel error is 218 hours.

To use these forced outage duration estimates to develop a cost savings estimate for Alternative B, the reductions in operator error rates developed in Section 4.1.1 (1-percent reduction in operator error rates for all plants due to improved written examinations, and 2-percent reduction in operator error rates due to improved operating tests only for those plants that will obtain a plant-referenced simulator or other appropriate simulation device as a result of Alternative B) will be used, along with the outage duration hours above, to calculate the outage duration improvement expected per year.

Using the guidelines of NUREG/CR-4012, "Replacement Energy Costs for Nuclear Electricity-Generating Units in the United States",[32] the average daily replacement energy cost for the 35 facilities affected by the operating test requirements is $300,000 (1984 dollars) while the average for all 125 facilities is $403,000 per day (1984 dollars). From this information, annual cost savings due to improved availability can be calculated both with and without TMI-2.

Annual cost savings (w/o TMI-2) = [133.2 hours x 0.01 x 125 facilities x $403,000/day] + [133.2 hours x 0.02 x 35 facilities x $300,000/day]
= $3.370,000

Annual cost savings (including TMI-2) = [218 hours x 0.01 x 125 facilities x $403,000/day] + [218 hours x 0.02 x 35 facilities x $300,000]
= $5,520,000

In the Draft Report "Estimating the Public Risk Reduction Affected By Human Factors Improvements,"[27] PNL developed a model of unavailability because of human error (based upon NRC outage data and hypotheses concerning human contributions to the frequency and duration of outages). This model estimates a 5.6-hour per year improvment in plant availability associated with a 1-percent reduction in operator error rates and an 11.3-hour per year improvement associated with a 2-percent reduction in operator error rates. Using the approach above this translates into an annual cost savings of $16,690,000.

The following is a separate way of estimating the cost savings due to improved availability. Aggregate data on utility outages maintained by the NRC show that the average facility is shut down about 32 unscheduled (forced outages). To estimate the percentage of these caused by personnel error, the findings of precursors to severe core damage accidents[6] were used. This study

reviewed 19,400 LERs that occurred between 1969 and 1979 to identify precursors of accident sequences and the number of precursors that involved human error based upon a review of the detailed events. The human errors of interest were errors in operations and maintenance that significantly affected the precursor event. The percentage of precursors that involved human error were compared with the percentage of all LERs pertaining to safety-related systems involving human error in 1979. These findings are listed as follows:

Event Type	Percent of Events Involving Human Error
Significant Precursors	38
All Precursors	36
1979 Safety-Related LERs	29

Assuming that a similar distribution exists between the human error contribution to safety-related LERs (29 percent) and the human error contribution to unscheduled outages, an estimate of 29 percent of forced outages caused by human error represents an estimated 9.3 days (32 days x 29 percent) per year per facility of unscheduled outages. Applying the estimated 1-percent and 2-percent reductions in operator error rates due to operator licensing examination changes developed in Section 4.1.1 and the estimated costs of replacement power discussed earlier, the annual availability cost savings due to using this approach are estimated to be $6.630,000.

The third source of cost savings data because of improved availability are industry estimates used in evaluating decisions to purchase simulators. These industry estimates range from 0.5 percent to 2.0 percent improvement in capacity factor. Using a baseline 65 percent average capacity factor (5694 hours per year), a 0.5-percent improvement is 28.5 hours (1.2 days) and a 2.0-percent improvement being 113.9 hours (4.7 days). If, consistent with Section 4.1.1, it is assumed that 10 percent of the simulator benefit is due to examinations and 90 percent due to training, then these improvements result in estimated annual cost savings of $5,990,000 (0.5 percent), $23,960,000 (2.0 percent) and $14,975,000 (1.25 percent).

The range of the annual industry cost saving estimates because of improved availability is as follows:

Range of Annual Industry Availability Cost Savings Estimates	
$ 3,370,000	(outage data excluding TMI-2)
$ 5,520,000	(outage data including TMI-2)
$ 6,630,000	(aggregate outage data)
$16,690,000	(PNL model)
$ 5,990,000	(0.5% improvement in capacity factor)
$14,975,000	(1.25% improvement in capacity factor)
$23,960,000	(2.0% improvement in capacity factor)

The best-estimate value of annual industry cost savings due to fewer forced outages from operator error to be utilized is $6,630,000 with an upper-bound value of $9,940,000 and lower bound of $3,310,000 (±50 percent). Therefore, the present value of the Alternative B cost savings because of fewer operator errors (discounted at 10 percent over the 24 remaining years of average facility lifetime starting in 1988; discount factor = 6.96) is $46.1 million with an upper bound of $69.2 million and a lower bound of $23.0 million. The present value of these cost savings, discounted at 5-percent (discount factor = 12.18) are $80.7 million (best estimate), $121.1 million (upper bound), and $40.3 million (lower bound).

Industry Cost Savings Due to Fewer Licensing Examination Failures

As discussed in Section 4.1.1, changes in licensing examinations to make them more performance-based are expected to reduce examination failure rates.

In order to quantify the cost savings resulting from fewer licensing examination failures, it is first necessary to estimate the number of operator licensing examinations to be administered each year. Based upon utility responses to NRC Generic Letter 83-01 "Operator Licensing Examination Site Visit," of January 11, 1983, it is estimated that an average of 11 written examinations will be administered per site per year. The average number of sites is estimated to be 86, which means that an average of 946 written examinations will be administered per year. Based upon the discussion of Type I and Type II errors in Section 4.1.1, it is assumed that Alternative B will reduce the licensing examination failure rate by 2 percent. This implies 19 fewer examination failures per year.

The following assumptions are made based upon industry practice when a candidate fails a licensing examination:

(1) Twenty percent will not be reexamined, resulting in an individual's receiving an additional 42 weeks of training (including an additional examination).

(2) Eighty percent will be reexamined, resulting in an additional 12 weeks of training per individual (including a reexamination).

These assumptions lead to the following calculation concerning the annual industry resources saved by reducing the licensing examination failure rate by 2 percent.

Annual industry resources saved = (19)(0.20)(42 weeks) + 19(0.80)(12 weeks)

= 158.4 + 182.4

= 342 person-weeks

= 6.6 person-years.

Converting these resource savings to 1984 dollars, a 2-percent decrease in the failure rate yields an annual cost savings of $660,000.

The present value of these cost savings for the average plant lifetime is $4.6 million (discounted at 10 percent) and $8.0 million (discounted at 5 percent). Upper and lower bound estimates are ±50-percent values.

Industry Cost Savings Due to Extending License Expiration

Extending license expiration to six years from the date of issuance from the current two years will reduce the administrative burden on the industry. It is estimated that one person-month of time will be saved per facility each year. For 128 facilities and $100,000 per person-year, this results in an annual industry savings of $1.1 million. The present value of these savings is $7.6 million, discounted at 10 percent (discount factor = 6.96) and $13.4 million, discounted at 5 percent (discount factor = 12.18). Upper and lower bound cost estimates were based upon ±50 percent values.

Industry Cost Savings Due to Requalification Examination Changes

Alternative A audit examinations are administered in addition to facility annual requalification examinations. Based upon an average of 9 operator audit examinations per site visit (20 percent of 45 operators per site), 5 hours per audit examination and 72 sites (in 1984), this is a total of 3240 hours of operator time required for Alternative A audit examinations. Assuming the number of sites increases to 89 by 1990 and remains constant and that the average remaining life of these plants is 28 years, then the average number of operator hours required for Alternative A is about 3900 hours.

If Alternative B were implemented, these 3900 hours per year could be saved because the NRC requalification examinations would be administered instead of utility requalification examinations. This would result in an annual cost savings for Alternative B of $187,500 (in 1984 dollars). The present value of these cost savings is $1.7 million (discounted at 10 percent) or $2.8 million (discounted at 5 percent). Upper and lower bound cost estimates were based upon ±50-percent values

4.1.2.3 NRC Costs

The costs to the NRC will include one-time implementation costs, and continuing operating costs, including cost savings.

NRC Implementation Cost

These costs refer to the effort required by the NRC to implement the operator licensing examination changes. The major components of this implementation effort include the following:

(1) Conducting confirmatory reviews of the adequacy of facilities' simulators or alternative training devices,

(2) Performing analyses and confirmatory research to develop better bases for simulator/alternative device reviews,

(3) Developing performance-based examination items using the INPO job and task analysis data base and other industry sources, and

(4) Developing an examination data bank where examination items are coded in a manner compatible with the INPO data base.

The simulator reviews are estimated to average 1 person-month per review. For these training and simulator reviews, a plant site with multiple reactors of similar type was counted as one review since these facilities do not normally have different training organizations for each reactor. A total of 85 program reviews would be required. Hence, total costs for initial training program and simulator reviews are:

$$1 \frac{\text{person-month}}{\text{review}} \times 85 \text{ reviews} \times \frac{\$100{,}000}{\text{person-year}} = \$0.7 \text{ million.}$$

In addition to these simulator reviews, it is assumed that two professional staff years of effort and $0.5 million of contractor support will be devoted to analysis and confirmatory research to develop better bases for these simulator reviews. For calculating the total cost of this combined NRC and contractor analysis and research effort, 1987 was used as the midpoint year for discounting (10-percent discount factor = 0.683, 5-percent discount factor = 0.823). For a 10-percent discount rate, the present value of these analysis and research costs is $0.5 million [($0.7 million) x 0.683 discount factor]. For a 5-percent discount rate, the present value is $0.6 million.

Calculated costs for implementation must be discounted for the estimated time period to complete implementation. Inspection preparations (guidelines, criteria, and workshops) are estimated to require one year to complete. For the purposes of discounting NRC implementation costs, it was assumed that the majority of simulator reviews would occur during the period 1985 through 1989. The year 1988 was used as the completion year for the purpose of calculating present value costs.

Thus, best estimates for total NRC implementation costs of present value dollars are $1.0 million (10-percent discount rate) and $1.2 million (5-percent discount rate).

NRC Operating Costs

NRC operating costs refer to the effort required by the NRC to review, on a continuing basis, compliance with regulations/guidance. These reviews will consist of periodic audits of simulators used in these programs.

The simulator reviews will ensure that reference plant updates have been adequately represented on the simulator and confirm the continuing suitability of the device(s)/system(s) used for each plant's operator licensing operating tests.

The following paragraphs develop estimates for these major components of NRC operating costs and (cost savings):

- o Simulator/alternatives device(s) audits,
- o Operator requalification examination changes,
- o Licensing examination failures, and
- o License expiration changes.

