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

AUG 8 1980

MEMORANDUM FOR: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

FROM: Robert J. Budnitz, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER # 96 - ADEQUACY OF CURRENTLY UTILIZED RADIATION TEST SOURCES TO SIMULATE THE LOSS-OF-COOLANT DESIGN BASIS ACCIDENT

INTRODUCTION

This memorandum transmits a summary of the results of a completed portion of the NRC Qualification Testing Evaluation (QTE) Program relating to the adequacy of currently utilized radiation simulators to conduct radiation qualification of safety-related equipment.

Radiation qualification is one part of the loss-of-coolant accident (LOCA) design basis accident qualification required by NRC Regulations.

Synergistic effects between radiation and other accident environments may not allow the separation of accident conditions. However, for those cases where separation is acceptable, this research provides the basis upon which the adequacy of radiation simulators can be judged.

Simulator adequacy can be judged by comparison of the radiation magnitude, rate, spectra and particle type of the calculated and simulated source terms. It is also possible to show equivalence of the source terms by showing that similar damage to materials would result from exposure to both source terms. The latter approach is utilized in the research covered by this RIL.

The research includes the development of a calculational method for determining the radiation magnitude, spectra, and particle type as a function of time that would result from the release assumptions defined in Regulatory Guide 1.89. In addition, scoping radiation dose rate calculations have been made for a typical empty containment structure.

Also, a study was performed to establish typical depth-dose profiles for a polymeric material in the configuration of a typical class IE cable insulation, and to identify the credible radiation damage mechanisms.

Finally, an assessment was made of the differences in the currently used test source characteristics and Regulatory Guide 1.89 radiation characteristics to identify damage mechanisms and to evaluate radiation simulator adequacy when utilized for LOCA qualification testing, including the related radiation aging.

SUMMARY

The research results support the following conclusions:

1. The calculations of radiation magnitude, spectra, and particle type as a function of time that result from the hypothetical release assumptions are documented in the referenced reports and summarized in Table I.

2. The calculated total dose is at least a factor of two higher than the dose currently utilized for LOCA qualification testing. However, the total integrated calculated dose is approximately equal to the total dose resulting from currently utilized fuel melt models and is, therefore, overly conservative for qualification for a terminated LOCA.

3. The calculated dose consists of a significant beta radiation component while cobalt-60, which is the typically utilized radiation source for LOCA qualification testing, consists entirely of gamma radiation.

4. The calculated peak dose rate from combined sources is a factor of ten higher than the dose rate typically utilized for LOCA qualification. This results from the instantaneous release assumption in Regulatory Guide 1.89.

   From a material damage point of view, as might occur on a typical polymeric material such as a cable insulation material, the total integrated dose is expected to be the important parameter and the higher calculated dose rate should not yield significantly more damage for any given dose level.

   However, the effects on electrical system performance due to the generation of induced electrical noise, caused by the Compton effect and/or charge build-up and discharge that may occur with signal leads and active components, have not been extensively evaluated. These effects are strongly dependent on the type of circuit that the material

is a part of and no general conclusion could be drawn. Furthermore, the current practice for LOCA testing does not, in general, include an accurate duplication of the circuit. For example, LOCA qualification testing of cable is usually conducted with a low resistive load which would not show the effects of noise pulses.

5. The damage to safety-related materials resulting from a predominately beta radiation source should not be any greater than the damage that would result from gamma radiation because the mechanisms are the same. Thus, an acceptable LOCA radiation qualification test can be established by either of the following:

   a. The total gamma radiation dose can be established at least at the level of the total calculated dose, which is approximately 450MR for a 30-day exposure, if the Regulatory Guide 1.89 release assumptions are used, or

   b. The relative damage effects of gamma and beta radiation for the specific component can be established. A comparison of the damage effects on a typical polymeric material, such as electrical cable insulation, showed the effects to be similar on a per unit volume basis. However, the gross effect on the cable of sustaining most of the damage on the surface, as opposed to a more uniform damage that results from a cobalt-60 exposure, was not evaluated. With the exception of electrical cable, most instrumentation and electrical equipment have a protective cover which greatly reduces the effects of beta radiation, but may result in secondary radiation (Bremsstrahlung) which should be accounted for. For this equipment, current LOCA qualification testing, in general, can be shown to be conservative.

