

**REPORT OF THE  
URANIUM TASK FORCE  
COMMONWEALTH OF VIRGINIA**

**OCTOBER 1, 1984**



# COMMONWEALTH of VIRGINIA

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## MEMORANDUM

TO: Coal and Energy Commission Members

FROM: Richard N. Burton

The Uranium Task Force submits this report to the Coal and Energy Commission in response to our assigned task of providing information, analysis and recommendations on whether to lift the current moratorium on uranium mining in Virginia. We have met our deadline of October 1 and have developed our recommendation in full view of the public.

We believe that this report and its supporting studies and documents provides a substantial base of information upon which an informed legislative decision can be made.

The recommendations that we offer represent the combined judgment of the membership of the Task Force.

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## I. Executive Summary

This Uranium Task Force (UTF) final report and set of recommendations is a summary and synthesis of a substantial body of data, technical memoranda, laboratory analyses, and consultant reports on economic and health matters, as well as the Marline Technical Summary and related data. These are all available to the public and we believe lead logically to our recommendations.

This report is the conclusion of our work as the Uranium Task Force. A major goal of the UTF this year was to develop a sense of confidence in our process of deliberation and not just our conclusions. We sought to do this through meetings open to the public, frequent interaction and communication between the UTF membership, the release of technical information when it was prepared, and discussions among the Marline/Umetco and state consultants.

The Task Force has provided an extensive base of information, analyses and interpretations. Yet the information we have developed does not answer all the questions which must be addressed before finally licensing such a facility if it is to be allowed in Virginia. Our information responds to the mandate for an improved technical and administrative base in order to make an informed legislative decision. Further prelicensing studies are to come if the legislative choice is to lift the ban.

Our studies and recommendations address statewide standards and Swanson site issues as a test case. In neither instance can we provide a simple "yes" or "no" answer. We conclude that there is no way we can say "yes uranium mining is safe and beneficial," or "no that it is unsafe and detrimental." This is not because

the appropriate technical and scientific studies have not been performed. Rather, it is because of the inherent limitations of expertise and the methods employed by experts. Neither risk analysis nor cost-benefit analysis are capable of offering conclusions without appropriate qualifications. The choice that must be made, therefore, must be made with uncertainty, albeit an uncertainty considerably reduced by the information developed under the supervision of the UTF.

Our evaluation of the respective risks and benefits leads us to conclude that a uranium development activity can be undertaken with an acceptable level of risk and with economic benefits to the state if the recommendations proposed are adopted and are treated as an essential ingredient that must accompany any lifting of the moratorium on uranium mining.

The following recommendations highlight the steps that we of the Uranium Task Force think need to be taken to assure that there is an acceptable level of risk. If the legislature chooses to lift the ban on uranium mining, then it is recommended that a comprehensive mining, milling and tailing statute be adopted to include the following features:

1. That Virginia become an agreement state with the right to license a uranium development facility.
2. That statewide standards for acceptable levels of radioactive exposure to the general public be made more stringent than current federal standards by including all sources and pathways in a single two part standard of 25 millirem per year (mrem/yr) for sources other than radon and 1 picocurie per litre (pCi/l) for radon to the maximally exposed individuals above existing background levels. Together these yield a maximum dose of approximately 285 millirem per year which can be compared to the federal standard of 500 millirem per year. The risks associated with the proposed state standard are 28.5 chances in a

million as compared to the federal standard of 50 chances per million of additional fatal cancers.

3. That a uranium mining statute be adopted with features that are appropriate for this particular mineral. The specific features that should be considered within that law are spelled out in supporting documents of the Task Force and are the subject of continuing work by the Division of Legislative Services.
4. That a non-degradation standard be upheld for groundwater protection.
5. That no process water be allowed to be discharged to surface waters from either the mill or the tailings facility.
6. That those state regulations and performance standards which govern hazardous waste land disposal facilities be specifically applied to uranium development facilities by statute.
7. That a schedule of financial guarantees and fines be developed to assure strict compliance with license and permit conditions. We also recommend and that a strict liability policy for damage be adopted by the state for uranium facilities and be supervised primarily by the courts rather than any administrative agency involved in regulating the facility.
8. That the state adopt an administrative strategy that assigns the Health Department lead responsibility for negotiating agreement with NRC and that assign the Department of Mines, Minerals and Energy lead responsibility for on-site monitoring for the mine, mill and tailings facility. Other agencies would retain responsibility within their established area of authority while coordination would be provided by continuing the Uranium Task Force until the state's proposal is fully in place and the first Source Material license has been issued.
9. That the UTF during the coming year prepare a detailed estimate of needed budgetary support in order to effectively administer the comprehensive uranium development law and regulations. The Director of the Council on the Environment should prepare an annual report each year thereafter on the adequacy of support for the effective administration of the statute.

## II Preface - History Leading to Uranium Task Force

The exploration for uranium in the Commonwealth of Virginia began in 1977. After the discovery of the Swanson ore body in Pittsylvania County by the Marline Uranium Corporation (MUC), the Virginia General Assembly, in its 1981 session, directed the Coal and Energy Commission to undertake a study of the issues related to uranium development in the Commonwealth. The Coal and Energy Commission (CEC) created the Uranium Subcommittee (US) which held several public hearings and undertook a fact finding trip to uranium development areas in Texas. Their study focused on the impact that would be associated with the development of the Swanson ore body and was limited primarily to Pittsylvania County.

In the 1982 legislative session, the Uranium Subcommittee recommended that Virginia adopt a statute which would regulate exploration for uranium ore in the Commonwealth. This recommendation was adopted through the passage of Senate Bill 179, which also placed a moratorium on actual uranium mining until July 1, 1983. Additional hearings, presentations and fact finding sessions were held by the Uranium Subcommittee during 1982. In the 1983 legislative session the Coal and Energy Commission recommended to the General Assembly that more in-depth studies take place under the guidance of a wider audience and that the moratorium on uranium mining be continued. The General Assembly accepted this recommendation through the enactment of Senate Bill 155 on February 24, 1983.

Senate Bill 155 (SB155) created the Uranium Administrative Group (UAG), which was charged with overseeing and reviewing studies that would examine the costs and benefits of permitting uranium development at specific sites in Pittsylvania County. SB155 encouraged the proponents of uranium development to participate in these studies and also gave the UAG authority to employ consultants to perform the duties established therein and report to the Coal and Energy Commission by December 1, 1983.

The UAG held its first meeting on May 5, 1983. Uranium proponents Marline Uranium Corporation and Umetco\* undertook extensive studies to assist the UAG in meeting its mandate. On June 8, 1983, Rogers, Golden & Halpern (RG&H) and SENES Consultants Limited were employed as consultants to the UAG. After an intensive study in a compressed time period, MUC/Umetco submitted a nine volume report on October 15, 1983. On November 15, 1983, RG&H and SENES completed their review of MUC/Umetco's nine volume report. In addition, a report entitled "Agreement or Non-Agreement: Options for Virginia" was submitted by a subcommittee of the UAG.

On December 15, 1983, the UAG submitted its recommendations to the CEC based on the various studies and reports that had been conducted over the previous nine months. Its recommendation included a proposal for expanding and concluding the studies called for in SB155. The Coal and Energy Commission held public hearings in Pittsylvania and Halifax Counties and the City of Richmond. After reviewing the various reports and hearing public

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\*Formerly the metals Division of Union Carbide Corporation.

comments, on January 13, 1984, the Commission passed a resolution which called for a continuation of the study by a state agency task force under the joint direction of the Uranium Subcommittee and the Uranium Administrative Group.

The Coal and Energy Commission resolution designated the agency head or director of seven state agencies as members of the Uranium Task Force (UTF). These included the Department of Agriculture and Consumer Affairs, the State Air Pollution Control Board, the State Water Control Board, the Department of Health, the Department of Conservation and Economic Development, the Department of Labor and Industry and the Council on the Environment. Governor Robb selected Richard Burton, Director of the State Water Control Board, as UTF Chairman. The resolution further outlined specific tasks to be accomplished by the UTF and certain procedures that should be followed in reporting to the US/UAG by October 1, 1984. These tasks included:

- o An assessment of the risks that could be expected from uranium development in the Commonwealth under the application of various existing and possible alternative policies and performance standards both in general and specifically as a result of the proposed Swanson mine/mill facility.
- o An assessment of the economic costs and benefits associated with the development of uranium in the Commonwealth both in general and specifically as a result of the proposed Swanson facility.
- o A recommendation to the Commission and General Assembly of a level of risk acceptable to the Commonwealth and guidelines for performance standards that would be necessary to limit risks to an acceptable level. These standards would be equivalent to or more stringent than existing federal standards.
- o An examination of the scope of the agreement state program under § 274 of the Atomic Energy Act of 1954, as amended, and recommendations as to the degree to which the Commonwealth shall seek to participate in the

program, and the appropriate lead or participating state agencies.