NRC Simulator Review Costs

Simulator/alternative device(s) reviews will require less effort than the initial reviews and are estimated to require an average of 0.5 person-month per audit each year. The cost of these annual audits for all 85 training programs is:

$$\frac{0.5 \text{ person-months}}{\text{audit}} \times 85 \text{ audits} \times \frac{\$100{,}000}{\text{person-year}} = \$0.35 \text{ million.}$$

This total annual cost of these training and simulation reviews of $0.35 million must be discounted over the remaining average plant life with the operator licensing examination changes implemented. This time period was calculated previously as 24 years. The 10-percent discount factor is 6.96 and the 5-percent discount factor is 12.18, assuming 1988 as the implementation year. The best estimates for NRC operating cost for these training and simulation audits are $2.4 million (10-percent discount rate) and $4.3 million (5-percent discount rate).

NRC Requalification Examination Cost Savings

For the operator licensing requalification examination changes, NRC experience with Alternative A indicated that about 15 professional staff years (PSYs) are needed to administer audit examinations to 20 percent of the operators at 100 percent of the facilities operational in 1984 (72 sites). By 1990 (when almost all planned facilities are scheduled to be operational), the number of sites is estimated to be 87, which is assumed to increase NRC resource needs for Alternative A to 18.5 PSY.

To estimate NRC resources for Alternative B the following assumptions are made:

(1) The NRC will administer Alternative B-type requalification examinations to 50 percent of the utilities in each calendar year.

(2) One full week of examiner effort is expended at each utility. This would yield on the average (depending on the number of operators at a utility) approximately 20 percent of the operators being examined at each utility.

(3) Each operator selected would be administered a full requalification examination by an NRC examiner.

Based upon the above assumptions, it is estimated that NRC resources of 10.5 PSY would be required in 1984, increasing to 13.0 PSY by 1990. The average annual decrease in NRC resources required for Alternative B (relative to Alternative A) is 5.0 PSY, which equates to $500,000 per year (in 1984 dollars)*. The present value of these Alternative B requalification examination savings over the average facility lifetime of 28 years is $4.7 million (discounted at 10 percent; discount factor = 9.31) and $7.5 million (discounted at 5 percent; discount factor = 14.9).

NRC Cost Savings Due to Fewer Licensing Examination Failures

Once the performance-based examinations are implemented, there will be no additional operating costs. There may be some improved efficiencies resulting from having the system in place, but no credit for any cost saving is taken. The cost savings that are quantified are those related to an expected 2-percent reduction in the licensing examination failure rate. As described earlier in Section 4.1.2.2 (Industry Operating Costs), it is estimated that an average of 19 fewer examinations would be administered each year because of this reduction in the examination failure rate. Given that an average of 6 examiner days are required per examination for preparation, administration, and scoring, the total NRC OLB resources saved per year are 114 person-days or 0.44 PSY, which translates to $44,000 cost savings per year. The present value of these cost savings for the average plant lifetime is $0.3 million (discounted at 10 percent) and $0.5 million (discounted at 5 percent)

NRC Cost Savings Due to Change in License Expiration

It is estimated that extending license expiration to six years from the current two years will reduce NRC staff review and administrative requirements by 2.5 PSYs per year, or $250,000 per year. The present value of these cost savings, discounted at 10 percent is $1.7 million, and $3.0 million, discounted at 5 percent.

*It is recognized that all or part of these "NRC operational costs" will be provided through "users' fees" paid by the utilities; however, in the interest of simplicity and consistency with other presentations of NRC/industry costs, these costs are included as NRC costs. The net effect on any cost/benefit presentation is unchanged no matter how these costs are grouped.

NRC Total Cost

The best estimate of NRC total implementation, and operating costs (assuming a 10-percent discount rate) is:

+ $1.0 million (implementation)
+ $2.4 million (simulator reviews) - $4.7 million (requalification examination cost savings) - $0.3 million (cost savings due to fewer failures) - $1.7 million (cost savings due to changes in license expiration)
= $3.3 million, total NRC cost savings.

Because large uncertainties are involved in this estimation, an upper bound of +50 percent or $5.0 million in cost savings, and a lower bound of -50 percent, or $1.7 million in cost savings, are assumed.

Total NRC cost savings assuming a 5-percent discount rate are $5.5 million, with an upper bound savings of $8.3 million and lower bound savings of $2.8 million.

4.1.3 Value/Impact Ratio

Following the guidelines of NRC Office Letter No. 16 (Revision 1) of March 14, 1983,[20] the value/impact ratio of total safety benefits (in terms of person-rems of public dose avoided) related to total costs (industry and NRC implementation and operating costs) was used as a measure for comparing Alternatives A and B. The total safety benefit in terms of public risk reduction is obtained from Section 4.1.1. Total industry implementation and operating costs are obtained from Sections 4.1.2.1 and 4.1.2.2, respectively. Total NRC cost savings were calculated in Section 4.1.2.3. Figure 4-1 summarizes these costs. These inputs result in the following value/impact ratios for a 10-percent discount rate:

	Alternative B		
	Public Risk Reduction (person-rem)	Total Costs ($ million)	Value/ Impact Ratio
Best Estimate	13,000	(25.8)	*
Upper Bound	25,000	(24.0)	*
Lower Bound	7,000	2.0	3500

*For these cases there is both a positive public risk reduction and negative costs (e.g., cost savings) projected for Alternative B. Therefore the value impact ratio is said to be "negative". The value impact ratio in these cases might also be considered to be infinite, because there is a positive benefit at no net cost to the industry or the NRC (in fact, a net cost savings is estimated).

COST COMPONENTS	COST ($ million) BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Industry Implementation Costs			
- Simulators	36.8	69.1	33.1
Industry Operating Costs			
- Simulators	0.7	2.0	0.6
- Operating Cost Savings Due to Improved Plant Availability*	(46.1)	(69.2)	(23.0)
- Initial Licensing Exam Changes	(4.6)	(6.9)	(2.3)
- Extending License Expiration	(7.6)	(11.4)	(3.8)
- Requalification Exam Changes	(1.7)	(2.6)	(0.9)
NRC Costs			
- Implementation	1.0	1.5	0.5
- Operation	(4.3)	(6.5)	(2.2)
TOTAL COSTS (NET)	(25.8)	(24.0)	2.0

*Parentheses indicate negative costs (i.e., cost savings)

Figure 4-1. Summary of Alternative B Costs (10-percent discount)

4.1.4 Special Considerations

This section addresses those considerations, other than the parameters used to calculate value/impact ratio, that are important for understanding the total benefits and costs associated with implementing Alternative B. These considerations include quantifiable terms such as avoided occupational exposure (accidental and routine), public and on-site property damage avoided, and other considerations of a qualitative nature. Each of these considerations is discussed separately.

4.1.4.1 Avoided Occupational Exposure (Accidental)

A methodology for calculating avoided occupational exposure from accidents was developed in NUREG/CR-3568 "A Handbook for Value-Impact Assessment."[34] This approach estimated the avoided occupational exposure from accidents as the product of the change in total core-melt probability (ΔF) and the occupational exposure likely to occur in the event of a major accident. The result is calculated as:

$$D_{TOA} = T \times \Delta F_{Total} (D_{IO} + D_{LTO})$$

where:

D_{TOA} = Total avoided occupational dose (person-rems),
T = Average reactor lifetime after implementation of the alternative,
ΔF_{Total} = Average change in core melt probability for all affected reactors per year,
D_{IO} = "Immediate" occupational dose (person-rems), and
D_{LTO} = Long-term occupational dose (person-rems).

The value of ΔF_{TOTAL} was calculated in Section 4.1.1, and is 1.65×10^{-4} core melts per year, which is the total average annual change in the core melt probability for the 125 plant units that are assumed to be in operation for this analysis.

The immediate occupational exposure (D_{IO}) occurs at the time of the accident and during the immediate management of the emergency. The TMI experience discussed in NUREG/CR-3568 was used to arrive at values for D_{IO}. A collective dose of 1000 person-rems could be attributed to the accident and was used as the best estimate for D_{IO}. An upper bound is estimated by assuming that the average dose received at TMI is 4.2, giving an upper bound estimate for collective dose as 4200 persons-rem. A lower bound of zero is used to indicate the case where no increase over the normal occupational dose occurs.

Hence, D_{IO} is given by:

D_{IO} = 1000 person-rems (best estimate)
= 4200 person-rems (upper bound)
= 0 person-rem (lower bound).

The long-term occupational dose (D_{LTO}) was also taken from NUREG/CR-3568 and is based on a study of decommissioning a reference light water reactor (LWR) following a major loss-of-coolant accident (LOCA) in which the emergency core cooling system (ECCS) is delayed in starting.[35] All fuel cladding is assumed to rupture and there is significant fuel melting and core damage. The containment building is extensively damaged and contaminated. In addition, the auxiliary building undergoes some contamination. The estimated occupational radiation dose from cleanup and recovery is 20,000 person-rems. An upper bound of 30,000 person-rems and lower bound of 10,000 person-rems were estimated by the authors of the study. Hence, D_{LTO} is given by:

D_{LTO} = 20,000 person-rems (best estimate)
= 30,000 person-rems (upper bound)
= 10,000 person-rems (lower bound).

Completing the calculations for total avoided occupational dose (D_{TOA}) for Alternative B yields a best estimate of 100 man-rem with an upper bound of 200 person-rems and a lower bound of 0 person-rems.

4.1.4.2 Avoided Occupational Exposure (Routine)

Since Alternative B involves improving operator performance, no increase in occupational dose will result from implementation. However, a potential exists to reduce occupational dose during annual operation and maintenance as a result of improved performance. This routine exposure reduction was based upon PNL's expert panel estimates developed during its prioritization review of TMI Action Plan Item I.A.2.2, "Safety Issue Resolution." These estimates are provided in NUREG/CR-2800. Based on the PNL panel's estimates and an assumed average of 300 to 500 person-rems/reactor-year accumulation of routine exposure by nuclear power plant workers (NUREG/CR-2800), a value of 6 person-rems/reactor-year is a best estimate of the potential decrease in occupational dose resulting from Alternative B implementation. The weighted average T for all PWR and BWR plants is 24 years. Hence, the Alternative B best estimate of total avoided routine occupational exposure is 18,000 person-rems. Because of the uncertainty associated with these estimates, an upper bound of +50 percent (27,000 person-rems) and a lower bound of 0 person-rems were assigned.

4.1.4.3 Public Property

The public property factor is intended to address the monetary losses and property losses of the public associated with an accident. The value of public property damage avoided can be calculated as:

$$V_{FP} = \Delta F_{TOTAL} \times D_G$$

where:

V_{FP} = Value of avoided off-site propery damage,
ΔF_{TOTAL} = Total annual change in accident frequency, and
D_G = Generic present value of propery damage conditional on release.