6. The following are the areas for which additional research is underway or planned:

   a. Best-estimate calculations are being performed to establish a more realistic LOCA qualification source term.

   b. Tests will be conducted to compare the damage caused by beta and gamma radiation on generic cable designs. Included in this area of research will be an evaluation of the secondary (Bremsstrahlung) radiation effects on instruments with protective covers that would be protected from the direct beta radiation, but not the secondary x-rays.

   c. LOCA tests may be conducted with materials and components in typical safety-related circuits to determine the significance of radiation-induced noise.

BACKGROUND

Basis for the Research

The specific research upon which this RIL is based is outlined in the Research Support Branch Plan (Enclosure 1) for Qualification Testing Evaluation. The overall QTE program is based on the research need identified in the research request, (SD77-7, dated August 19, 1977), the NRR program support letter from E. G. Case, dated January 5, 1978, as well as through consultation and formal review with the NRC user groups. The QTE Review Group has been, and continues to be, the focal point for both formulation of the research program and evaluation program results that form the basis of this RIL.

The specific user requirement for the research conducted to date on the adequacy of radiation simulators is based on the need to guarantee that current loss-of-coolant accident qualification testing conforms with the Regulatory Guide requirements and that licensee qualification programs are technically sound.

The calculation of the radiation field inside containment following a LOCA is directly linked to the assumed release from the core and the specific containment geometry. Historically, the assumption of a large fission product release from a design basis accident arose from the issuance of 10 CFR Part 100 in 1962 which referenced TID-14844 as an acceptable fission product source term.

The concern that equipment be not only designed to the appropriate accident conditions, but also be qualified under these conditions, culminated eventually in the development of IEEE 323-74 as the accepted industry standard. The standard was written with this position as a focal point. Appendix A to the standard suggested a course-of-accident exposure of 1.5×10^8 rads for PWR's and 2.6×10^7 rads for BWR's, but no specific bases were provided for these values in the standard. Part of this standard was adopted in Regulatory Guide 1.89, "Qualification of Class IE Equipment for Nuclear Power Plant," which was issued in November 1974. However, the radiation source term contained in Appendix A was specifically excluded from adoption in Regulatory Guide 1.89 because it did not conform to a TID-type of fission product release.

The current NRC staff position is that cobalt-60 or similar simulator, which is the most widely used radiation test source, can adequately simulate the LOCA radiation environment. The calculational model developed as part of this research and the damage assessment performed provide a technical basis upon which the adequacy of simulators can be judged.

ANALYSIS

Source Term Definition

In order to assess the adequacy of currently used radiation sources, it was first necessary to accurately define the magnitude, rate, spectra and particle type of the radiation release that would result from the Regulatory Guide 1.89 accident assumptions. These calculations were made along with calculations to determine the sensitivity of these measurements to reactor fuel composition, operating duration, power level, and treatment of progeny, and are documented in Reference 1.

Calculations of absolute magnitudes and rates require that certain plant-specific assumptions be made. The containment structure was assumed to be an empty cylinder (i.e., internal structure was not modeled) having an inside radius of 17.7m, inside height of 63.6m, and concrete walls that were 1.1m thick. This results in a total free volume of $6.25 \times 10^{10} cm^3$ (2.2 million ft^3). The calculations were made for a power level of 4000 MW (thermal) and were based on the Regulatory Guide 1.89 assumption that the accident resulted in an instantaneous and uniform release, the effects of engineered safety features were ignored, and containment leakage was not accounted for.

The primary code used for the fission product energy release calculations was RIBD-II. RIBD calculates isotopic concentrations resulting from fission sources with normal down-chain decay by beta-emission and isomeric transfers and interchain coupling resulting from n-gamma reactions. The program library used is based on the ENDF/B-IV fission product data set and contains 818 fission product isotopes for each of fourteen different fissile isotope/energy combinations together with fission product transmutation cross-sections for both fast and thermal systems. For each isotope, only the average gamma and beta energy release is given.

The CINDER code was used for calculation of the composite spectra of the fission products. Using the concentrations of all fission product nuclides of interest from the RIBD code, the spectra were calculated using CINDER and the spectra data that are included in the ENDF/B-IV library. The method of calculation of the gamma and beta spectrum has been designated as the GABAS spectrum code.