Perhaps the critical issues confronting the Task Force were to be faithful to the charge of SBI55 and the Coal and Energy Commission directives while at the same time introducing a process which would develop confidence in our results.

There was an expressed concern that the nine volume MUC report was difficult to interpret and evaluate. It was also felt that the questions generated by state consultants, citizens and public officials should receive more extensive evaluation before a recommendation was made to the legislature.

A major goal of the Task Force was to respond to the directives in a fashion that would reduce the adversarial climate that had emerged. The Task Force sought to involve the public in an open process of study and evaluation. It also sought to involve the various experts, whether they were retained by MUC or the State of Virginia, in a process of joint study which would help to clarify where there was technical agreement and where there were differences of opinion and judgement on technical matters.

The Institute for Environmental Negotiation (IEN) was retained by the UTF to structure what was termed a technical mediation process which would, wherever possible, seek to employ the information and studies already performed. This called for joint effort by the MUC, the state consultants, and informed citizens to review the adequacy and appropriateness of the scientific and technical studies to determine where the studies were sufficient or where additional studies, analyses, or

clarification were required. It was also assumed that some information would not be complete, and that there would be some continued technical disagreements, but it was felt that the final product would be a much improved basis for legislative decision-making.

The process was undertaken and the following steps were followed:

1. A list of the most important issues, questions and concerns was developed by the experts involved and added to by agency personnel and public representatives.
2. Once the list was agreed upon, a set of studies and tasks were agreed upon to address those concerns. Involved were MUC experts, state consultants and some state agency people with special knowledge.
3. Wherever possible, and especially in the case of assessing aspects of the MUC proposal which would have critical relationships to environmental quality or public health, it was established that there would be consensus on the appropriate procedures and assumptions to be employed. Where there was disagreement, the more conservative or pessimistic assumptions would be employed for analysis.
4. Essentially the same procedures were used for the economic analysis performed by the Tayloe Murphy Institute (TMI) at its initial stages. However, after the initial list of issues and concerns was developed, TMI independently performed its analysis with the support of MUC, state agencies and citizens as it was deemed appropriate by TMI.

Monthly meetings of the Task Force were held to review and evaluate the progress of the studies and negotiations during this period. The UTF held their meetings in public and sought the reaction and recommendations of the company, state agency personnel and the interested public throughout the process. It was hoped that the mutual education and interaction would produce a superior evaluation and set of recommendations. Each step of the process was visible.

We believe that this report, with its various appendices, will allow any interested person to review and understand not only the final conclusions and recommendations, but the supporting documents and studies which led to them.

### III. Introduction - Establishing a Context & Perspective on The Choices Before the Commonwealth

This report is more than the combined recommendations of individual Uranium Task Force agencies. It represents the collective judgment of the UTF. It represents an effort to produce a document which has the support of the entire group.

From the beginning of our work we assumed that there would be no bright line between "safe" and "unsafe." We anticipated the limitations of expert techniques in producing a definite or simple answer.

Yet, there was no area where the UTF had greater concern than on the potential effects of radiation which would be produced by the uranium development facility. We planned to comply with our mandate by framing our recommendations in the form of an analysis of the risks and benefits to Virginia, rather than in "safe" and "unsafe".

In the absence of a clear finding that excessive risk was present, we anticipated that we would recommend that the legislature evaluate our technical studies, performance standards and recommendations and then proceed with its own judgment without a clear "yes" or "no" recommendation from the Task Force. Our final product, in fact, is a "yes, but..." or a "yes, if..." and with a recommendation that without the "buts" in the form of performance standards and regulatory apparatus, uranium activity should not go forward in the Commonwealth. Our recommendation, put simply, is a qualified yes and the qualifications are viewed as essential.

We have concluded that a uranium development complex can be undertaken with an acceptable level of risk to individuals and to the population only if standards and safeguards recommended here are reflected in state laws and regulations. However, we note that this depends not only on legislation, but on the development of regulations and effective administration and enforcement. We also call attention to the fact the the final design of any facility will have to be carefully reviewed and engineered. Effective and safe operation consistent with environmental protection and human health ultimately depends upon a strong committment on the part of the firm that undertakes to operate it. We recommend that the history of any such potential applicant be evaluated for responsiblity in these respects.

We also conclude that the studies and evaluations which we have performed do not answer all of the important questions which would be and should be answered before a licensing decision is be made or before some critical environmental permits are granted. The UTF recommendations and analysis are suitable for informed public discussion and legislative decision-making. Many of the important environmental questions raised in our hearings are most appropriately studied in detail as part of required prelicensing studied. Our recommendations and analyses do not end the process of public decision; they should, however, inform and guide it.

The Task Force believes that the following can be asserted:

- o We have substantial confidence in the completeness, clarity and technical integrity of the Marline Technical Summary. It provides a useful reorganization of portions of the nine volume study. It differs in some respects from the earlier document and should be

read in conjunction with the State's consultants' reports.

- o The evaluations of the Swanson site are based upon plans and designs presented by the MUC. These designs and plans represent the best current thinking of the company about this site's development. If these designs should change - and some changes should be anticipated - this could appreciably alter the impacts of the site's development. These changes would also have the effect of negating or depreciating the analyses performed here. We note that the MUC proposal represents advanced concepts and calls for careful engineering evaluation, technical skill in construction, sensitive management, and controlled operations.
- o The reports and studies evaluated this year do not represent a comparison of all of the potential concepts, designs, and technologies that might be employed or recommended. It is entirely possible that fuller environmental analysis and technical studies could lead to better alternatives. These alternatives might emerge from company analysis, state agency proposals, or citizen suggestions.
- o The technical analyses performed are themselves subject to assumptions, methodologies, and conclusions which must be treated with appropriate caution. We believe that they represent competent and reliable models and methodologies, but both the pathways analysis and the cost-benefit study are limited in their scope and precision.
- o Virginia would be the first state east of the Mississippi River which would have an operating mine and mill should the MUC proposal go forward with legislative approval. Because of the perceptions attached to radioactive material and the legitimate concern of the public about additional exposure to radiation some national attention will be conferred upon Virginia as a result of its decision. New York, New Jersey, Minnesota, Wisconsin, Michigan and Kentucky have all confronted the issues of uranium mining either alone or in conjunction with concern about low-level waste disposal. Moratoria on uranium mining have been enacted in some of these states. In other states it appears that political controversy and changed market conditions for uranium have caused potential mining firms to withdraw their proposals. We do not know whether Virginia's approval would encourage the other states to also allow mining or whether it would leave Virginia to be the lone uranium mining state east of the Mississippi.
- o We note that apart from the political issue, there is

no experience in the U.S. with uranium mining, milling and tailings management in the relatively wet conditions that exist here. The net precipitation status (more rainfall than evaporation and plant uptake) of Virginia however, could be a potential advantage as well as a source of potential environmental risk. The scale of the proposed mine and tailings facility, combined with the wet Virginia climate and some innovative design characteristics, make the Swanson site proposal difficult to assess from previous experience. Consequently, the UTF had to rely on methods of analysis other than operating experience to draw conclusions and recommendations.

- o We also note that the federal licensing and review process is undergoing substantial revision in light of increasing concern about radon emanations from uranium mining and from a desire to protect the environment from contamination from uranium mining activities and waste. In effect, we recommend here that this facility, if it goes forward, not only be treated as a mine and mill, but also as a complex that must handle hazardous waste. This, we believe will assure that the surface and groundwater will be more adequately safeguarded against possible degradation.
- o With the exceptions noted in this report, the regulatory powers of the various agencies involved in some aspect of uranium mining, milling and tailing management regulation are seen as adequate for effective management. However, the comprehensive uranium statute which we recommend should place special attention to the need for a special section that creates a uranium mining regulatory authority. We believe that uranium is sufficiently different from coal mining or minerals other than coal to justify a separate statutory base. However, many of the features that cover Virginia coal mining are seen as appropriate to uranium mining as well. The comprehensive uranium mining, milling and tailing management draft law being developed by the Division of Legislative Services reflects many of these concepts.
- o However, we reemphasize that effective realization of the various objectives will demand additional resources in the form of budgetary increases, equipment and technology. To some extent, the Nuclear Regulatory Commission would provide technical advice and support, but the passage of uranium mining, millings and tailings management bill would signal a need for substantial public agency actions. Particularly urgent needs for the Health Department and the new Department of Mines, Mineral and Energy would be created. As noted in the Executive Summary, during the coming year the UTF should prepare a detailed estimate of needed

budgetary support in order to effectively administer the comprehensive development law and regulations. The Director of the Council on the Environment should prepare an annual report each year thereafter on the adequacy of support for the effective administration of the statute.