The estimate for D_G was obtained using the results from NUREG/CR-2723[36] and the recommended application of these in NUREG/CR-3568. The NUREG/CR-2723 study reported off-site property cost for accidents at 91 U.S. sites with licensed reactors or construction permits. These costs were based directly on CRAC2 computer code results. The resulting scaled public property damage per event estimates are $1.67 billion (best estimate) with an upper bound of $9.20 billion and a lower bound of $830 million. These estimates must be discounted for the 24-year period (T) that Alternative B programs are considered to be in place (i.e., years 4 though 28 after implementation). The 10-percent discount factor is 6.96 and the 5-percent discount factor is 12.18. Hence, the 10-percent and 5-percent discount rate present dollar values for D_G are:

	10% Discount Rate ($ billion)	5% Discount Rate ($ billion)
Best Estimate	11.62	20.34
Upper Bound	64.03	112.06
Lower Bound	5.78	10.11

The value of ΔF_{TOTAL} was calculated in Section 4.1.1, and is 1.65×10^{-4} core melts per year, which is the total average annual change in the core melt probability for the 125 plant units that are assumed to be in operation for this analysis.

The estimated total public property damage avoided due to reduced accident frequency for Alternative B is:

	10% Discount Rate ($ million)	5% Discount Rate ($ million)
Best Estimate	1.9	3.4
Upper Bound	10.5	18.5
Lower Bound	0.9	1.7

4.1.4.4 On-Site Property

On-site property costs from an accident are the economic costs to plant, equipment, land, and materials within the boundaries of the utility site. The value of on-site property damage avoided can be calculated as:

$$V_{OP} = \Delta F_{Total} \times U$$

where:

V_{OP} = Value of avoided on-site property damage, and
U = Present value of property damage conditional on release.
ΔF_{total} = Total average annual change in core melt probability for affected reactors (125 units).

An estimated cost of plantwide cleanup before discounting to present worth was taken as $1.2 billion. This is the cost value suggested in NRR Office Letter No. 16 (Revision 1), which provides supplemental guidance for preparing regulatory analyses in accordance with NUREG/CR-0058.[37]

This $1.2 billion value is based on TMI estimates. These costs need to be discounted to 1984 as were the public property costs. Upper and lower bound cost estimates were the ± 50 percent values. Hence, the estimated total on-site property damage avoided because of reduced accident frequency for Alternative B is:

On-Site Property Damage Avoided

	10% Discount Rate ($ million)	5% Discount Rate ($ million)
Best Estimate	1.4	2.4
Upper Bound	2.1	3.6
Lower Bound	0.7	1.2

4.1.4.5 Other Considerations

The following quotation from Swain and Guttman's "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Application - Final Report" (NUREG/CR-1278[25]) provides a reference point for the discussion of other considerations:

> "In WASH-1400 (p. III-64) we judged that the level of training of NPP personnel was outstanding. Based on our subsequent studies and on the EPRI review (pp. 18-9 to 18-14), it is apparent that this earlier judgement should be modified. We still believe that the training of NPP control room operators is generally good, but there is much room for improvement (Kemeny, 1979). Moreover, another EPRI report indicated that the training of maintenance personnel is quite deficient (Seminara, Parsons, et al., 1979). As was that case in the training of military electronics personnel in the 1950s, some NPP training courses include much theory that may not be necessary for plant personnel who perform operation, maintenance, or other hands-on activities. With limited amounts of time for training, and with costs between $100,000 and $200,000 to train each operator, the elimination of job-irrelevant training from the syllabus would allow more time for operationally oriented content. It is apparent from the EPRI reports that the training of NPP personnel needs a thorough reevaluation."

The systems approach to training (SAT) has, during the past 20 years, been researched and refined through its use for complex systems in the defense, aerospace, and communications industries. SAT has gained acceptance in these diverse industries because it has demonstrated an ability to:

(1) Identify what training should be provided for specific jobs,

(2) Design and develop training based upon these job requirements,

(3) Provide objective and measureable ways to determine whether trainees have mastered these job requirements before they are working in their assigned jobs, and

(4) Evaluate training and use these results to improve training and, therefore, job performance.

Probabilistic risk assessment studies, industry operating experience, and major incidents clearly show that nuclear power plant personnel are a major contributor to risk and act not only as accident initiators and accident propagators, but also as accident mitigators. Given this importance of nuclear power plant personnel to public health and safety, there is a need to subject training and other related human performance issues to the same scrutiny and careful decision making undergone for structures, systems, and other components important to safety. The SAT has been demonstrated to provide the necessary effectiveness, accountability, and control to ensure that adequate scrutiny is provided of how well nuclear power plant personnel perform based upon job requirements.

Outside the nuclear industry, the use of simulators for both training and qualification (examination) of operators of complex systems is extensive. The commercial aviation industry, the U.S. military services, NASA, and the maritime industry have thousands of operational simulators in use. Of the 125 reactors planned or operational, 71 have plant-referenced simulators in operation. Another 41 reactors have plant-referenced simulators under construction. Eight more reactors have stated the intent to purchase, or are considering the purchase, of a plant-referenced simulator. This means that only 13 of 125 operational reactors have no plans for plant-referenced simulators. When probable waivers relative to plant age, operating characteristics, or size are considered, as well as when similarities among these reactors and other plant-referenced simulators are taken into account, as few as two additional plant-referenced simulators may be required to provide a plant-referenced control room simulator (or acceptable alternative device) for all planned and operating reactors. The vast majority of applicants and licensees have confirmed the efficiency and the effectiveness of a plant-referenced simulator for training and qualification. This proposed change in the regulation would provide the remainder of the industry with the training devices that simulation specialists have indicated are necessary for adequate assurance of an operator's qualification and that examiners, trainees, and trainers agree are highly desirable.

The benefit-cost analysis developed in previous sections includes the effect that the NRC operating examinations on plant-referenced simulators (or acceptable alternative devices) would have on reducing operator errors that lead to major core-melt accidents. Another benefit would be the improvement in validity of NRC and utility examination of operators. The use of these simulation devices would help standardize the tests given to the operators as compared with the present situation. The utility can use the simulator/device to improve its own internal evaluation of operator and other personnel competence. The utility can also perform plant-specific job and task analyses and similar studies with these simulation devices to improve safety and efficiency of the operation of the power plant. These devices should also aid the utility in establishing effective emergency procedures and aid in diagnosing any abnormal or emergency events that may arise in the control room. All of the above benefits are in addition to the main purpose of the simulators, which is to train reactor operators, senior reactor operators, and shift supervisors and evaluate their performance, so as to reduce rates of operator error.

INPO has committed to use a SAT for the development and evaluation of industry training programs. INPO is developing a SAT model called the Training System Development approach, which is specifically applied to the nuclear power industry. A commitment to SAT is one of the requirements for INPO Training Program Accreditation.

It is anticipated that those utilities that pursue and receive INPO accreditation of their training programs will also meet the requirements of this proposed regulatory action. It is further anticipated that, through NRC monitoring of the INPO accreditation program, double reporting and auditing will be avoided.

Much of industry believes that training provided to pass the operator licensing written examination and training provided to be a competent operator are, in large part, independent. By basing operator licensing written examinations on learning objectives developed from the facility's system approach to training, Alternative B would serve to unite these two utility training goals, resulting in improved efficiency for the utility's training system.

4.1.5 Summary Benefits and Costs

Table 4-6 provides a summary of the quantifiable benefits and costs associated with implementation of Alternative B, assuming a 10-percent discount rate. Table 4-7 is provided to permit comparisons and show these results assuming a 5-percent discount rate.

Benefits and costs can have either positive or negative algebraic signs. For benefits, improvements in meeting the NRC's goals are positive. For costs, increases in costs are positive. Negative parameters are indicated by parentheses. The negative total costs shown indicate that for the assumptions associated with the estimate there is an overall net cost savings for the expected lifetime of reactor operation with the indicated alternative implemented. Comparison of the 5-percent and 10-percent discount rate tables shows the effect that industry operating cost savings have on total costs since the cost savings are realized during the 24-year period.

The need for simulator instructors identified by this analysis may result in a shortage of good instructors by the time SAT is implemented. This constraint may, in the short term, limit the attainment of the potential safety benefits and cost savings identified previously. This constraint can be overcome in time if utilities commit to attaining the needed staffing levels. Implementation of high-quality instructor training program as part of SAT will have a positive effect on expanding the potential entry-level resource base for instructors and, hence, help overcome this constraint.

The principal constraint with respect to operator licensing examination changes (that the written examination change to develop examination content from plant-specific, performance-based learning objectives) is based upon the assumption that development of plant-specific learning objectives through the systems approach to training is implemented for licensed operator, as a minimum.

TABLE 4-6

SUMMARY OF ALTERNATIVE B BENEFITS AND COSTS
(10-PERCENT DISCOUNT RATE ASSUMED)

	DOSE (person-rem)		
BENEFITS	BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Public Risk Reduction	13,000	25,000	7,000
Avoided Occupational Exposure (Accidental)	100	200	0
Avoided Occupational Exposure (Routine)	18,000	27,000	0
TOTAL BENEFITS	31,100	52,200	7,000

	COST ($ million)		
COSTS	BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Industry Implementation Costs			
- Simulators	36.8	69.1	33.1
Industry Operating Costs			
- Simulators	0.7	2.0	0.6
- Operating Cost Savings Due to Improved Plant Availability*	(46.1)	(69.2)	(23.0)
- Initial Licensing Exam Changes	(4.6)	(6.9)	(2.3)
- Extending License Expiration	(7.6)	(11.4)	(3.8)
- Requalification Exam Changes	(1.7)	(2.6)	(0.9)
NRC Costs			
- Implementation	1.0	1.5	0.5
- Operation	(4.3)	(6.5)	(2.2)
Avoided Public Property Damage	(1.9)	(10.5)	(0.9)
Avoided On-Site Property Damage	(1.4)	(2.1)	(0.7)
NET COSTS	(29.1)	(36.6)	0.4

*Parentheses indicate negative costs (i.e., cost savings).

TABLE 4-7

SUMMARY OF ALTERNATIVE B BENEFITS AND COSTS
(5-PERCENT DISCOUNT RATE ASSUMED)

	DOSE (person-rem)		
BENEFITS	BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Public Risk Reduction	13,000	25,000	7,000
Avoided Occupational Exposure (Accidental)	100	200	0
Avoided Occupational Exposure (Routine)	18,000	27,000	0
TOTAL BENEFITS	31,100	52,200	7,000

	COST ($ million)		
COSTS	BEST ESTIMATE	UPPER BOUND	LOWER BOUND
Industry Implementation Costs - Simulators	38.8	76.0	34.9
Industry Operating Costs			
- Simulators	1.2	3.6	1.1
- Operating Cost Savings Due to Improved Plant Availability*	(80.7)	(121.1)	(40.3)
- Initial Licensing Exam Changes	(8.0)	(12.0)	(4.0)
- Extending License Expiration	(13.4)	(20.1)	(6.7)
- Requalification Exam Changes	(2.8)	(4.2)	(1.4)
NRC Costs			
- Implementation	1.2	1.8	0.6
- Operation	(6.7)	(10.0)	(3.4)
Avoided Public Property Damage	(3.4)	(18.5)	(1.7)
Avoided On-Site Property Damage	(2.4)	(3.6)	(1.2)
NET COSTS	(76.2)	(108.1)	(22.1)

*Parentheses indicate negative costs (i.e., cost savings.)