Using the Regulatory Guide assumptions and the codes discussed above, the calculations were made for the accident case where the airborne source is uniformly distributed throughout the containment volume, the plate-out source is uniformly distributed on the containment wall, and the waterborne source is uniformly distributed in a pool on the containment floor. Using these assumptions and those explicitly defined in the Regulatory Guide, the spatial dependence of the maximum radiation was calculated and occurs on the containment center line near the top of the water pool. A limited number of calculations were also made using other codes and the regulatory guide assumptions to verify the results.

Material Damage Calculations

In order to determine the adequacy of currently utilized radiation simulators, quantitative values of depth-dose and charged particle distribution were determined.

The calculations of depth vs. dose were made using the code SANDYL. The code computes the photon and electron transport and energy deposition within the system defined by use of a Monte Carlo computational method.

The depth-dose calculations were made for a typical organic material exposed to both the calculated LOCA accident source release and typical radiation test simulators. The material chosen for the depth-dose and damage evaluation was a polymeric material in the configuration of a typical class IE electrical cable consisting of a copper conductor surrounded by an ethylene-propylene rubber insulator and a hypalon jacket. The energy and charge deposition, as a function of radial depth in the cable, was determined for the spectral extremes of the calculated LOCA radiation release and for Cobalt-60 and Cesium-137. Although the calculations were made for a specific cable, they are typical of the results that would be obtained for any exposed organic materials.

Damage Assessment

The final determination of the adequacy of a radiation simulator must be based on a comparison of the resulting damage and damage mechanisms to the exposed material from both the simulators and accident sources. The analysis was performed by first identifying all the potentially significant damage mechanisms. This was accomplished by a review of the literature on radiation effects on materials and by evaluation of the physical effects resulting from radiation particle interactions.

The damage assessment was based on the depth-dose analysis previously discussed. For most of the calculations, it was assumed that the surrounding environment was at typical reactor ambient conditions. However, calculations using typical LOCA conditions of 143°C and 60 psia showed that the temperature and pressure did not significantly effect the results. The following specific damage mechanisms were examined:

1. There is a possibility that the extent of damage resulting from the charge distribution within the material is dependent on the type of radiation source. Ionization occurs by either collisions of beta particles and electrons or by photon-electron interactions. The hypothetical accident radiation source consists of a considerable amount of beta radiation while the electrons resulting from the simulator sources are generated primarily by photon-electron interactions in the exposed material. The beta radiation deposition is primarily in a region near the material surface while the photon-electron interactions are more uniformly distributed within the exposed material.

   The effect of the radiation-induced nonuniform charge distribution could cause the following problems. First, the unbalanced charge distribution could cause noise in electrical circuitry; and second, the nonuniform charge distribution if sufficiently large could cause the breakdown of the material dielectric strength.

   Since there is a potential difference with regard to charge buildup distribution between the hypothetical source-term and radiation simulators using only gamma radiation, a quantitative assessment of this damage mechanism was made. Estimates of charge distribution were made as a function of material thickness for extremes of the LOCA spectra profiles and for Cobalt-60. The effect on the dielectric strength of a typical polymeric cable material was then determined by calculating the resultant electric field caused by the charge buildup.

   The question of radiation induced signals was addressed. Specific calculated estimates were made of conductivity changes caused by radiation in typical polymeric material. These calculations were made using an empirical relationship for conductivity change with dose rate that is generally true for polymeric materials. Leakage current was estimated by using the change in conductivity and calculated estimates of the electric field caused by charge buildup. The discharge of the excess charge that can buildup as a result of the nonuniform radiation field can cause noise pulses which could effect the operability of the equipment. An estimate of this effect was made by assuming that the discharge occurred between the insulation and copper conductor of a typical plant signal cable.

2. There is a possibility that the extent of damage caused by the increase in temperature within the material resulting from the radiation source attenuation is dependent on the type of

radiation source. If radiation sources have unequal attenuation, then the resulting temperature profiles will be different. The hypothetical LOCA source term, based on the accident assumptions in Regulatory Guide 1.89, results in a temperature profile that is higher at the surface and lower within the material than would be the case with a Cobalt-60 radiation simulator. Because of this difference, a quantitative assessment of the effects of unequal temperature distribution and of temperature rise was included in this research.