The following section summarizes the major consultant inputs which the Task Force has considered this year. That section is followed by a more detailed presentation of the recommendations of the Task Force.

#### IV. Summary of Consultant Reports

##### A. Ore and Waste Rock Analyses

The potential for adverse environmental impacts and increased health risks from uranium mining trace back to the chemical and radiological properties of the rock being mined. A careful analysis of the properties of the commercial grade ore, as well as the barren waste rock that must be removed to gain access to the commercial grade ore and the mineralized waste rock (i.e., rock that is neither up to commercial richness nor barren) serves as the foundation for all other environmental and health impact analyses. At the end of the 1983 study period, the UAG consultants' report concluded that "the chemical character of the ore, and waste rock are not clearly known at this time. We have no concrete information on heavy metals." During 1984, a major effort has been made to address this deficiency with studies conducted under the auspices of the state, including the Division of Mineral Resources, and state consultants, and the Marline firm. Documentation of these studies are included in Appendix E.

In April 1984, under the leadership of Stanley S. Johnson, Chief Geologist in the State Division of Mineral Resources, the state's consultants (SENES Ltd. and Rogers, Golden and Halpern) and Marline officials jointly developed a strategy for characterizing the chemical and radiological properties of the ore and waste rock. This strategy involved breaking the rock into four categories; that which had uranium content greater than .05%; the mineralized waste rock which was defined as having uranium between .01% and .05%; and barren waste rock from both

Triassic and crystalline composites. This analysis employed the use of 120 individual samples.

The composite samples were then delivered to four laboratories which independently analyzed for 36 chemical elements, six radionuclides and a dozen additional rare earth elements. The results of these analyses were compiled by the staff at the Division of Mineral Resources and evaluated for inter-lab consistency. The report dated June 27, 1984, confirms that with few exceptions the results are consistent and therefore provide a reliable base of knowledge. The June 21, 1984, memo from Rogers, Golden and Halpern also concurs that the results are "remarkably similar attesting to the efficacy of the sample preparation procedure."

With the accuracy of the analyses confirmed, the next step was to review the results to determine whether any chemical elements or rare earth elements were detected at significantly high levels. The conclusion of the State's Chief Geologist, Mr. Stanley Johnson, was that "none of the values reported by the various laboratories indicates an element enrichment (including the rare earth elements) above the normal background for average rocks and soils, other than uranium, in the ore body." The Task Force concludes that the 1984 ore analysis is substantially consistent with the 1983 analysis in showing no significant concentration of any toxic elements.

#### B. Leachability Tests

Concurrent with the state's analyses of the chemical and radiological characteristics of the Swanson ore and waste rock,

Marline was utilizing identical composites to conduct "leachability" experiments at the Colorado School of Mine Research Institute (CSMRI). The purpose of these studies was to determine the quality of water after it comes into contact with ore and waste rock. The intent was to simulate field conditions in the laboratory to determine the chemical and radiological characteristics of oxidized mine water and water that might run off as seepage from the overburden (waste rock) piles. The procedures for conducting these experiments were also developed in close consultation with the state's consultants who suggested improvements in the proposed procedures (see MUC Technical Memoranda Number 4 and Appendix E).

Once again, four separate composites were analyzed including an ore-grade composite, a mineralized waste composite, a barren crystalline rock composite and a barren Triassic sediment composite. The first was used to determine mine water quality and the latter three were used to determine the water quality of seepage from the overburden piles. The results of these studies were used either directly or indirectly as key inputs to the radiological pathways analysis, or more specifically as input parameters to the PABLM computer model.

The results of the study for the nonradioactive elements indicated that, none of the samples produced solutions containing excessive concentrations of these elements. According to the CSMRI Report, none of the elements which are most strictly regulated and which were analyzed (such as As, Sb, Bi, Cd, Cr, Cv, Pb, Mg, Mo, Se, Ag, and Tl) were leached to excessive concentrations and were only present at trace levels. It should

be noted that additional elements such as sodium, barium and lanthanum would need to be addressed at the licensing stage.

The results of the study for the radiological elements showed elevated levels of  $U_3O_8$  uranium in the mine water solution from the ore-grade composite and elevated levels of Radium 226 in all of the samples except for that derived from the barren Triassic composite.

The report states that "the quantity of  $U_3O_8$  leached from the ore-grade may become excessive depending on the dilution factor." Under the conditions of the tests,  $U_3O_8$  was leached from the ore-grade composite to a concentration of .455 mg/l in the sample analyzed.

With regard to the elevated levels of Radium 226, the report states, "the radiochemical analyses showed the barren Triassic sediment to be the only material which did not give potentially problematic response. The barren Pre-cambrian (crystalline) rock responded to the water leaching with a Radium 226 concentration of 3.7 pCi/l under the leaching conditions used. The ore-grade composite and the low-grade (mineralized) waste, respectively, responded with concentrations of Radium 226 at 29 and 26 pCi/l with associated high alpha-beta counts."

As noted above, the results of these studies were utilized either directly or indirectly as input parameters to the PABLM computer model. In particular, the mine water discharge parameters were derived directly from the CSMRI data for all constituents except Ra226. In the case of radium, the maximum allowable soluble discharge (3.0 p Ci/l) to streams under the EPA New Source Performance Standards (40 CFR 440) was used. The

assumption used here, backed by data collected from industry practice, was that the proposed barium chloride treatment processes will successfully treat Swanson mine water to bring Ra226 levels down to at least the maximum allowable concentrations and probably lower.

The CSMRI data was also used to determine the radionuclide content of the seepage from the mine overburden storage pile. The reported radiological concentrations for leach from the mineralized crystalline and barren Triassic and crystalline waste rock were averaged together based on weighing each parameter by the ratio of the total tonnage of each category of rock. The ratio of the barren Triassic: mineralized crystalline: barren crystalline, as reported by Marline, was 1.44:1.0:1.0. It should be noted that the actual ratio could not be verified by state consultants because this information was confidential. It should also be noted that the level of Ra226 that results from averaging the ratio of each type of rock is 9.0 pCi/l. EPA recommends that concentrations Ra226 above 5.0 pCi/g be treated as hazardous waste. The UTF recommends that this standards be applied to the uranium development facility.

### C. Clay Evaluation

The 1984 clay studies were based on the assumption that they would be essential to the tailings management design and performance. Ultimately, the particular type of liner technology used to manage the tailings leachate, and the amount and

quality of the clay will be specified under the performance standards. But the Marline proposal was based on a single liner with controlled seepage and the studies were conducted to determine its adequacy as a concept.

Considerable discussion among the MUC and state consultants was necessary to get agreement on the clay characteristics in order to run the PABLM computer model which would assess the radiological impacts on the water, and ultimately human health. All parties agreed that the studies that were undertaken would not be sufficiently detailed to justify a licensing decision. Attention was focused on the information needed for legislative decision.

Two model runs were made with different assumptions about the clay qualities. These produced the two different scenarios reported in the PABLM run. In neither case did the assumptions lead to a radionuclide release that exceeded federal health standards. However, some explanation of the process is necessary because of its importance in determining non-degradation criteria.

The suitability of clay for its use as liner and/or cap material in a waste management facility is determined by three factors:

- 1) its geochemical properties which determine its ability to attenuate or remove and temporarily hold the chemical constituents of a particular waste fluid;
- 2) its geotechnical properties which will determine its ability to act as a structurally stable element in a properly designed facility; and

- 3) its compaction properties which will determine its ability to achieve specified permeability rates or rates at which fluids will pass through the liner and/or cap.

Each of these suitability factors were discussed at length by State and company consultants. On the basis of these discussions and on the written materials submitted by all parties, several issues were resolved and agreements were reached on how to approach those issues that were left unresolved.

Of particular importance was the decision to utilize both an attenuated and an unattenuated scenario in the PABLM computer model. Attenuation refers to a clay's ability to remove and hold, over some period of time specific chemical constituents. This decision to evaluate two different scenarios resulted from the preliminary nature of the studies conducted in 1983 and disagreement over the certainty of any assertions that can be made about the results of the column percolation tests conducted by MUC in 1983. These scenarios represent a more optimistic assumption in the case of the attenuated scenario and a more pessimistic assumption in the case of the unattenuated scenario. As noted by R.A. Knapp (SENES), the most accurate long term estimate of geochemical attenuation probably lies somewhere in between these two upper and lower limits. (See Appendix D.)