5. DECISION RATIONALE

All the quantitative decision factors determined in this analysis point toward a decision to implement training, qualifications, and operator licensing examination changes of this regulatory analysis. These positive decision factors include the following:

(1) Public risk reduction estimated is high (best estimate: Alternative B = 13,000 person-rems);

(2) Value/impact ratio is negative (positive public risk reduction and negative net costs (net cost savings)

Qualitative factors that strongly indicated a positive decision:

(a) Reduction of risk to plant equipment or down time due to elimination of need to practice on actual equipment;

(b) Reduction of opportunity costs due to elimination of need to travel to other simulators;

(c) Increased management and employee commitment to performance-based training and practice due to simulator relevance and availability;

(d) Increased use of simulators for related uses such as training, engineering problem-solving, procedures development, and human factors research;

(e) Increased concentration on performance indicators in training and drills;

(f) Increased confidence in examination and testing procedures due to consistency provided by simulators;

(g) Reduction of plant start-up time and costs through provision of hands-on practice to crews before plant equipment can be operated;

(h) Elimination of need for trainees to "unlearn" details related to other plant simulators.

6. IMPLEMENTATION

6.1 Schedule of Implementation

For purposes of this regulatory analysis, the following assumption was made regarding the implementation schedule for these training, qualification, and operator licensing examination changes:

> The operator licensing requalification examination changes would be implemented immediately. (The NRC staff has studied coordination of oral and simulator examinations with utilities. Draft procedures for selecting utilities to be administered the NRC portion of the written examination have been developed. The NRC has requested OMB clearance.)

This assumption is based both upon the projected availability of generic task analysis data from efforts underway by the NRC and INPO and upon the experience of the military and industry in implementing a systematic approach to training. In addition, this period should provide adequate time for all current or future licensees to procure, install, and test a plant-referenced simulator or other acceptable alternative device(s)/system(s) or to arrange with another utility or a vendor for adequate training time on a "borrowed" simulator/device/system.

In addition, no attempt has been made to quantify other benefits/cost savings that may result from implementing Alternative B. Rather, the following sentences address these items in a qualitative fashion:

(1) There is a widely held industry opinion that training provided to pass the operator licensing examinations and training provided to be a competent operator are in a large part independent. Alternative B would serve to bring these two utility training goals together.

(2) Participation by the utilities in the examination development process would aid in fostering a more cooperative and positive relationship between regulators and industry, much as the FAA has achieved.

6.2 Impact on Other Requirements

Implementation of Alternative B should have the impact on other requirements shown in Table 6-1.

TABLE 6-1

IMPACT ON OTHER REQUIREMENTS

NUREG/CR-0058 APPENDIX C AREAS OR PROGRAMS POTENTIALLY AFFECTED	EFFECT	REGULATORY ANALYSIS SECTION
NRC regulations	Rule/Regulatory Guide development	4.1.2.3
NRC licensing actions under review	Initial acceptance review of simulators	4.1.2.3
NRC Implementation/Enforcement Program	Periodic simulator reviews	4.1.2.3
Licensee implementation for operating facilities and facilities under construction	Industry implementation costs (simulators)	4.1.2.1
Size or quality of licensee's staff	Additional staff may be required for simulator facilities	4.1.2.1 and 4.1.2.2

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NMSS Branch

Not in PDR

Nor DCS

ENCLOSURE A-5

REVISED VALUE IMPACT STATEMENT

ACCESS AUTHORIZATION PROGRAM - FINAL RULE

G25

VALUE/IMPACT STATEMENT
POWER REACTOR ACCESS AUTHORIZATION RULE

1. FINAL RULE

1.1 Description

The Commission has amended 10 CFR Part 73 to establish uniform minimum criteria for granting individuals unescorted access to protected areas and vital areas at nuclear power plants.

1.2 Background of and Need for the Rule

The Commission has long endorsed an industry-run clearance program for personnel at nuclear power plants and has relied for this purpose on licensee adherence to the employee screening guidance contained in American National Standard Institute (ANSI), "Industrial Security for Nuclear Power Plants" (ANSI N18.17). This endorsement and reliance is given in Regulatory Guide 1.17, "Protection of Nuclear Power Plants Against Industrial Sabotage," June 1973 and supplementary information published in connection with amendments to 10 CFR Parts 50 and 73 concerning the physical protection of nuclear power reactors (42 FR 10836, February 24, 1977).

As a result of a recommendation contained in the final report of the Joint ERDA-NRC Task Force on Safeguards (NUREG-0095) and other factors, the Commission, in March 1977, proposed amendments to 10 CFR Parts 11, 50, and 70 to establish criteria for determining an individual's eligibility for access to or control over special nuclear material. As a result of comments received, the Commission established a hearing board to consider additional oral and written communications on the proposed rule. After reviewing the recommendations of the Hearing

Board, the Commission issued amendments to its regulations requiring that certain individuals be subject to a federal clearance program. These individuals included those involved in the operation of licensed fuel manufacturing and fabrication facilities using, processing, or storing certain quantities of special nuclear material. In publishing the amendments, the Commission noted that nuclear power plants (except for the Ft. St. Vrain Facility) were not covered by the amendments, but would be the subject of a separate rulemaking action (45 FR 76968, November 21, 1980).

In discussing the question of screening personnel at nuclear power plants, the Hearing Board noted it was "persuaded by the discussion of those who favor the use of personnel screening in order to ensure employee suitability and trustworthiness," and agreed "that it is important to assess current emotional stability in any program designed to screen out potential saboteurs." (Hearing Board Report, pp. 33, 63.) The Hearing Board examined the results of a staff survey of existing personnel screening programs at 39 power reactor facilities (see Figure 10 and, noting "the disuniformity in private industry compliance with screening standards," concluded that "This checklist of varied solutions demonstrates the need for a more explicit standard than that contained in ANSI N18.17." (Hearing Board Report, pp. 33-34.) The Board noted that, "there was general agreement among the participants that there is a need to have greater uniformity in industry-conducted screening programs and that the present ANSI N18.17 standard is too vague to accomplish that purpose." (Hearing Board Report, p. 65.) Accordingly, the Board agreed with the suggestion made by several participants that the NRC issue a rule requiring all entities subject to the rule to meet specific standards which would build upon and improve those contained in ANSI N18.17, in the conduct of their screening programs. The Hearing Board recommended that the NRC mandate such standards rather than revising ANSI N18.17, since the latter is issued by industry and is not mandatory. (Hearing Board Report, p. 65.)

The Hearing Board's, recommendations were accepted by the Commission in June 1980 and provide the basis for this action.

2. IMPACT ON THE NRC

2.1 A codified access authorization program will assure that a uniform approach meeting minimum requirements will be applied in screening personnel for

unescorted access to protected areas and vital areas at power plants. The program will provide increased assurance that persons, whose behavioral history or patterns indicate a potential for committing acts detrimental to the public health and safety, would be identified before harmful acts were committed.

2.2 NRC Developmental Impact

NRC anticipates no significant developmental cost resulting from this rule.

2.3 NRC Implementation Impact

2.3.1 The impact on the NRC resulting from the implementation of this rule will occur in the areas of licensee's Access Authorization Plan review and additional inspections.

2.3.2 The implementation impact is estimated to be:

Existing Sites:

Licensing review and approval of Access Authorization Plans (assuming 14 staff-days/plan x 61[1] plans x $480/staff-day)	$409.9K
Additional inspection effort (preparation of revised inspection procedures [0.5 man-year] and additional inspector hours [1 man-year]) (1.5 man-years at 124,800/man-year)	$187.2K
Total estimated implementation cost to the NRC from the existing sites.	$597.1K

[1]It is assumed that the program will be organized and administered on a site rather than a reactor unit basis. Information obtained from NUREG-0020, Volume 9, No. 4, April 1985 Licensed Operating Reactors Summary Status Report Data.

New Sites[2]

Licensing review and approval of Access Authorization Plans (14 staff-days/plans x 15 plans x $480/staff day)	$100.8K
Additional inspection efforts (1.0 man-years @ 124,800/man-year)	$124.8K
Total estimated implementation cost for new sites to the NRC	$225.6[2]
Total estimated implementation cost to the NRC	$822.7

2.4 NRC Operational Impact

There are no identified or anticipated NRC operational cost impacts associated with this rule.

3. IMPACT ON OTHER GOVERNMENT AGENCIES

The proposed action will have no significant affect on the FBI (criminal history checks) and the General Services Administration (military history checks). The impact on the FBI is judged to be minimal inasmuch as the estimated 11,000 checks per year represent a minimal increase in the number of

[2]Based upon projections of an additional 15 sites being licensed on average within the next 5 years. Although, technically these costs are future oriented, the impacts are sufficiently near term that no discounting has been applied.

criminal history checks currently conducted by that agency. The General Services Administration's National Personnel Records Center has indicated that the proposed military history check would not present an undue burden on their operations.

4. IMPACT ON INDUSTRY

In addition to the safeguards objective, each element of the proposed screening program (background investigation, psychological assessment and continual observation) has potential safety benefits for the industry.

The background investigation elements and their associated benefits are:

1. True identity - Assures that the individual seeking unescorted access is not assuming the identity of another.
2. Employment history - Verifies the individual's claimed experience and qualifications and identifies possible past behavioral actions which would be predictive of future actions that could be detrimental to the public health and safety.
3. Educational history - Verifies the individual's training, credentials, and true identity.
4. Credit history - Establishes financial responsibility and relates to the possibility that the individual may be subject to coercion, influence, or pressure to act in a manner contrary to the protection of the public health and the minimization of danger to life and property.
5. Criminal history - Determines if the individual:

   (a) Has been involved in any act of sabotage or other unlawful destruction of property;
   (b) Has been convicted of any felony or a series of lesser offenses indicating a pattern of criminal behavior; or
   (c) Is a habitual abuser of a controlled substance or alcohol.

Both the psychological tests and clinical interview are for the purpose of detecting current behavioral attributes which indicate a high potential for committing acts detrimental to the public health and safety or, personality attributes which, when combined with the expected work environment, could

develop into a potential for committing acts detrimental to the public health and safety.