3. There is a possibility that the extent of damage caused by bulk energy deposition and the spatial energy deposition within the material is dependent on the energy spectra and on the type of radiation source. The hypothetical LOCA radiation source, based on the Regulatory Guide 1.89 assumptions, is a time-varying energy spectra and is different from the energy spectra of radiation simulators. Because of this difference, a quantitative assessment of the relationship of damage to energy spectra was included in this research. In general, radiation energy deposition in polymers can result in the formation of ions, the breaking or creation of molecular chains, and the evolution of gas. The creation of ions and the resulting charge buildup are included in item 1. The remaining radiation induced effects are included in this category.

   The calculated source term includes a sizeable beta contribution that is generally not considered in equipment qualification programs and this contribution, in terms of total dose, is higher than the total dose currently utilized in radiation qualification programs. The calculated gamma radiation, however, is lower than that currently used in radiation qualfication programs.

   Table I shows that the calculated peak dose rates for both gamma and beta radiation are higher than the gamma radiation dose rate currently utilized in radiation qualification programs. The calculated source term is characterized by changing gamma and beta spectra with the hardest spectra occurring about a minute after the release and the softest spectrum occurring in about 4 days, and the emissions are, in general, different from the line spectra radiation source simulators currently utilized in radiation qualification programs.

4. There is a possibility that the extent of damage caused by the gradient of the energy deposition is dependent on the type of radiation source. Material degradation can result from stress generated by differential material shrinkage caused by nonuniform energy deposition and may be enchanced by a loss of elasticity

also caused by the radiation. Nonuniform energy deposition results in greater energy deposition close to the surface than in the interior of the cable. If there is insufficient cable elasticity to allow for the shrinkage, cable damage can occur. Thus, in a typical polymeric electric cable, nonuniform shrinkage could result in circumferential or radial cracking and possible material damage.

Experimental data were evaluated to establish typical elasticity and shrinkage loss rates using several commonly used safety related electric cables. Elongation was used as a measure of elasticity.

RESULTS

Calculated Radiation Source Term

The objective of the research was to calculate a definitive radiation source term based on the NRC Regulatory Guide release assumptions, and to determine the adequacy of currently used radiation qualification simulators to duplicate this radiation environment. Considerable data were generated with regard to the source term definition.

Table I represents a cumulative 30-day value of gamma and beta dose and maximum values of dose rates. The data in the references give the detailed time histories separated as waterborne, airborne, and plate-out sources and also shows their spatial dependence. The generally accepted source term, which is used for LOCA qualification, is also included in Table I.

Examination of Table I raises the following two questions. First, what is the sensitivity of the calculated source term values to the assumptions that were made to obtain these values; and second, what is the significance of the differences between the calculated and simulated source term values.

Source Term Calculation Sensitivity

The references include a significant amount of parametric calculations showing the sensitivity of the results to changes in release assumptions and core parameters. Examination of these data lead to the conclusions that the total energy released, the release rates and spectra are not significantly changed by fuel composition, power level, duration of operation, and treatment of progeny. However, the total energy released, the release rates, and spectra are significantly changed by the nuclide fraction release assumptions.

Although not included in this research, it is evident that if plant specific internal containment structures are included, the results would be significantly affected.

Damage Assessment

Examination of Table I indicates significant numerical differences in the calculated source term and the one currently utilized by industry. The significance of these differences was studied to determine if the source term, currently utilized in radiation qualification programs, duplicates the damage that would be caused by the calculated source term. Certain damage mechanisms that could be dependent on the choice of radiation source were studied to determine if the magnitude of the differences is significant.

Charge Buildup Effects

The charge buildup is primarily the result of a nonuniform electron radiation dose deposited in the cable. This occurs because of the radiation attenuation within the material. The specific mechanism is that the secondary emission leaving a unit volume is not balanced by secondary emission from an adjacent unit volume. Table I shows that the calculated LOCA source is comprised of a sizeable beta radiation contribution therefore, this effect would be more prevalent with the calculated LOCA source because the beta radiation is attenuated more than the gamma radiation from a simulator source such as Cobalt-60. (Although Cobalt-60 does decay by beta emission, the beta particle energy is low, and therefore, remains within the cobalt material or encapsulation.) For the hypothesized LOCA and Cobalt-60 radiation sources to be equivalent, either the damage caused by charge buildup will have to be shown to be negligible or the charge distribution will have to be shown to be the same.