On the basis of the discussions it was also agreed by all parties to utilize a permeability rate of  $1 \times 10^{-7}$  cm/sec. for the clay liner under the tailings management area, rather than the initially posited permeability value of  $1 \times 10^{-8}$  cm/sec. Since the permeability rate depends heavily on quality control mechanisms utilized in field conditions, it was felt that this number was generally a more conservative figure (i.e. greater

permeability) and might better reflect the lower limit of what would be attained in the field.

In terms of the geotechnical characteristics, it was agreed by the State consultants that the information provided at this point in time was sufficient to proceed. In referring to the MUC submittals, the RG&H report stated that they provide "reasonable assurances that this part of the project is feasible." This is not to say, however, that more detailed and complete studies will not be necessary at the licensing stages but rather, the information provided at this stage constitutes a reasonable estimate of likely conditions in the future in terms of the geotechnical stability.

Studies conducted during the year established that quantities of clay suitable for the facility as proposed by MUC were locally available. However, these amounts of clay may not be sufficient for the design that will ultimately be required under appropriate state standards. In any case, impact assessments would be needed before any clay borrow activity takes place.

D. Review of the Marline/Umetco Technical Summary and Supporting Memoranda

As described in the forward of their September 5, 1984, report (attached as Appendix C) the firm of Rogers, Golden and Halpern (RG&H) was retained by the Task Force to provide a review of:

1. Methods of analysis for and chemical characteristics of uranium ore, mineralized rock, waste rock and their leachates,
2. Clay quantity, mechanical, and chemical studies,

3. The tailings and waste rock management concept,
4. Input parameters for the PABLM computer model (waterborne radionuclide pathways analysis), and
5. Adequacy of other site-specific uranium studies.

Contributions made by RG&H on the ore and waste rock analyses, leachability studies and clay evaluations have been described above. The following section will summarize and respond, where appropriate, to the remaining aspects of RG&H's 1984 review, with particular emphasis on the discussion of the PABLM computer model input parameters.

In general, the RG&H report provides a good overview and an important perspective on the 1984 technical mediation efforts. The introductory section of the report outlines the "current specifications" of the Swanson Project and throughout the remainder of the report it details the critical assumptions utilized in the 1984 analysis.

As noted in their reports as well as in other reports, if any of the more important specifications and critical assumptions are not adhered to, it will necessitate reexamination of the Swanson project impacts. The report provides a succinct basis upon which to focus more detailed and complete licensing stage studies in the future.

In the discussion of the PABLM computer model, the report criticizes the use of that model in so far as "unequivocal evidence that would support the use of this model for this application" was unavailable. The report states, "RG&H's primary reservation is that PABLM has not been used for a similar project at a specific site." However, it goes on to say that the same reservations would apply to all other surface water radiological

assessment models available at this time. The report concludes that the PABLM computer model is as appropriate for use in the assessment of the Swanson project waterborne radiological impacts as any other existing model. The Task Force concurs both with this qualification and the conclusion. In terms of specific input parameters, the Task Force believes that RG&H has pointed out some significant issues which arose during the study period. Some of these, as noted in the RG&H report, can be dealt with through a sensitivity analysis of the PABLM results. This entails isolating and changing the magnitude of specific input parameters to determine the sensitivity of the overall results to these changes. This can and has been done without great expense or technical difficulty. (Note MUC Technical Memoranda Number 13-Table 14).

One of the issues raised in the RG&H discussion of the PABLM input parameters is the limited usefulness of the "pond breach scenario". The original purpose of this scenario was not to provide a worst case analysis. This scenario provides a calculation of dose exposure that would result from a specified high intensity storm (the 10 year/24 hour event) that would cause the mill pond to be breached by the amount of precipitation to be expected from that storm. The Task Force agrees, however, with the warning of the RG&H report that, "Reviewers of the Technical Summary should be aware that the effects of a catastrophic tailings dam failure are not included in PABLM as run." Several points should be noted here:

1. The intent of the 1984 radiological impact assessment was to provide an analysis of the impact of the Swanson

project under representative normal operating conditions, as best as they could be determined.

2. As noted in the RG&H report, the effects of a "catastrophic tailings dam failure" are better estimated outside of PABLM. The "worst case" problem is probably not a pond breach but a tailings pile collapse of some sort. We recommend a worst case analysis during the environmental impact assessment if mining is authorized by the legislature.

Another issue raised that cannot be readily addressed in a sensitivity analysis is the possible uptake of radionuclides in tobacco plants in the vicinity of the Swanson project. There has been no attempt during the 1984 study period to study this particular crop. The Task Force suggests that this be addressed in future licensing stage analyses. The RG&H report states that "other PABLM inputs have been treated as recommended and as agreed in conference calls and follow-up memoranda."

In making their conclusions about the 1984 PABLM computer run, RG&H has stated that the 1984 PABLM results should take precedence over the 1983 results because they are more comprehensive in scope and use additional and more accurate input data. In addition, they have stated that in their professional opinion the 1984 PABLM assessment, even with the problems noted, represent a reasonably accurate assessment of the surface water radiological impacts of the Swanson project, given the current state-of-the-art in this field. The Task Force endorses these conclusions.

In summarizing their overall review of the MUC Technical Summary and 1984 Supplement, RG&H has raised some important concerns and caveats which bear repeating:

"Marline/Umetco has responded to a number of issues raised by Virginia's consultants during the 1984 technical mediation process. Not all of these issues have been resolved. The question that remains is the significance of these unresolved issues to the impact analyses that have been presented and ultimately to the regulatory process that may occur. It is RG&H's professional judgement that any decisions to be made based on the analysis must bear in mind the following:

1. The dose from tobacco pathways and its impacts on the crop have not been considered.
2. No radiological dose calculations have been performed for acid leaching processes or mill discharges.
3. A receptor similar to the 1983 "Mill Creek receptor" is most likely to be the maximally affected individual in terms of radiologic dose unless Marline/Umetco can guarantee control of enough property to prevent access to and use of water from whatever diversion of Mill Creek is ultimately proposed. The revised (1984) PABLM analysis has not been performed for such a receptor.
4. Marline/Umetco must control access to groundwater so that no potable water wells withdraw water seeping from the tailings pile and waste rock area before it enters adjacent streams.
5. The effects of a catastrophic tailings release have not been analyzed.
6. Short-term (one-year) radiological doses would be higher than those presented in the PABLM results for what RG&H would consider a reasonable worst case analysis because of more seepage, lower flows, and higher radium-226 concentration.
7. Liner and reclamation cap clays must meet the permeability specifications proposed (even if they have to be imported from considerable distance) if the dose estimates are to be realistic.
8. The tailings must be dewatered for the tailings management and encapsulation plan to work as proposed.

9. The PABLM dose calculations estimate only incremental dose from the project and do not include background.

10. Interpretation of the PABLM outputs in terms of exposure standards and background dose is within the scope of other state consultants and RG&Hs comments should be considered in light of their review of the technical summary."