The continual observation program exists to detect changes in an individual's behavior or emotional condition which could lead to the commission of acts detrimental to the public health and safety. The program requires that individuals exhibiting such behavioral changes be referred to the person responsible for administration of the licensee's access authorization program. This person would determine if further referral of the individual to competent medical authorities with suspension or revocation of the individual's access authorization is appropriate.

The rule provides the licensee with a previously unavailable opportunity to provide unescorted access to unscreened temporary workers under certain plant conditions, waives the background investigation and psychological assessment requirements for persons screened under a published industry standard, and provides for licensee acceptance of an access authorization granted under an approved plan by another licensee.

Atomic Industrial Forum subcommittee reviewed cost estimates and the estimates reflect their assessment of impact on the industry.

4.1 Industry Implementation

In generating the cost estimates shown below, the staff did not consider the fact that licensees presently have screening programs containing some elements of the proposed action. For example, 48% of the utilities in the staff survey submitted to the Hearing Board conducted background investigations which went beyond a simple check of personal references (see Figure 1). Sixty-four percent had a formal behavior observational program. Given the wide variation in the screening programs presently in place, both in general makeup and in details of implementation, a site-by-site survey would be necessary to determine the actual additional cost to the industry of the proposed program. The staff has not undertaken such a study due to the large number of staff and licensee resources which would be required. However, because no credit is given for industry programs in place to meet their present access authorization standards (ANSI N18.17), the staff views it's assessments of industry cost reported here as conservative (high).

4.1.1 The estimated implementation costs per existing licensee site is:

Preparation of the Access Authorization Plan and associated procedures (100 person-days/site x $480/person-day)	$48K
Training necessary for implementation of the continual behavioral observation program ($30K [150 persons[3]/site x $200/person [assumed average salary for trainees for a 2-day period]] + $4K [instructor cost and overhead for 10 training classes of 15 trainees each])	$34K
Storage of each individual's access authorization file (assuming that the average file size is 1/2" thick x 9" high x 12" wide [1,500 files x 0.0312 ft^3/file x $209.17 storage/$ft^3$])	$9.8K
Estimated implementation costs per existing site	$91.8K
Total estimated industry implementation costs for existing sites (assuming 61 licensed site)	$5600K

4.1.2 The implementation costs per site[4] licensed after the effective date of the rule are estimated to be:

Preparation of the Access Authorization Plan and associated procedure (100 person-days/site x $480/person-day)	$48K

[3]Licensee and contractor supervisors (foremen and above).
[4]Assumed to not benefit from "Grandfather" provision of the rule.

Training necessary for implementation of the continual behavioral observation program ($30K [150 persons[3]/site x $200/person [assumed average salary for trainees for a 2-day period]] + $4K [instructor cost and overhead for 10 training classes of 15 trainees each])	$34K
Background investigation (assuming an average of 1500 persons/site x $250/investigation)	$375K
Criminal history requests to FBI (1500 checks x $13.00/check)	$19.5K
Review/Grievance process (assuming: direct costs of $1K/day, indirect costs of $500/day, an average of 2 days/review, and that 60 persons [or 4% of all persons being screened] are denied the access authorization and appeal)	$130K
Psychological testing (2 written tests @ $35/test x 1500 persons) (no grandfathering)	$105K
Clinical interview ($100/interview x 500 persons [assuming 1/3 of all persons tested require a clinical interview]) (no grandfathering)	$50K
Storage of each individual's access authorization file (assuming that the average file size is 2" thick x 9" high x 12" wide [1,500 files x 0.125 ft^3/file x $209.17 storage/ft^3])	$39.2K
Estimated implementation cost per site licensed after the effective date of the rule and not benefitting from Grandfathering	$850.7K

Total estimated implementation cost for industry sites licensed after the effective date of the rule and not benefitting from Grandfathering (Assuming 15 sites)[2,5] $12,760K

4.2 Industry Operation

4.2.1 The estimated annual operational cost[6] per existing licensee site is:

Maintenance of the Access Authorization Plan and associated procedures (25 person-days/site x $480/person-day) $12K

Licensee program director and clerical support ($62,400 for program director + $21K for clerical and support costs) $83.4K

Background investigation for new personnel (300 persons, assuming a 20% turnover in an average of 1500 persons/site x $250/investigation)[7] $75K

Criminal history requests to FBI for new personnel (300 checks x $13/check) $3.9K

Psychological testing for new personnel (20% turnover) (two written tests x $35/test x 300 persons/site) $21K

Clinical interview for new personnel ($100/interview x 1/3 of new personnel require a clinical interview [100 people]) $10K

[5]Based upon projections of an additional 15 sites being licensed within the next 5 years. Although, technically these costs are future oriented, the impacts are sufficiently near term that no discounting has been applied.
[6]Based upon 1985 dollar values.
[7]Cost estimate based on informal data received from two private investigative firms, seven utilities, and the Atomic Industrial Forum.

Initial training of new personnel for the continual observation program (40 persons[4]/site x $200/person + $1.2K [instructor cost])	$9.2K
Refresher training for supervisors for continual observation program (150 persons[3]/site x $100 [assumed salary for 1-day training period] + $4K [instructor cost])	$19K
Review/Grievance process (assuming: direct costs of $1K/day, indirect costs of $500/day, an average of 2 days/review, and that 9 [or 0.4% of 1500 employed personnel and 4% of 75 new personnel being screened] are denied the access authorization or have the authorization revoked and appeal)	$27K
Total estimated annual operational cost per existing site	$260.5K
Total estimated annual operational cost for the industry (assuming 61 sites initially)	$15890.5K

The present value of the stream of cost discounted at a 10% real rate over an anticipated life of 25 years is:

Present value of the total estimated operational cost per existing site	$2365.3K
Present value of the total estimated operational cost for industry for all existing sites	$144295.7K

4.2.2 The estimated annual operational costs per future licensee sites (based on an assumed additional 15 sites) is anticipated to be the same as defined in 4.2.1 for existing sites, with the exception of a difference in the present worth factor.

Total estimated annual operational cost per future site $260.5K

Total estimated annual operational cost for the sites licensed after the effective date of the rule (assumed to be an additional 15 sites) $3907.5K

The present value of the stream of cost discounted at a 10% real rate over an anticipated life of 40 years is:

The present value for the total estimated operational cost per future site $2547.7K

The present value for the total estimated operational cost for all sites licensed after the effective date of the rule (assumed to be an additional 15 sites) $38215.4K

4.3 Cost Savings due to Reciprocity

4.3.1 The estimated operational savings associated with licensees establishing a reciprocity program for exchanging screening records is as follows:

Utilization of 225 (75% of annual 300) pre-screened people per site per year at $250.00 per investigation $56.3

Utilization of 225 prescreened people per site per year at $103.00 per psychological screening [Test $70 x 225 people + 75 (1/3 of 225) people x $100 interview] $23.2K

Estimated cost per site to licensees for transferring of records among licensees ($50 per check X 225 people) - $ 11.3K

Estimated net savings per site per year $68.2K

Estimated net annual savings for all existing sites (61 sites) $4160.2K

Estimated net annual savings to sites not licensed prior to effective date of the rule (assuming 15 additional sites) 1023

The present value of the stream of savings discounted at a 10% real rate over an anticipated life of 25 years is:

Present value for the estimated savings per existing sites $619.3K

Present value for the estimated savings for all existing sites $37774.6K

The estimated annual savings per future licensee site is anticipated to be the same as that for an existing site, $68.2K, with exception of a difference in the present worth. The present value of the stream of savings discounted at a 10% real rate over an anticipated life of 40 years is:

Present value for estimated savings per future site $667K

Present value for estimated savings for all sites licensed after the effective date of the rule (15 sites). $10005K

5. SUMMARY OF COSTS

5.1 NRC Cost

Implementation	$822.7K
Operational	~0
Total NRC cost	$822.7K

5.2 Industry Costs

Implementation		
Existing Sites	$5600K	
New Sites	$12760K	
Total implementation		$18360 (~18.3M)
Operational		
Existing sites, present value of annual operating cost over 25 years...	~$144M	
New sites, present value of annual operating costs over 40 years...	~$38M	
Less present value of cost savings due to reciprocity...	~$48M	
Total industry present value, operating costs...		~$134M
Total industry cost for all existing, planned nuclear power stations over their remaining useful lives...		~$152M
Average site cost, assuming 76 sites...		~$2M

6. THE PUBLIC

The public would benefit from increased protection against the insider threat and from greater assurance that only reliable individuals have unescorted access to protected areas and vital equipment at nuclear power plants.

The cost to the general public would be in the form of higher electric bills as a result of increased electrical generating cost.

Based on generation of 292,100 million net kilowatt hours of electricity by nuclear reactors and a generating cost of about 3.3 cents per kilowatt hour (DOE's Annual Energy Review, April 1984 and DOE's Update - Nuclear Power Program, September 1984), the industry spends about $9 billion to cover nuclear generating costs. The estimated industry implementation cost associated with this change would represent an increase of approximately 0.2% in annual nuclear generating costs, similarly the annual industry operating costs would also represent an increase of approximately 0.2%. These increases would not represent a significant increase in the cost of electricity to the public.

7. DECISION ON THE RULE

The rule will provide increased protection against the insider threat and will provide increased assurance that only trustworthy and reliable personnel have access to vital, safety-related equipment at nuclear power plants. The costs associated with achieving this increased protection and assurance are not considered to be major. It is anticipated that no occupational exposure will be associated with implementation of this proposed rule.

8. IDENTIFICATION AND ANALYSIS OF ALTERNATIVE COURSES OF ACTION

8.1 Maintain Status Quo

As noted by the Hearing Board, there is great diversity in the ways in which the industry has implemented the recommendations of ANSI N18.17. The Hearing Board also reported that "most utilities agree with the NRC that this standard [ANSI N18.17] is probably too vague and should contain more specific guidelines in order to achieve greater uniformity in application throughout the industry." (Hearing Board Report, p. 51.)

Thus, the Commission and the Hearing Board, as well as the regulated industry itself, has found the status quo less than satisfactory in achieving the intended goal.

8.2 Government Clearance Program

The proposed regulations published by the Commission in March 1977 would have established a government-run clearance program for the private nuclear industry. In considering the 1977 proposed rule, especially as it relates to power reactors, the Hearing Board concluded that the need for a rule of such scope had not been satisfactorily established. Additionally, the Hearing Board observed that the proposed government-run program had greater social and economic costs than the industry-run program now proposed.