The problem in making this comparison is complicated because the hypothesized LOCA spectra varies with time and as a result, the charge distribution is also changing. The time histories of the beta and gamma spectra, calculated as part of this research, show that the spectral extremes of the radiation energy occur at approximately 1 minute and 4 days.

Beta and gamma energies were calculated for these spectral extremes for typical polymeric cable material. Using experimental and analytical data from other work referenced in the radiation effects literature, charge buildup distributions were calculated for both radiation sources. From these charge buildup distributions, values of electric field were determined and shown to be small compared to those established when rated voltage is applied to the cable.

The effect of the charge buildup on the signal integrity of a cable used in a safety-related system was not determined because it is so strongly dependent on the type of circuit. For example, charge buildup in a cable which is part of a high impedance circuit could result in a serious noise problem or signal error. However, since current practice is to not duplicate the circuit or even the circuit impedance, this effect should not be a factor in evaluating currently utilized radiation sources. This issue may be further evaluated as part of the QTE program at a later date.

Temperature Effects

The radiant energy from the calculated LOCA source and a simulator, such as Cobalt-60, is deposited within the exposed material and increases the material temperature. As described in the previous section, the deposition profiles of the calculated and Cobalt-60 sources are not the same, and therefore, the resulting increase in temperature or temperature gradient of the exposed material may be different. For example, the calculated LOCA source results in more energy deposited closer to the surface of the material than does the Cobalt-60 source. As part of the research, these temperature effects were analyzed for both the calculated and Cobalt-60 radiation sources. For the maximum dose rate calculated, the effects due to temperature gradients caused by both the nonuniform energy deposition and the thermal lag in the transfer of heat to the surrounding environment are not significant enough to cause material damage.

Total Energy Effects

Bulk energy deposition within the test specimen is dependent on the energy spectra. Energy deposition values were calculated for the hypothetical and Cobalt-60 radiation sources, including variations, as a function of depth in a typical polymeric cable material.

For the calculated LOCA source, which has a time varying energy spectra, the maximum energy deposition rate was used. These energy deposition values were used to calculate the heat flow across a generic electrical cable and to determine the resulting temperatures. These data show that if poor conduction to the surrounding environment is assumed, damaging cable insulation temperatures could be reached and that the cable temperature would depend primarily on the heat transfer coefficients between the cable and the environment, and to a much lesser degree on the energy deposition profile or the deposition rate. Thus, the question of overheating of cable due to energy deposition at high dose rates deserves further consideration. The calculations made as part of this research did not include the heat contribution from any direct steam impingement on the cable. The combined effects of high radiation dose rate and energy deposition from LOCA steam could cause damage to exposed polymeric materials. In any event, the effect is not strongly dependent on the radiation source as long as the energy deposition rates are equal.

An additional damage mechanism that was considered for a typical polymeric material is the total chemical and mechanical change such as scission and crosslinking. It was shown that these changes were not significantly dependent on the type of radiation source as long as the total energy deposition is similar. This is because the energy interaction mechanism in polymeric material is the same for both radiation sources.

Mechanical Stress Effects

One additional damage mechanism that was considered for a typical polymeric material is the mechanical stress that could result from the shrinkage of the elastomer, along with a significant reduction in elongation. This could result in surface cracking and loss of insulating qualities when subjected to a LOCA environment. The amount of shrinkage is dependent on the energy deposition profile as a function of depth below the surface, and hence, the damage mechanism, if important, could be source dependent. Experimental data giving shrinkage and loss of elasticity of certain commonly used cable insulating materials were obtained showing that for these materials the shrinkage is small (generally less than 5%). Also it was noted that most of the shrinkage occurred early in the experiment before the material lost any appreciable elongation. Thus, although insulating materials may become brittle (as evidence by a loss in elongation) as a result of radiation, there should be no significant differential stress caused by shrinkage and accompanying loss of elongation. Since these data do not include all currently utilized insulating materials, the issue should be reconsidered when additional data become available.

EVALUATION AND RECOMMENDATIONS

The data obtained in this RIL and an advanced copy of the RIL have been reviewed with members of the Qualification Testing Evaluation Review Group.

The data discussed in this RIL are of primary concern for the review of LOCA qualification for safety-related equipment that must operate following the accident for periods of time that result in a high accumulated dose.