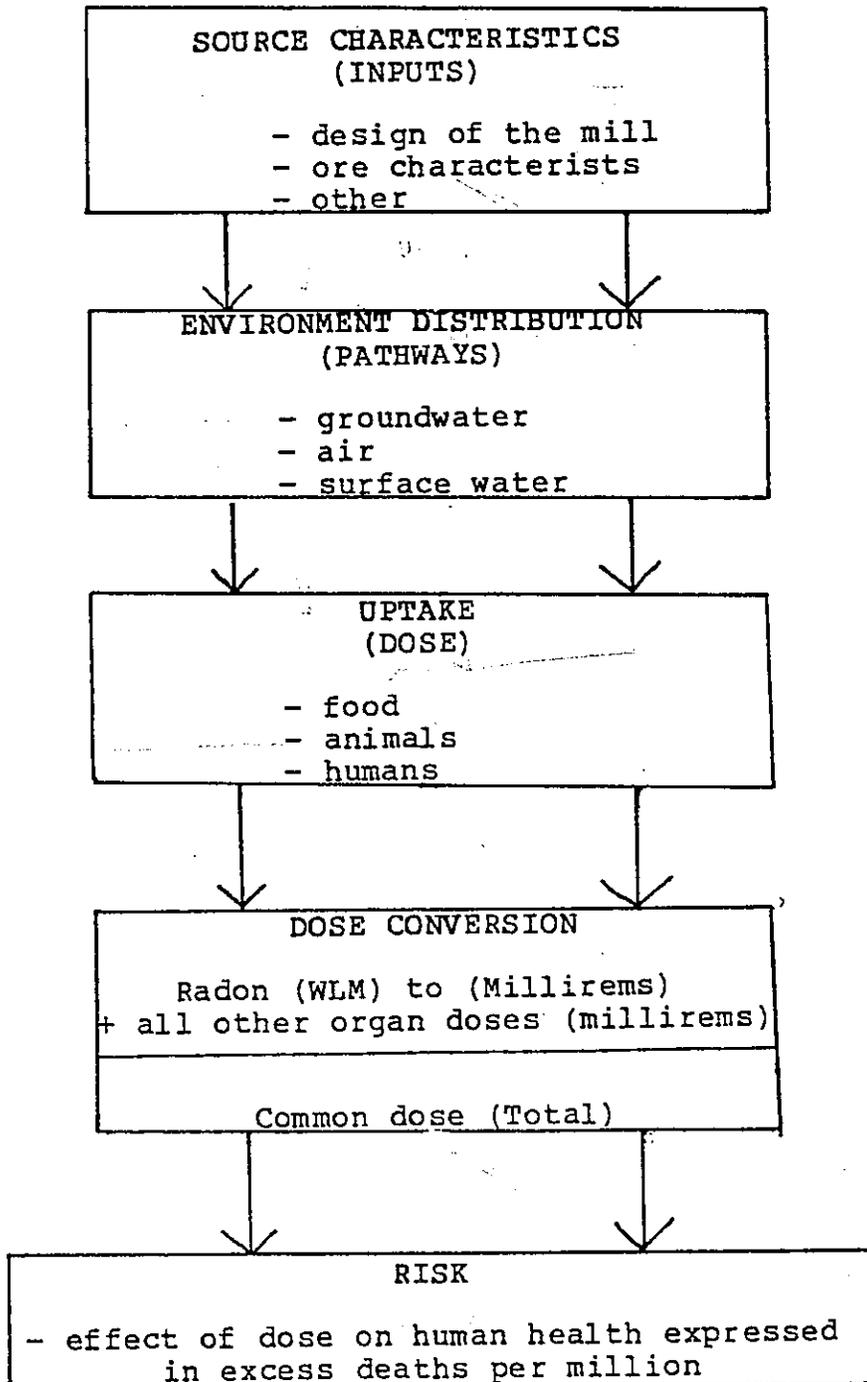
#### E. Risk Assessment

Risk assessment, as used in this report, refers to the estimating procedure employed to assess the additional risks of mortality from the increments of radionuclide dose to critical individuals, groups and the population within a 50 mile radius of the proposed Swanson site.

The risk assessment included a series of investigations undertaken jointly by state consultants SENES Consultants, Ltd. and MUC consultants under the supervision of the UTF and the IEN. The various studies and processes involved in the determination of risk are set out in this report and in Appendix A. The background data necessary for a risk assessment include the characterization of ore, water and surrounding rock, water balance, design characteristics of the operation, mathematical models and calculations of dose and population studies described earlier. Figure 2 depicts the general steps that we followed.

The UTF wanted to present to the legislature our assessment of the risks from increased radiation in terms of any additional statistical deaths based on the most sophisticated techniques that we could employ. Consequently, we directed Marline and the state consultants to undertake the PABLM computer run under

Figure 2  
Risk Analysis



agreed conditions. Once the difficult and lengthy process of agreeing upon the inputs had been decided and the model had been run, we took the output in terms of increased radiation from both the 1984 PABLM run and 1983 MILDOS run and translated dose to risk.

Federal law and regulations specify the maximum amounts of doses that individuals and populations are allowed to receive from uranium development activity. Those standards are set at what the U.S. government now believes are safe levels (i.e. minimum and acceptable risk). The UTF also decided to assess whether federal levels were acceptable to Virginia.

The UTF had to deal with a number of problems and issues in performing this task. Under federal regulations, 500 millirems per year above background radiation is the maximum individual dose for the general public from all sources and types of exposure. For the contribution from the nuclear cycle, the federal standard is 25 millirems per year for the maximally exposed individual from all radionuclides except radon. Radon, which is, perhaps, the major source of risk to individuals from uranium mining/milling, is a heavy gas and its measurement and risk evaluation must be performed by a different process than is used for other radionuclides.

A second issue arose from the fact that milling and tailings are regulated under federal law while mining is regulated under state law. The federal rules, including the 500 mrem standard, would not necessarily cover dose from the mine. We sought to assure that total risk to the population would be calculated from all potential sources. Thus, we called on our consultants and

the Health Department to develop a process to add radon from the mine to other radionuclide exposures.

The final figures in our reports include dose levels to individuals and populations from exposure including radon converted into a common basis for assessing risk. They also include contributions from all potential sources. It should be noted that this greater inclusiveness has the effect of mandating a more stringent standard than is currently required under current federal regulations.

The final dose figures and associated risks that would result from the current MUC design are listed in Table I & II. Table III represents the risks associated with UTF recommended performance standards. The methods by which these numbers are arrived at are included in the Risk Assessment Appendix A of this report.

The key conclusion reached by the SENES study and based on the numbers displayed in the tables is this:

"The total annual dose equivalent for all the people living 50 miles of the project during the 13 years of operations translates into a lifetime risk of about 0.04 additional fatal cancers. This can be put in perspective by noting that the current incidence of cancer related mortality in the U.S. (approximately 18%) indicates that over a lifetime more than 140,000 cancer fatalities can be expected to occur in the population living within a 50 mile radius of the site irrespective of whether or not the Swanson project were developed."

With the addition from the Swanson site activity, that figure would increase to 140,000.04, or less than one additional fatal cancer.

Table I

Summary Comparative Dose and Risk  
(Source: SENES Consultants)

Receptor/Characteristics	Annual Whole Body Dose	Annual Risk of Fatal Cancer per Million Persons
NRC limit for general population (excluding background exposure and any release from mines)	500 mrem	50
Average risk of dying from cancer in the U.S.	not applicable	180,000
Exposure to local residents from natural background radiation in vicinity of project prior to mining activity (dose equivalent due to external radiation and inhaled radon daughters)	210 mrem	21
<u>Addition from Proposed Swanson Project</u>		
Coles Hill property (on mining site)	16.4 mrem	1.6
Hyothetical off-site receptor with the largest potential exposure* (the location is currently unoccupied)	7.8 mrem	0.78
Hypothetical receptor living at Cedar Hill Hunt Club*	3.5 mrem	0.35
Hypothetical receptor living in Halifax*	0.15 mrem	0.015
Dose to hypothetical average receptor of the population currently living within 50 miles of project*	0.04 mrem	0.004

NOTE:

\* Exposure estimates for hypothetical receptor, the Cedar Hunt Club resident and typical Halifax resident include contributions of all radionuclides released from all sources. Federal regulations exclude some sources and radionuclides.

**Table II**

**Risk from Whole Body Radiation  
(Source SENES Consultants)**

Annual Dose Equivalent mrem/year	Annual Risk per Million Persons Exposed at the Specified Level
500	50
170	17
100	10
25	2.5
10	1
1	0.1

**Risk From Inhalation of Radon**

Radon Level (pCi/L)	Annual Risk per Million Persons Continuously Exposed at the Specified Level
1.92	50
1.00	26
0.65	17
0.38	10
0.096	2.5
0.0038	1

**NOTE:**

1) A conversion factor relating pCi/L of radon to an equivalent (on a risk basis) whole body exposure can be derived as follows for continuous exposure conditions:

$$1 \text{ pCi/L} + 1 \text{ pCi/l} \times \frac{0.5 \text{ WLM}}{100 \text{ pCi/L}} \times \frac{8760 \text{ hours/year}}{170 \text{ hours/working month}}$$

$$= 0.258 \text{ WLM/year}$$

On the basis that the risk of mortality from exposure to 1 WLM is approximately equal to the risk of mortality from exposure to 1 rem of whole body radiation the risk from continuous exposure to 1 pCi/L of radon-222 is approximately equal to the risk from whole body exposure to 260 mrem per year, or 1 pCi/L = 260 mrem per year on a risk basis.

2) Existing indoor and outdoor radon levels in vicinity of Swanson Project are  $1.6 \pm 1.9$  pCi/L and  $0.58 \pm 0.2$  pCi/L respectively (MUC 1983).

Table III

Risks from Proposed Performance Standards<sup>1</sup>  
(see Section V.C. 1)

The Task Force recommends state standards for the maximum radiation exposure to any one individual of the general public from the entire operation, not to exceed 25 millirem per year, radon excluded.

The Task Force recommends state standards for the maximum exposure to any one individual of the general public for radon not to exceed 1 picocurie per liter.