8.3 Industry Clearance Program

8.3.1 "Multi-Level" Clearance

Consideration was given to establishing differing investigative criteria for unescorted protected and vital area access. A program of this type is included in a December 1980 draft revision to ANSI N18.17 and calls for a two-year retrospective period for granting protected area access and five years for vital area access. Such a graded program has logical appeal in that persons with access to more sensitive areas (vital areas) are investigated to a greater degree than other persons. The Commission staff has attempted to determine the relative cost of a multi-level versus a single-level screening program. While specific dollar amounts were not known, representatives of private security agencies indicated that the overall cost difference between a two- and a five-year retrospective period would be slight. Additionally, the multi-level program would be somewhat more complex, and therefore somewhat more expensive, for the licensee to administer. Discussion with seven licensees also indicated that a single-level program would provide the licensee greater operational flexibility and efficiency in the use and assignment of personnel, which would offset the difference in cost.

8.3.2 Psychological Testing and Interview

8.3.2.1 All Persons Receive Both Written Tests and Interview. While written psychological tests can detect a number of relevant indicators, there are also individual personality traits which are not effectively detected by the tests. There is substantial expert opinion that a combination of both

personality tests and clinical interviews is the most powerful predictor of complex behavior. However, there is a paucity of hard research data which supports this body of opinion. Additionally, using the estimates contained above, this alternative would cost the industry some $3.8 million more than the alternative which follows without clearly providing greater benefit. This alternative is also contrary to the recommendation of the Hearing Board.

8.3.2.2 All Persons Receive Written Tests With Some Persons Referred for Interview. The Hearing Board reported that most of the hearing participants who commented on alternatives to the March 1977 proposed rule preferred this approach. This alternatives provides a method for detecting personality disorders (the written tests) and a method for resolving inconclusive tests and evaluating the significance of apparent deviations from the expected tested norm (the interview). This approach is consistent with the recommendation of the Hearing Board (Hearing Board Report, pp. 50-52, 66).

8.4 Decision on the Alternative Courses of Action

The rule is considered to be more cost-effective in achieving the program objective than any identified alternative.

9. TECHNICAL ALTERNATIVES

The rule is procedural in nature. Therefore, a discussion of technical alternatives is not applicable.

10. PROCEDURAL APPROACH

10.1 Procedural Alternatives

10.1.1 Regulation

The Commission intends this action to be an agency statement of general applicability and future effect which is designed to prescribe policy and practice requirements for granting persons unescorted access to protected areas and vital areas at nuclear power plants. An action undertaken with such a

purpose and intent is defined by the Administrative Procedure Act (5 U.S.C. 551) as a rule. Therefore, the appropriate procedural approach is an amendment to the Commission's rules and regulations.

10.1.2 ANSI Standard Endorsed by Regulatory Guide

This approach has been employed in the past. ANSI Standard N18.17 has been endorsed by Regulatory Guide 1.17. As noted by the Hearing Board, this approach has not produced a uniformly effective program to meet the general performance requirements for physical protection of nuclear power plants. The Hearing Board also considered the question of continuing this approach in conjunction with a revised ANSI Standard and concluded that an NRC-established rule was preferable.

10.1.3 Staff Position

Staff positions have been set forth in specific comments to licensees and applicants regarding screening commitments contained in submitted physical security plans and in general guidance. This approach has also failed to produce uniformly satisfactory and effective results.

10.1.4 License Condition

An attempt to implement the actions recommended by the Hearing Board by license condition would result in the imposition of generic license conditions. Such an approach is both an inefficient use of staff time and resources and contrary to the Administrative Procedure Act.

10.2 Decision on Procedural Alternatives

The proper approach under the requirements of the Administrative Procedure Act is publication for public comment of a proposed amendment to the Commission's regulations. Furthermore, any other approach would be retention of the present situation which has not been satisfactory.

11. STATUTORY CONSIDERATIONS

11.1 The statutory considerations are addressed in other sections of this value/impact statement and as indicated result in insufficient impact. The

rule is within the Commission's authority under sections 161b and 161i(3) of the Atomic Energy Act of 1954, as amended, to prescribe regulations designed to protect the public health and minimize danger to life or property.

11.2 Need for NEPA Assessment

The rule is not a major action as defined by 10 CFR 51.5(a)(10) and does not require an environmental impact statement.

12. RELATIONSHIP TO OTHER EXISTING OR PROPOSED REGULATIONS

There are no identified conflicts or overlaps with other existing or proposed NRC regulations.

13. SUMMARY AND CONCLUSION

The Commission has thoroughly studied the matter of screening personnel at nuclear power plants. A codified access authorization program will materially assist in assuring that a satisfactory, uniform approach meeting minimum requirements will be applied in determining an individual's eligibility for unescorted access to nuclear power plant protected areas and vital areas. The rule increases the ability of licensees, within the framework of the Commission's regulations, to detect an individual at a power reactor whose behavioral history or emotional makeup could result in the commission of acts detrimental to the public health and safety. The codified access authorization program will also permit reciprocity in granting an access authorization to an individual based upon screening conducted by another licensee, and provides a method of accommodating temporary workers during major outages for refueling.

Licensees Surveyed →	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Psychological Eval. by Physician	X				X	X		X	X	X	X	X		X
Interview with Psychologist				X										
Written Psychological Testing Only		W I		X										
Written Test & Interview by Psych.		L I		X										
Personal Reference Check		M E	X	X		X	X			X	X			
Previous Employment Check	X	E I	X	X		X	X					X	X	X
Education Records Check		A		X		X	X							
Court (Conviction) Record Check		N S												
Police Record Check		I		X			X							
Credit Reference Check	X			X										
Previous Residence Check	X	18, 17					X							
Formal On-Job Observation Program	X		X	X		X				X	X		X	

FIGURE 1

Enclosure 1-2

FIGURE 1 (cont.)

Licensees Surveyed	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Psychological Eval. by Physician				X	X	X				X				X
Interview with Psychologist														
Written Psychological Testing Only								X				X	M t	
Written Test & Interview by Psych.													t l	
Personal Reference Check		X			X	X	X	X	X			X	A N	
Previous Employment Check			X	X	X	X	X	X	X		X	X	S l	X
Education Records Check			X		X		X	X	X		X	X		
Court (Conviction) Record Check			X		X				X		X	X	18.17	
Police Record Check				X							X			
Credit Reference Check			X											
Previous Residence Check								X			X	X		
Formal On-Job Observation Program	X		X	X		X	X	X	X	X	X	X		X

FIGURE 1 (cont.)

Licensees Surveyed →	29	30	31	32	33	34	35	36	37	38	39
Psychological Eval. by Physician	X	X			X	X	X			X	X
Interview with Psychologist								EQ			
Written Psychological Testing Only								UI			
Written Test & Interview by Psych.								VA			
Personal Reference Check		X						LE	X		
Previous Employment Check	X	X			X			NI	X	X	X
Education Records Check	X							IO	X		
Court (Conviction) Record Check	X							AN	X		
Police Record Check	X	X			X			SI		X	
Credit Reference Check	X				X				X		
Previous Residence Check	X	X			X						
Formal On-Job Observation Program	X		X	X		X	X	18	17	X	

(NMSS - Burns)

REGULATORY ANALYSIS

REQUIREMENTS FOR CRIMINAL HISTORY CHECKS

10 CFR PART 73

1. ACTION - PROPOSED RULE

1.1 Description

The Commission is adding a new requirement, 10 CFR 73.57, for the control and use of criminal history data received from the Federal Bureau of Investigation (FBI) as part of Federally mandated criminal history checks of individuals with unescorted access to nuclear power facilities or individuals granted access to Safeguards Information by power reactor licensees.

1.2 Need for the Rule

Public Law 99-399, "The Omnibus Diplomatic Security and Anti-Terrorism Act of 1986," requires nuclear power facility licensees to conduct criminal history checks through the use of FBI criminal history data on individuals with unescorted access to the nuclear power facility or access to Safeguards Information. This data is made available to the private sector only through Federal law. The legislation requires the NRC to issue regulations to establish conditions for the use and control of the criminal history data received from the FBI. These conditions include procedures for the taking of prints, limits on use and re-dissemination, assurance that the information is used solely for its intended purpose, and provision that individuals subject to fingerprinting are provided the right to complete and correct information in their criminal history records prior to any final adverse action. It is important that individuals granted unescorted access to nuclear power facilities or access to Safeguards Information be subject to FBI criminal history checks to help assure that these individuals do not have a criminal history bearing upon their personal trustworthiness and reliability.

Enclosure 2

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Annual Criminal History Requests-Industry wide

(20,000 checks x $15.00/check)	$ 300K
(20,000 fingerprint cards x 1/3 hour/card x $40.00/hour)	$ 268K
Total Industry Operational Cost	$ 568K/year

4. IMPACT ON OTHERS

Although this action will affect the FBI, the annual impact is judged to be minimal inasmuch as the estimated 20,000 checks per year represent a 0.36% increase in the number of criminal history checks currently conducted by that agency. Further, industry fees will fully reimburse the FBI for this incremental burden.

5. STATUTORY CONSIDERATIONS

5.1 NRC Authority

The Atomic Energy Act of 1954, as amended, Section 161(b) provides authority to the Commission to prescribe regulations described to protect the public health and minimize danger to life and property.

5.2 Need for Environmental Assessment

This rule is the type of action described in categorical exclusion 10 CFR 51.22(c)(3). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this rule.

5.3 Relationship to Other Existing or Proposed Regulations or Policies

There are no apparent potential conflicts or overlaps with other NRC regulations or policies nor with other agencies' regulations or policies.

5.4 Paperwork Considerations

There will be no significant paperwork cost associated with this action.

(NMSS - Burns)

(1)

REGULATORY ANALYSIS

REQUIREMENTS FOR CRIMINAL HISTORY CHECKS

10 CFR PART 73

1. ACTION - PROPOSED RULE

1.1 Description

The Commission proposes to add a new requirement, 10 CFR 73.57, for the control and use of criminal history data received from the Federal Bureau of Investigation (FBI) as part of Federally mandated criminal history checks of individuals with unescorted access to nuclear power plants or individuals granted access to Safeguards Information by power reactor licensees.

1.2 Need for the Rule

Public Law 99-399, "The Omnibus Diplomatic Security and Anti-Terrorism Act of 1986," requires nuclear power plant licensees to conduct criminal history checks through the use of FBI criminal history data on individuals with unescorted facility access or access to Safeguards Information. This data is made available to the private sector only through Federal law. The legislation requires the NRC to issue regulations to establish conditions for the use and control of the criminal history data received from the FBI. These conditions include procedures for the taking of prints, limits on use and redissemination, assurance that the information is used solely for its intended purpose, and provision that individuals subject to fingerprinting are provided the right to complete and correct information in their criminal history records prior to any final adverse action. It is important that individuals granted unescorted access to sensitive areas within the reactor facility or access to Safeguards Information be subject to FBI criminal history

G 28

checks to help assure that these individuals do not have a criminal history bearing upon their personal trustworthiness and reliability.