The data show that the use of Cobalt-60 or other similar simulator as a radiation source for LOCA qualification should be accepted by the licensing staff. There is no basis, at this time, for requiring a change to a different radiation source. However, the question of whether or not some additional beta radiation qualification should be required from the licensee for exposed polymeric materials cannot be fully answered without further work, which is in the current QTE research program. Requiring additional beta radiation qualfication, pending these results, is not warranted since current estimates show that even with surface damage on exposed polymeric cable, the cable probably will be able to perform its function because the bulk elasticity probably will not degrade significantly. A series of scoping tests is planned in the near future to verify this supposition.

The source term calculations show that the Regulatory Guide 1.89 release assumptions result in a source comparable to current core melt releases. This is an overly conservative requirement, particularly for equipment designed to terminate the LOCA and prevent a core melt. The core melt source term should be reserved for instruments that may be required to perform following an unterminated LOCA. Also, the instantaneous release assumptions result in dose rates that are difficult to achieve during equipment qualification testing. Research has been conducted on obtaining "best estimate" source term values. A report on this work will soon be available and could be used in specifying a multi-level qualification source term.

NUREG-0588 "Interim Staff Position on Environmental Qualifications of Safety Related Electrical Equipment," published for comment in December 1979, proposes a radiation source term different than that derived from Regulatory Guide 1.89 by the Sandia work. The differences arise from the assumptions made with regard to the deposition of the source and the allowance for the beneficial effects of emergency containment spray. The NUREG-0588 source term is somewhat less conservative than the Sandia calculated source term. If either the NUREG-0588 or Sandia source term is used for licensing, it should be modified as quickly as possible with a best estimate source, including reasonable conservatism.

Current LOCA qualification practice does not include demonstration of system performance although, the general requirement is implied in the industry standard IEEE-323. Consideration should be given to addressing the question of system performance degradation that may be caused by radiation induced electrical noise. The current research program on LOCA methodology will address this issue, and the staff should wait for these results before deciding on this issue. It should be pointed out that the "best estimate" source term calculations minimize this effect by reducing the maximum dose rate.

COORDINATION CONTACT

For coordination of further evaluation of these results and for discussion and future experiments, the reader is advised to contact Mr. Ronald Feit, Qualification Testing Evaluation Research Program Manager, telephone number (301) 427-4272.

T.Murley/Acting

Robert J. Budnitz, Director
Office of Nuclear Regulatory Research

Enclosure: Table 1

TABLE I

		Current Practice*	Theoretical Calculations*
1.	Total Dose	150-200 MR	450 MR
	Gamma	150-200 MR	50 MR
	Beta	**	400 MR
2.	Dose Rate		
	Gamma	.1 - .5 MR/HR	5 MR/HR
	Beta	**	50 MR/HR
3.	Spectra	Usually a fixed energy source (Cobalt-60)	Time dependent Energy Spectra

* These data are based on a 30-day exposure.

** Beta radiation is usually not specified for radiation qualification.

References:

1. L. L. Bonzon, Sandia Laboratories, "Radiation Signature Following the Hypothesized LOCA, SAND 760740," NUREG/766521, October 1977.

2. L. L. Bonzon, William Buckalew, Sandia Laboratories, "Evaluation of Simulator Adequacy for the Radiation Qualification of Safety Related Equipment, SAND 791787," NUREG/CR 1184, June 1980.

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Original Signed by
T. E. Murley
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Robert J. Budnitz, Director
Office of Nuclear Regulatory Research

Enclosure: Table 1

Distribution
Subject
Circ
Chron
Branch RF
RFeit RF
RFeit
WSFarmer
CEJohnson
LSTong
TEMurley
JLarkins
RBudnitz

Record Note: This RIL has been reviewed in draft form by NRR, I&E, and Standards thru the QTE Review Group. A copy was also sent to the Environmental Qualification Branch (Rosztoczy and DiBenedetto) who feel a RIL at this time is worthwhile.

OFFICE	RSR:RSB	RSR:RSB	RSR:WST	RSR	RES	RES:D
SURNAME	RFeit/ama	WSFarmer	Johnson/Tong	TMurley	JLarkins	RBudnitz
DATE	6/4/80	6/5/80	6/24/80	6/24/80	8/8/80	8/8/80