25 mrem = Risk<sup>2</sup> of 2.5/million

1 pCi/L = 260 mrem<sup>3</sup> = Risk<sup>2</sup> of 26.0/million

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Totals            285 mrem = Risk<sup>2</sup> of 28.5/million

- 1) Dose standards refer to increments above background which must be determined prior to any uranium mining and milling activity.
- 2) Risk here refers to X additional chances per million of fatal cancer for the individual exposed to this maximum allowable dose.
- 3) See Footnote 1 of Table II.

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The Task Force wishes to make the following comments on the risk assessment generally and the study conducted by SENES particularly.

1. We have used risk analysis in the narrow sense of using expertise to give numerical estimates of excess risks of cancer from radionuclides. We have not performed an economic evaluation of how much one might be willing to spend to reduce risk below the level presented here.
2. As SENES has noted in its report to the UTF the use of models such as the MILDOS and PABLM are "inherently uncertain. . . and mathematical models are at best only approximations." The analysts hope to err if at all on the safe side by overestimating the risk of exposure.

SENES also appropriately notes that there is some disagreement and ongoing modification of radiation standards and conversion factors within the scientific communities and the regulatory agencies. We believe that the calculations

used here represent a balanced and reasonable formulation given the ranges employed in informed debate. To continue this, the UTF has decided that a limited peer review of certain aspects of the risk analysis be undertaken because of the complicatedness of the conversions from radon to WLM to millirems, and from millirems to risk. We are confident that this review will not alter appreciably the risks to health and that it will provide one additional assurance of the appropriateness of these conversions. That review will be available in time to be considered by those considering these issues next.

3. Risks of excess death do not include the risk to miners or other workers in the complex. These risks must be assessed by the Mining Safety and Health Administration. Our estimates go to the individuals and populations who are outside of the restricted area, with the exception of the Coles Hill House. Other sources of risk such as from asbestos type material have also not been assessed. Further study on this topic should occur in the future.

4. We also strongly recommend that the proposed performance standards for maximum dose, which we have spelled out elsewhere in this report, be adopted by statute so that they become legal maximums.

5. Calculated risk and the radiation dose leading to it should be approached as an hypothetical upper value. We recommend that the ALARA principle (as low as reasonably achievable) be vigorously followed in all aspects of the design, engineering, regulation and management of the facility if it is approved.

6. We are concerned that it may be even more difficult to forecast the impacts if additional mines or mine/mills might be erected in the immediate area of the Swanson tract. We have not been able to model any contributions of additional doses that might occur. The dispersion of radon is rapid, however, and it is reasonable to assume that additional mines or mines and mills would not violate any of the standards we propose. But an additional assessment should be conducted when and if additional mines are to be permitted.

7. The models we have run assume normal operating conditions, with the single exception of the mill pond breach. But even the mill pond breach is not what some call a "worst case analysis". It should be noted that the worst case potential of the Swanson site has not been fully evaluated and is difficult to assess. Of fifteen accidental releases in the U.S. of tailings slurry between 1959 and 1977 seven have been dam failures. (USGPO 1980). This included the Church Rock, New Mexico occurrence. The Swanson facility does not have a dam comparable to those which have broken elsewhere. The most likely catastrophe

would be some form of structural failure of the tailings pile itself. This possibility should be evaluated during the EIS stage under a worst case analysis.

8. The technique we have employed has the advantages of expert judgment and quantification, however, critics of the techniques we have employed call it "body count" analysis and maintain that the mathematical probability techniques, the computer models used, and the other techniques of conversion from dose to risk make it difficult for informed and intelligent laymen to evaluate it effectively. We agree but see no alternative to these methods for addressing the essential questions of risk in an objective fashion.

Some members of the UTF and of the broader public too, have expressed concerns about the potential hazards which do not seem justified on the basis of our consultants' reports. We do not consider the minimally projected numerical risks to be the only evidence that goes into an "assessment".

As SENES noted in its report to the UTF "the concept of acceptability is a key component in the study of risk. Being a personal and subjective matter acceptability is not directly measurable nor is it easily quantified."

We have also noted that the scientific literature on risk notes that perceptions of risk involve not only quantitative factors but also qualitative factors. (Perrow, 1984; Gertz, 1973; Lave, 1982)

Among the qualitative factors which seem to enter the public's assessment of risk are the following:

- o lack of control over the activity;
- o high catastrophic potential;
- o concern about the fairness of risks and benefits to specific groups, including future generations;
- o the belief that the risks would increase and would not be easily reduced;
- o fear of the unknown as opposed to the known risks;
- o the fear of unobservable risks and new, as opposed to familiar risks;
- o risks that are delayed in their manifestation.

From the point of some public officials and Virginia citizens, it is clear that a uranium development facility inherently has many of these more qualitative elements of risk. These elements of risk by their very nature cannot be quantified, they should, however, be taken into account by individual legislators in whatever fashion they deem appropriate.

## F. Costs and Benefits Analysis

The Tayloe Murphy Institute (TMI) cost-benefit study of the MUC proposal indicates that total economic benefits to the state of Virginia could range from \$119,186,000 to \$176,852,000 over the life of the project. Total costs, according to the study, could range from \$4,046,000 to \$5,611,000. Using the middle values of those two estimates, the benefit to cost ratio would be 26-1. The TMI study forecasts 468 jobs during the period of operations with direct annual employment benefits of \$6,117,228. To give a perspective on the value of these additional jobs the TMI study indicates that this addition is less than 1% of current levels within the regional study area. The TMI study notes that even with the range of costs and benefits they believe will be produced by the proposed project, they advise readers that the report is at this stage of rough feasibility gauging based on "incomplete and rough information and certain costs and benefits have not been quantified." Thus, as with the other consultant studies, the UTF has had to maintain a sense of perspective about the results.

The UTF has reviewed this report in detail and believes that the study represents a valuable economic evaluation. We also note that it is not inconsistent with the 1983 MUC economic analysis.

However, the UTF wishes the following points, issues and comments to be emphasized about cost-benefit methods generally and this study in particular.

1. The favorable ratio of economic benefits to costs must be kept in perspective. This ratio is not like a direct public investment which would have much higher costs that

would be balanced against benefits. The investment here is by a private firm, the costs to the state which are quantified are largely of a regulatory nature. The study might be better termed a cost-revenue analysis since many of the costs that might fall upon the environment, health, or because of consumer reactions have not been quantified.

2. We note that the TMI study does not specifically evaluate the compliance costs of particular performance standards which we have now proposed. The Task Force assumed that these costs to the industry for complying with proposed performance standards could be met and still provide a reasonable profit. The Task Force was not unaware or insensitive to the potential economic effects of proposed standards. Nevertheless we gave a higher value to preventing or minimizing health and environmental impacts than to the economic effects this might have on the applicant. We could not predict the profitability of the mine. We note that TMI similarly felt that profitability would be difficult to determine with or without regulatory cost calculations.

3. The TMI study assumes that the conditions of operation as specified by MUC would be realized if the mine opened. These are, in general, optimistic assumptions in light of the recent history of the U.S. uranium industry. This is unlike our risk analysis where we attempted to employ conservative or pessimistic estimates of actual conditions. The proposed operating period of 13 years, for example, might be lengthened depending on economic and other conditions. It is also possible that cyclical economic effects would produce layoffs of miners and other workers. It appears that the immediate costs of unemployment would be covered by insurance, but the fiscal effects could be a different matter.

4. The distributional effects of the mine and mill are not evaluated either for fairness or social desirability. For example many of the jobs and taxes will accrue to Pittsylvania County but some potential costs could fall to Halifax County which receives few tax benefits. Generally, however, it was assumed that the jobs created will fall to those who are currently unemployed.

5. Because of the corporate organization of MUC/Umetco and the way in which Virginia corporate income tax laws are applied, it was impossible for TMI to estimate the contribution of these taxes to the state. In the 1983 MUC study, it was assumed that \$20 million would be paid in state income taxes over the life of the project. However, the potential contribution is included as a range of estimates for the benefits of the project in the TMI study to reflect the condition of this level of revenue.

6. The regulatory costs which are analyzed by TMI in the

report include licensing, inspections and other activities for milling and tailings management. These are the costs that are associated with NRC agreement as reported in the 1983 Agreement/Nonagreement subcommittee study. The purpose of that study was to compare agreement and non-agreement costs without overlapping elements. The TMI report did not include the costs for regulating uranium mining activities which occur regardless of agreement status. In 1983, the Division of Mine Land Reclamation estimated a minimum staffing and funding requirement for a twelve month period of approximately \$370,000, of which \$177,000 is a one time cost (see Appendix G). These costs should be added to those reported in the TMI study to get a more accurate assessment of total regulatory costs. Some means to raise these funds is necessary but no particular recommendation is made by the TMI study. We note that their suggestion of combined licensing fees, other user fees and appropriations is reasonable. Perhaps some tax on uranium operations would be as equitable and efficient.