2. IMPACT ON THE NRC

2.1 Developmental Impact

NRC anticipates no significant developmental cost resulting from this proposed rule.

2.2 Implementation Impact

NRC anticipates no significant implementation cost resulting from this proposed rule since all costs for the processing of fingerprints will be paid by the licensee.

2.3 Operational Impact

NRC anticipates no significant non-reimbursed operational cost resulting from this rule. Inspection effort resources are accounted for as part of the proposed Policy Statement for Access Authorization Program at Nuclear Power Plants.

3. IMPACT ON INDUSTRY

3.1 Industry Implementation

The impact on industry implementation will occur in the area of cost of fingerprint submittal through the NRC to the FBI for the criminal records check. Protection and storage of each individual's criminal history record, anticipated to be one page, is considered negligible.

Implementation cost to the industry is estimated to be:

Criminal History Requests (200,000 checks x $15.00/check)	$3000K
Total Industry Implementation Cost	$3000K

3.2 Industry Operation

Annual Criminal History Requests-Industry wide

(20,000 checks x $15.00/check)	$ 300K
Total Industry Operational Cost	$ 300K/year

4. IMPACT ON OTHERS

Although the proposed action will affect the FBI, the annual impact is judged to be minimal inasmuch as the estimated 20,000 checks per year represent a 0.36% increase in the number of criminal history checks currently conducted by that agency.

5. STATUTORY CONSIDERATIONS

5.1 NRC Authority

The Atomic Energy Act of 1954, as amended, Section 161(b) provides authority to the Commission to prescribe regulations described to protect the public health and minimize danger to life and property.

5.2 Need for Environmental Assessment

This proposed rule is the type of action described in categorical exclusion 10 CFR 51.22(c)(3). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this rule.

5.3 Relationship to Other Existing or Proposed Regulations or Policies

There are no apparent potential conflicts or overlaps with other NRC regulations or policies nor with other agencies' regulations or policies.

5.4 Paperwork Considerations

There will be no significant paperwork cost associated with this action.

10 CFR PART 73

BACKFIT ANALYSIS

Requirements For Criminal History Checks

I. SUMMARY REGULATORY ANALYSIS

1. Objective

The objective of this proposed rule is to establish conditions for the use and control of criminal history data received from the Federal Bureau of Investigation (FBI) as part of the Federally-mandated criminal history checks of individuals granted unescorted access to nuclear power plants or access to Safeguards Information by power reactor licensees, (Public Law 99-399, "The Omnibus Diplomatic Security and Anti-Terrorism Act of 1986"). Licensees cannot have access to the FBI criminal history data provided by the legislation until NRC has established regulations for the control and use of the data.

2. Description Of Activity

The new requirement:

(1) Implements procedures for taking of fingerprints;

(2) Establishes conditions for the use of the criminal history data to include limits on redissemination and assurance that the information is used solely for its intended purpose; and

(3) Provides individuals subject to fingerprinting the right to complete and correct information contained in their criminal history records prior to any final adverse action.

3. Potential Change In Risk To The Public From Accidental Offsite Release Of Radioactive Material

It is important that individuals granted unescorted access to protected areas and vital areas within the reactor facility or access to Safeguards Information by power reactor licensees be subject to FBI criminal history checks

to help assure that these individuals do not have a criminal history bearing upon their personal trustworthiness and reliability. By providing increased assurance that an individual having unescorted access to sensitive areas of the facility or sensitive information does not have a criminal history record indicating criminal tendencies, the risk of radiological sabotage from an insider and offsite release of radioactive material (risk to the public) is reduced.

4. Potential Impact On Radiological Exposure Of Facility Employees

To the extent that the risk of radiological sabotage is reduced, the potential impact on radiological exposure of facility employees would also be reduced. Otherwise, with respect to radiological exposure, there is no impact on facility employees.

5. Installation And Continuing Costs

Total Industry Implementation Cost	$3000K
Annual Operational Cost Per Site	$300K

6. Potential Safety Impact Of Changes In Plant Or Operational Complexity

Not applicable.

7. Estimated Resource Burden On The NRC

NRC anticipates no significant non-reimbursed costs resulting from this rule.

8. Potential Impact Of Differences In Facility Type Or Age

No potential impact is noted of differences in facility type or age on the relevance or practicability of implementing this rule.

9. The rule is proposed.

II. JUSTIFICATION

1. Increased Protection Of The Public Health And Safety

Public Law 99-399 requires the NRC to issue regulations to establish conditions for the use and control of criminal history data obtained from the FBI by power reactor licensees. Licensees cannot have access to the FBI criminal history data provided by the legislation until the NRC has established regulations for the control and use of the data. Since the proposed rule will allow licensees access to the FBI criminal history data, increased assurance is obtained that individuals with criminal histories impacting upon their reliability and trustworthiness are not permitted unescorted access to sensitive areas of the plant or access to sensitive safeguards information. For this reason, protection against radiological sabotage by an insider will be increased providing a substantial increase in the protection of the public health and safety.

2. Cost Implications

The cost of the proposed criminal history check requirements associated with implementation is $40K per site. However, industry burden will be reduced by this legislation and associated regulation because it will facilitate more efficient conduct of background investigations by allowing licensees to have access to the nationwide criminal history data maintained by the FBI. Licensees at present are, for the most part, limited to conducting criminal history checks through such limited resources as local court records, which is manpower intensive and costly.

3. Priority And Scheduling

Based upon the resulting substantial increase in the overall protection of the public health and safety, as discussed above, this backfit is considered to be high priority.

In addition, the proposed changes do not affect the schedules of other regulatory activities ongoing at the facility.

4. Findings

NMSS finds that issuance of this rule will result in a substantial increase in the overall protection of the public health and safety, and direct and indirect costs are justified in view of the increase in protection.

NMSS - Burnett

(1)

ENCLOSURE B-4

REVISED VALUE/IMPACT STATEMENT
SEARCH REQUIREMENTS - FINAL RULE

REVISED IN RESPONS TO CAG COMMENT

VALUE/IMPACT STATEMENT
NUCLEAR POWER REACTOR SEARCH PROCEDURES RULE

1. FINAL RULE

1.1 Description

The Commission has amended 10 CFR 73.55(d)(1) to clarify requirements for searches of individuals at power reactor protected area entry portals.

1.2 Need for the Rule

This amendment supports the Commission's goal of increased assurance that power reactors are adequately protected against sabotage by an insider. This amendment clarifies the use of a safeguards component designed to provide a measure of deterrence (as well as outright detection) against those persons who might otherwise attempt an act of sabotage by the introduction of firearms, explosives, or incendiary devices. Within 45 days of the amendment's effective date, each licensee is required by the rule to submit an amended security plan which states how the search requirement will be met. The security plan commits the licensees to the provisions specified in the plan. The information provided will be treated as safeguards information and used by the NRC licensing staff during their security plan evaluation process.

2. IMPACT ON THE NRC

2.1 Developmental Impact

NRC anticipates no significant developmental cost resulting from this rule.

2.2 Implementation Impact

The impact on NRC implementation will occur in the area of licensing review of the licensee's security plan for existing sites. New sites are required to submit security plans and, therefore, no additional costs are associated with new sites.

Implementation cost to the NRC is estimated to be:

Licensing Review and Approval of Security Plan (assuming 2 staff-days/security plan x 61* plans x $480/staff-day)

Cost Per Plan Review	$ 0.96K
Total Implementation Review Costs	$58.6K

2.3 Operational Impact

NRC anticipates no significant operational cost resulting from this rule.

3. IMPACT ON INDUSTRY

3.1 Industry Implementation

The required firearms and explosives detection equipment are currently in place at most reactor sites. Therefore, the most expensive item in the implementation cost has already been absorbed by the nuclear industry. However, for sites that do not have the equipment (approximately two facilities are without equipment) and those that are scheduled for licensing, the following estimates apply:

Cost estimates were derived by a random polling of seven reactor facilities.

Item	Price Range
Firearms/Metal Detector	$1.6K - $5.1K
Explosives Detector	$5.0K - $21.0K

An arithmetic average of equipment prices was computed for planning purposes. Because equipment manufacturers are numerous, significant price variations were evident.

*Information obtained from NUREG-0020, Vol. 9, No. 4, April 1985, Licensed Operating Reactors, Status Summary Report.

Item	Average Cost
Metal Detector	$ 3.4K
Explosives Detector	$13.0K

These costs are representative of those a licensee may expect to pay for such equipment. The variation in costs per facility will be based upon site-specific differences such as the number of portals in use at the site. Assuming 17 sites will be impacted at an approximate cost of $16.4K results in total industry implementation cost of: $280K

3.2 Industry Operation

No significant additional operational cost is anticipated as a result of this rule.

4. IMPACT ON OTHERS

There are no known impacts on others as a result of this rule change.

5. STATUTORY CONSIDERATIONS

There will be only an insignificant paperwork cost burden associated with this proposed rule change.

NMSS - Burnett

Not in PDR

ENCLOSURE B-4

REVISED VALUE/IMPACT STATEMENT
SEARCH REQUIREMENTS - FINAL RULE

VALUE/IMPACT STATEMENT
NUCLEAR POWER REACTOR SEARCH PROCEDURES RULE

1. FINAL RULE

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2. IMPACT ON THE NRC

2.1 Developmental Impact

NRC anticipates no significant developmental cost resulting from this rule.

2.2 Implementation Impact

The impact on NRC implementation will occur in the area of licensing review of the licensee's security plan for existing sites. New sites are required to submit security plans and, therefore, no additional costs are associated with new sites.

Implementation cost to the NRC is estimated to be:

Licensing Review and Approval of Security Plan (assuming 2 staff-days/security plan x 61* plans x $480/staff-day)

Cost Per Plan Review	$ 0.96K
Total Implementation Review Costs	$58.6K

2.3 Operational Impact

NRC anticipates no significant operational cost resulting from this rule.

3. IMPACT ON INDUSTRY

3.1 Industry Implementation

The required firearms and explosives detection equipment are currently in place at most reactor sites. Therefore, the most expensive item in the implementation cost has already been absorbed by the nuclear industry. However, for sites that do not have the equipment (approximately two facilities are without equipment) and those that are scheduled for licensing, the following estimates apply:

Cost estimates were derived by a random polling of seven reactor facilities.

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Explosives Detector	$5.0K - $21.0K

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Item	Average Cost
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These costs are representative of those a licensee may expect to pay for such equipment. The variation in costs per facility will be based upon site-specific differences such as the number of portals in use at the site. Assuming 17 sites will be impacted at an approximate cost of $16.4K results in total industry implementation cost of: $280K

3.2 Industry Operation

No significant additional operational cost is anticipated as a result of this rule.