7. Costs and benefits are not distributed over the same time span. Nearly all the benefits of the project accrue over a 13 year operational period, but the risks and costs potentially continue for thousands of years. Careful negotiations are needed to assure that sufficient funds are available for decommissioning and long term surveillance. The TMI report comments upon the NRC maintenance fund requirements: "we think that the \$250,000 requirement would not provide sufficient income to cover surveillance costs." With Virginia in the position of being an agreement state, these fees could be specified by a legislative formula or by negotiations with the applicant based on more accurate estimates of risk and cost.

8. There is a special issue of perception involved in assessing the risks of facilities which involve radioactive releases. This may be unfair in some sense, but it does make it difficult to predict the impact of a facility on businesses which might consider locating in the area. The potential "perception" of the uranium complex on local agricultural products, industries and businesses seeking a location are difficult to judge. A limited survey of local people by TMI suggests that this perception is not evident among people there now. They report that "local businesses and institutions are generally not expecting adverse effects from the proposed mine and mill."

9. The environmental cost section is appropriately qualified in terms of the inability to develop dollar estimates for the most part. The subjective evaluation of risk that appears in the report is not contradicted by other studies the Task Force authorized but the reader is encouraged to review the technical memoranda that address those issues.

10. The Task Force does not endorse the concept of an economic analysis of excess deaths. Although this is common practice in economic cost/benefit studies, we do not believe these dollar values are particularly useful or pertinent to our judgment. Although implicitly human life must be valued in public decisions, we do not believe that economic quantification is a tool capable of evaluating these cost.

11. Neither do we endorse the use of the discounting technique which is suggested for evaluating remedial costs of any possible accident. This also involves the discounting of future lives. Generally, we have followed the principle that averting accidents through establishing stringent design and operating conditions is cheaper than remedial costs in economic terms. The environmental and psychological costs that are involved in accidents cannot be easily quantified or compensated.

The reader is urged to examine the complete cost/benefit study by TMI in order to appreciate both the substance of and the qualifications upon its conclusions.

## V. Recommended Concepts and Performance Standards

While the above reports were being prepared, the Task Force followed their progress and requested certain information along the way that would assist us in developing performance standards. The UTF itself undertook the task of developing performance standards and an administrative strategy that would minimize risks if uranium development were allowed to proceed in the state. The following are our recommendations.

### A. Agreement Status

The January 13, 1984, Resolution of the Coal and Energy Commission declared that "the recommendation that Virginia seek agreement status is persuasive and is tentatively endorsed by the Commission to the end that the State will be in a position to take primary responsibility for regulation of all aspects of a Uranium mine-mill-tailings complex in a comprehensive program tailored to Virginia's environment and demography." The resolution further directs that "the task force shall examine the scope of the agreement state program. . .and recommend the degree to which the Commonwealth shall seek to participate in the program and the appropriate lead or participating state agencies."

After early discussion within the Task Force and with the Uranium Administrative Group and the Uranium Subcommittee, it was decided that seeking agreement status with NRC, at least with respect to uranium milling and tailings management activities, would form an assumption upon which the other work of the Task Force would be based. While there may be economies of scale or other advantages from pursuing agreement status for all five NRC

categories, the Task Force felt this question of additional agreements for activities other than uranium regulation was best addressed by others if the Task Force was to complete its work in a timely fashion.

The Task Force now reaffirms and recommends that agreement status for the regulation of the mine-mill-tails complex be sought by the Commonwealth.

Steps necessary to becoming an agreement state can take from one to two years or possibly longer. As described in the 1983 Agreement/Non-agreement Subcommittee Report, these steps include:

- o certification by the Governor that the Commonwealth desires to take over regulation of the materials covered by the agreement and that the state has a radiation hazard control program adequate to protect public health and safety in connection with such material.
- o a finding by the NRC that the state program is adequate and "compatible with the Commission's program for such materials."

For NRC to make such a finding the Commonwealth would first need to:

- o adopt enabling legislation;
- o promulgate appropriate regulation; and
- o set up staff and facilities to operate the program.

NRC model documents provide guidelines for the types of provisions that are required to be contained generally in enabling legislation. The development of such legislation, however, is not directly a part of the Task Force charge. Simultaneous with the work of the Task Force, the Division of Legislative Service's staff and several legal advisors have been

working on legislative language. In carrying out the Task Force's charge to recommend performance standards, the Task Force has concluded that certain critical performance standards need to be established in legislation and not left to agency discretion. These provisions are needed to set the stage for promulgating regulations and to guide the particulars of negotiating agreement with NRC. Our recommendations for essential policies to be specified in legislation are presented in this report.

The Atomic Energy Act of 1954, as amended, requires that state agreement programs be both "compatible with" and "equivalent, to the extent practicable, or more stringent than" the appropriate NRC standards. The NRC indicates in a Statement of Policy (46 FR 59341) that radiation dose standards and effluent limits must be "essentially identical" to their own. The Task Force does not know whether there will be serious issues with the more stringent radiation protection standards that we are proposing to the legislature. Virginia is the first state to seek a limited agreement for milling and tailings regulation, exclusively. There is, apparently, no precedent with other agreement states for the more stringent radiation protection standards that we propose. It is the UTF's view based on discussions between the NRC legal staff and Institute for Environmental Negotiation, that the standards we seek should be proposed and pressed, if necessary, during the agreement negotiations with NRC. We feel that they are justified on the basis of minimizing risk to human health.

Although the Task Force reaffirms that agreement status has significant advantages for Virginia (e.g. agreement would allow the state to include radiation from mines as well as mills under one regulatory concept while NRC is not authorized to deal with radiation from mines), we have in the process also learned that a range of agreement formats can be developed through the negotiation process with NRC as long as they meet NRC's minimum standards. The following is the agreement/lead agency format that the Task Force recommends as being most appropriate for Virginia.

#### B. Administrative Strategy

In approaching the question of how best to organize the state's proposed regulation of the uranium industry several considerations were especially important.

First, because it is important that the uranium mine-mill-tails complex be dealt with as a complete unit, coordination among agencies and functions is of great significance. Through effective coordination applicants can also have confidence that unnecessary delays and/or conflicting requirements can be reduced. Responsiveness to citizen inquiries and concerns is also best achieved in a coordinated mode.

Second, building out from existing state agency capabilities and authorities is a way of producing a cost effective system. Since there is no way of knowing how many uranium mines or mine-mill-tails complexes will ultimately seek to develop in the state, it seems prudent that the government proceed incrementally rather than creating an elaborate new apparatus.

Third, since NRC expectations will be important considerations in agreement negotiation and ultimately in accepting or rejecting agreement with the state, these expectations must be taken into account. NRC's general expectation is that a state's health department would be the entity designated as that state's radiation control agency.

Finally, administrative arrangements should recognize that regulating the uranium industry involves several phases and that each phase calls for somewhat different capabilities. Five phases have been identified:

- o agreement negotiation
- o prelicensing study
- o licensing and permitting
- o monitoring and inspection
- o enforcement

The administrative strategy that the Task Force is recommending reflects the above considerations and especially the need for coordination throughout all five phases of activity.

The Task Force recommends that:

1. The Uranium Task Force with its familiarity with the subject of uranium, remain in existence and be involved as a working body throughout the phases of agreement negotiation, prelicensing study and licensing. We also recommend that the Director of the Council on the Environment be convenor for the group and provide necessary logistical staff support. The Uranium Task Force would act as the coordinating body through the various stages of review and regulation but at each stage one or more of the member agencies would be assigned responsibility for leadership on the substantive matters involved in a particular phase. The recommended assignments of responsibility are as follows.

## 2. Agreement Negotiation

The Virginia Department of Health (VDH) should be designated the "lead agency" for purposes of NRC agreement. As such, it will play a lead role in conducting the negotiations with NRC and will, eventually, issue the Source Material License. In this manner all aspects of radiation control including non-agreement related radiological concerns, such as radon releases from the mine, will be the responsibility of VDH as is consistent with Title 32.1.229 of the Virginia Code.