4. IMPACT ON OTHERS

There are no known impacts on others as a result of this rule change.

5. STATUTORY CONSIDERATIONS

There will be only an insignificant paperwork cost burden associated with this proposed rule change.

ENCLOSURE C-4

REVISED VALUE/IMPACT STATEMENT
MISCELLANEOUS AMENDMENTS - FINAL RULE

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VALUE/IMPACT STATEMENT
MISCELLANEOUS AMENDMENTS CONCERNING
PHYSICAL PROTECTION OF NUCLEAR POWER PLANTS

1. THE FINAL RULE

1.1 Description

The Commission has amended 10 CFR Part 73 to:

(i) Revise vital area access control requirements;

(ii) Permit the suspension of safeguards measures during safety emergencies;

(iii) Require protection of certain physical security equipment; and

(iv) Revise requirements for key and lock controls.

1.2 Need for Proposed Action

The subject actions are being pursued in order to clarify and/or modify certain existing physical protection requirements for nuclear power plants. The amendments have been designed to foster plant safety while maintaining adequate safeguards.

2. IMPACT ON THE NRC

2.1 Developmental Impact

NRC anticipates no significant developmental cost impact resulting from this rule.

2.2 Implementation Impact

The impact of these amendments on NRC will fall in the areas of licensing negotiations and conducting of field inspections to assure compliance. Sites

are being used to determine costs instead of reactors as the vast majority of physical security plans are by site, not reactor, as are field inspections.

The implementation cost[1] to the NRC is estimated to be:

Existing Sites

(1) Licensing negotiation, review of amended security plans, preparation of SER, and license amendment (assuming 4 staff-days/plan x 61 plans[2] x $480/staff-day)..... $117.1K

(2) Inspection and Enforcement Staff support time for the negotiation process on per site basis (assuming 2 staff-days/site x 61 sites x $480/staff-day.).... $ 58.6K

Total..... $175.7K

New Sites[2]

No additional costs are incurred as pre-operational inspections and licensing review and approval of security plans are already required for new sites.

2.3 Operational Impact

There are no significant operational costs resulting from this rule. NRC actions necessary to assure compliance with (1) proposed amendments to 10 CFR 73.55(d)(7) concerning vital area access control, (2) protection requirements

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[1]The manpower resources required to amend the licenses to reflect this regulation have been included in budget projections for the period involved. No budgetary changes will be required as a result of this rulemaking.

[2]It is assumed that the program will be organized and administered on a site rather than a reactor unit basis. NUREG-0020, Volume 9, No. 4, Licensed Operating Reactors Summary Status Report Data as of March 31, 1985, was used to determine the number of currently licensed sites.

for certain physical security equipment,[3] and (3) revised key and lock control requirements are minimal relative to the present review and inspection process of NRC.

3. OTHER GOVERNMENT AGENCIES

It is not expected that these rulemaking actions will have any impact on other government agencies.

4. THE PUBLIC

The public's protection from radiological release will be maintained by assurance of adequate safeguards of vital areas and equipment from sabotage within nuclear facilities.

There would be negligible impact on the public or effect on customer electric bills.

5. IMPACT ON INDUSTRY

5.1 Implementation Cost

a. No industry implementation costs have been identified for the following sections of the rule:

(1) Vital area access control requirements.
(2) Suspension of safeguards measures during safety measures.
(3) Revised key and lock controls.

b. In order to protect security-related equipment, such as secondary power supply systems for intrusion alarms and non-portable communications equipment, the typical reactor site would incure the following estimated implementation costs:

[3]Such equipment would include secondary power supply systems for intrusion alarms and non-portable communication equipment.

(1) To enclose (cage or fence) secondary power supply systems and non-portable communications equipment (assumes the installation of 100 linear feet of cage or fence materials at $.030K per foot). $3.0K

(2) To alarm secondary power supply and non-portable communications equipment locations (assumes three locations, two area alarms per location, hardware and labor per alarm $1.2K). $7.2K

Total Project Cost Per Site: $10.2K

Total industry implementation cost based on a site population of 76[4] x $10.2K per site: $775.2K

5.2 Operational Cost

No increased industry operational impacts have been identified. For most sections of the rule change, the proposal is cost neutral. This includes the following sections:

(1) Vital area access control amendment.
(2) Suspension of safeguards measures during a safety emergency.
(3) Protection of physical security equipment.

With respect to revision to § 73.55(d)(9), annual operating savings are expected because of reduced requirements concerning an effective key and lock control program, i.e.,

(1) The labor cost to change the key and lock system under present requirements (assumes a site average of 1500 persons, 24 people issued keys, 30% annual turnover rate or 7 persons with keys terminate annually, or 1 person leaves every 51 days thereby requiring key/lock changes 7 times per year at $3K per change). $21.0K

[4]Assumed average remaining life for mix of present and future sites.

(2) The labor cost to change the key and lock system under proposed requirements (assumes a site average of 1500 persons, 24 people issued keys, 30% annual turnover rate or 7 persons with keys terminate annually). As the proposed requirements cause lock/key changes annually and when persons are terminated for lack of trustworthiness or inadequate work performance (projected 1 of 7 persons), lock/key changes would average once every 180 days or 2 times per year at $3K per change. less $6.0K

Net Savings Per Site: $15.0K

Annual savings for industry based on a site population of 76 is: $1140K

The present value of industry saving in operating cost, assuming average remaining life of 30 years[4] and 10% real discount rate, is: $10750.2K

Net savings to the industry on a present worth basis are therefore estimated to be: $2.0M

5.3 Benefits

Although substantial net savings to industry result from the implementation of this rule, most benefits are qualitative and not quantifiable, being reflected in improved security, reduced sabotage risk and improved ingress, egress and emergency access.

5.3.1 Vital Area Access Control Amendment

In accordance with the proposed amendments to § 73.55(d)(7),) industry control of vital area access would result in the following benefits:

- Improved emergency ingress or egress thereby fostering plant safety.

- Better assurance that approved up-to-date nonemergency access lists are used. This reduces the number of persons with access to reactor areas vulnerable to sabotage.

- Reduced risk of sabotage committed by a person who received a termination notice.

5.3.2 Suspension of Safeguards Measures During Safety Emergencies

The Safety/Safeguards Committee recommended that power reactor licensees be given improved flexibility to facilitate response to site emergencies or "unusual events." Consequently, the revision to § 73.55(a) provides authority for licensees to suspend safeguards measures if required to accommodate emergency response.

5.3.3 Protection of Physical Security Equipment

Under § 73.2 (i), certain security equipment, which significantly impacts plant security, currently does not appear to qualify as vital equipment. Protection of this equipment would:

- better assure its availability during a safeguards emergency, thereby reducing the chance of successful radiological sabotage.

- increase assurance of compliance with the general performance requirements specified in § 73.55(a).

5.3.4 Revised Key and Lock Controls

Revised industry procedures, in accordance with the amendment to § 73.55(d)(9), will result in substantial reduction in the expense and administrative burden of implementing a key and lock control program without significantly reducing the safeguards benefits of such a program.

6. DECISION ON THE AMENDMENT

The benefit to be derived from these amendments would be lower costs to fully implement NRC regulations regarding reactor safeguards while continuing to provide adequate protection of the public health and safety.

7. STATUTORY CONSIDERATIONS

7.1 NRC Authority

The Atomic Energy Act of 1954, as amended, Section 161(3), provides authority for the Commission to prescribe regulations designed to protect the public health and minimize danger to life or property.

7.2 Need for National Environmental Protection Act Assessment

As defined by 10 CFR 51.5(a)(10), this is not a major action, and does not require an environmental impact statement.

7.3 Relationship to Other Existing or Proposed Regulations or Policies

There are no apparent potential conflicts or overlaps with other NRC proposed regulations or policies nor with other agencies' regulations or policies.

7.4 Paperwork Considerations

There will be no sufficient paperwork cost associated with this action.

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October 20, 1987

FREEDOM OF INFORMATION ACT REQUEST
FOIA-87-714
Rec'd 10-23-87

Director
Division of Rules and Records
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Freedom of Information Act Request

Dear Sir/Madam,

Pursuant to the federal Freedom of Information Act, I hereby request the following on behalf of the Union of Concerned Scientists:

1. All cost-benefit or value-impact analyses done since September, 1985 in connection with the consideration by NRC staff of generic or site-specific backfits.

2. Any and all lists, compilations or other identifications of potential generic or site-specific backfits under consideration by the NRC staff at any time since September, 1985.

3. Any and all memoranda or other documents since September 1985, from the Committee to Review Generic Requirements ("CRGR") containing requests or direction to the NRC staff to perform, modify or reconsider value-impact or cost-benefit analyses regarding any potential generic or site-specific backfit.

4. Any and all documents containing guidance, criteria or examples used by the NRC in deciding which generic or site-specific backfits are appropriate for cost-benefit analyses under the backfit rule and which are not so appropriate.

8712090092 2pp.

Please call me if you have any questions regarding this request.

Very truly yours,

Ellyn Weiss

Ellyn R. Weiss
HARMON & WEISS
2001 S Street, N.W.
Suite 430
Washington, D.C. 20009

General Counsel
Union of Concerned Scientists

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

12/29

DEC 19 1986

MEMORANDUM FOR: James H. Sniezek, Chairman
Committee to Review Generic Requirements

FROM: John G. Davis, Director
Office of Nuclear Material Safety and Safeguards

SUBJECT: REVIEW OF FINAL RULE: "REPORTING REQUIREMENTS FOR SAFEGUARDS EVENTS"

Enclosed for Committee to Review Generic Requirements (CRGR) review is a final rule which revises 10 CFR 73.71, "Reporting Requirements for Safeguards Events". Revisions to this rule were approved for publication in proposed form by the CRGR under memorandum dated July 3, 1985. Since that time the rule has undergone a 120 day public comment period and been revised in response to public comment.

The enclosed memorandum, prepared for transmitting the rule to the Executive Director for Operations after CRGR review and approval, summarizes major changes made in response to public comment. Please also note that a backfit analysis has been incorporated within the Federal Register Notice for the rule.

The Offices of Nuclear Reactor Regulation, Inspection and Enforcement, Analysis and Evaluation of Operational Data, and Administration concur in this rule. The Office of the General Counsel has reviewed this rule and concurs and the Office of Public Affairs concurs in the public announcement prepared for the rule.

We appreciate your prompt attention to this matter. Cognizant Office of Nuclear Material Safety and Safeguards staff person is Priscilla A. Dwyer, 42-74773.

John G. Davis, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure:
As stated

cc: W. Schwink, ROGR staff
(15 copies)

8707210822 tf.

NMSS - Burnett

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