## 3. Prelicensing Study

This stage will be conducted in much the same manner that federal agencies conduct environmental impact statements under the National Environmental Policy Act including a full scoping and analysis of all relevant issues. The particulars of what is to be included and how the environmental evaluation will be conducted would be subject to negotiation with NRC during the agreement negotiation phase. It is recommended that the Council on the Environment play a leadership role in coordinating this phase. This is consistent with the existing functions of the Council and its staff. They will ensure that the impact analysis addresses all issues raised by regulatory agencies in relation to their permitting responsibilities, as well as those issues raised by the general public. The Council on the Environment would organize and chair meetings of the UTF agencies to scope and review the adequacy of the environmental studies.

## 4. Licensing and Permitting

It is the recommendation of the Task Force that each agency maintain existing permitting authority with regard to non-radiological environmental and health related concerns. In other words, SWCB would continue to issue NPDES permits, 401 certification and Discharge Certificates; the SAPCB would continue to be responsible for air pollution control permits and for fugitive dust; the Department of Mines, Minerals and Energy (DMLR and DMQ) a mining permit; etc.

As suggested above, the VDH would issue the Source Material License. In the case of a joint mine/mill complex or a single mill, this license will serve as the final approval and will be issued when and only when all other permits have been issued. In the case where a single mine is proposed, the DMLR mining permit, with the concurrence of VDH on radiological aspects and all other agencies on their areas of responsibility, will serve as the final review permit.

The Council on the Environment will coordinate the multiple permit review process scheduling joint hearings if appropriate, facilitating discussion among permitting agencies when required permit conditions conflict, and maintaining the momentum of the permitting process.

#### 5) Monitoring and Inspection

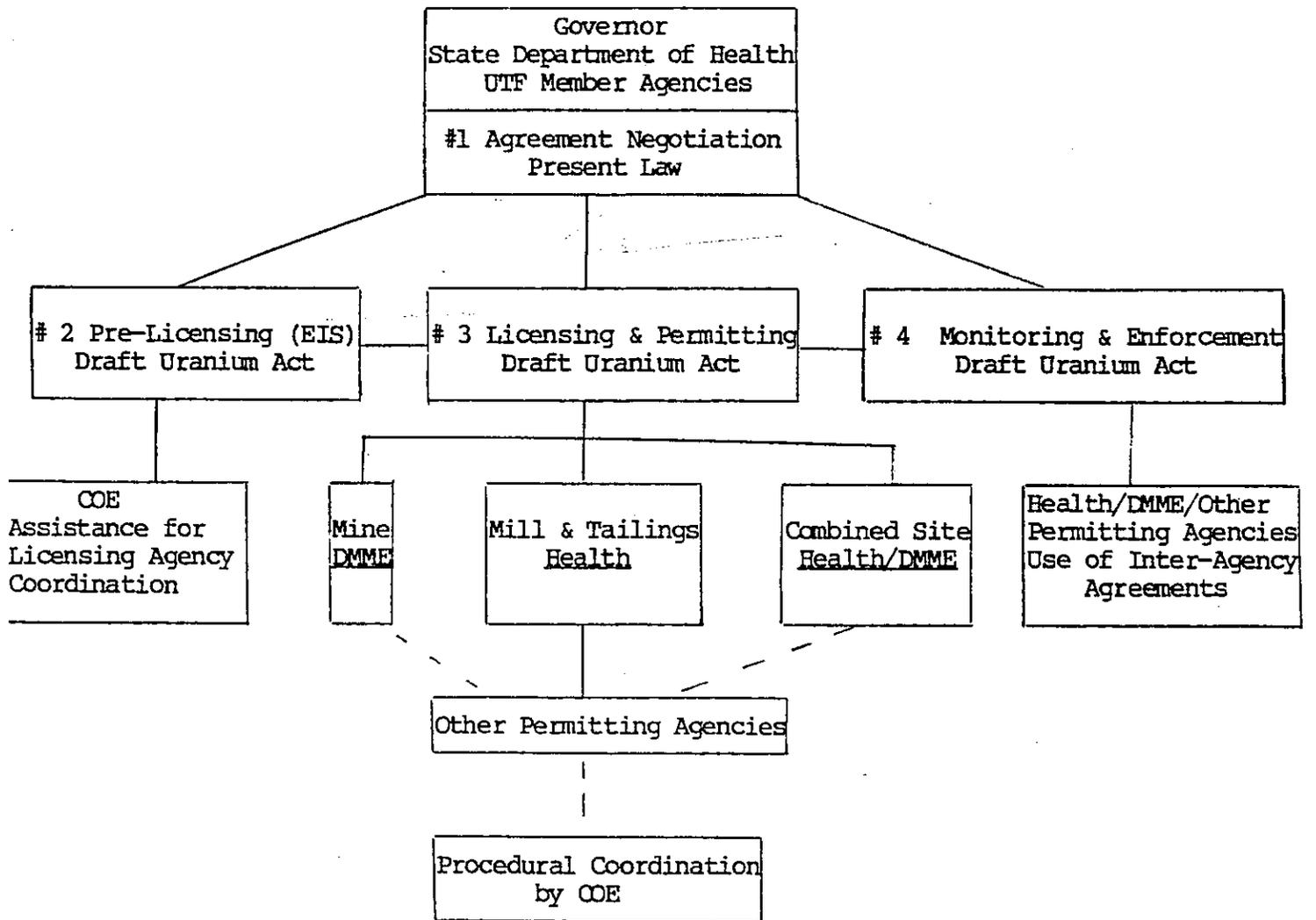
Each individual agency needs to be ultimately responsible for monitoring and inspections necessary to enforce their individually issued permits. However, the new Department of Mines, Minerals and Energy and more specifically, the Division of Mine Land Reclamation (DMLR) should serve as the lead coordinative agency during this phase. They will develop cooperative monitoring and inspection agreements with other agencies when it is appropriate and feasible to do so. As such DMLR will act as the "on-site/day-to-day" regulatory presence. These agreements will need to be fully delineated in memoranda of understanding between the relevant agencies.

#### 6) Enforcement

As with monitoring and inspection, each agency will ultimately be responsible for enforcing independently derived permit conditions. The DMLR will play the lead coordinative role in the sense that they will be doing so with regard to monitoring and inspection which will provide the information and data for enforcement action by other agencies. They will be a "referral" agency for data collected during the earlier monitoring and inspection stage and for public contact regarding complaints or suspected violations in the field. Furthermore, DMLR can be authorized to take certain immediate short term enforcement and remedial action in clearly defined emergency situations. Such situations and the range of appropriate actions would need to be developed in subsequent memoranda of understanding and regulations. These would be in addition to DMLR's own enforcement authority. DMLR's role would extend to long-term monitoring and necessary remedial actions after closure as well.

These recommendations depicted generally on Figure 1 represent an administrative strategy that is felt to be necessary if the legislature lifts the ban on uranium activity in the state.

**Figure 1**  
**Organizational Chart**



### C. Legislative Standards

The Task Force was charged by the Coal and Energy Commission with developing performance standards which, once the legislature approved an acceptable level of risk, would assure the safe conduct of uranium development in the state. The Task Force has been particularly aware of the considerable importance of this part of its charge. Appendix G contains minutes of the UTF meetings and memoranda from each agency, reflecting their concerns and recommendations in this area.

In reviewing potential performance standards, the Task Force has identified certain policies and standards which are of such significance that these are proposed for inclusion in legislation. These legislative standards are discussed here. Subsequent sections of the report address standards that should be developed and contained in regulations. Other standards, pursuant to these regulations, would be site specific and attached as conditions to a license or permit.

The following are recommended for establishment in legislation:

- 1) A total radiation dose standard for the general public of 25 millirem per year (mrem/yr) (whole body equivalent) above background for sources other than radon and a concentration standard of 1 picocurie per liter (pCi/l) for radon are recommended. Background levels and variability will need to be determined prior to mining and milling activity. Together these numbers represent a combined maximum dose of approximately 285 mrem/yr. The current federal standard is 500 mrem/yr. The proposed dose standard translates into an additional statistical risk of fatal cancer for an individual of 28.5 chances per million. It should be noted that the tentative design proposed by Marline/Umetco for the Swanson site has been evaluated to emit significantly less radiation than this maximum standard (16.4 mrem at the Coles Hill site and 7.8 mrem at the maximally exposed off-site location). It should

also be noted that the proposed state standard is more stringent with regard to radon release than current federal NRC specifications which allows up to 3 pCi/l. It is as a result of this, that the proposed state standard overall is more stringent (285 mrem/yr maximum) than the current federal standard(500 mrem/yr maximum).

2. It is recommended, in addition to the above numerical standards, that the legislature also specify that the ALARA principle (as low as reasonably achievable) be applied during permit review at a specific site in order to achieve doses less than the maximum allowable of 25 mrem/yr and 1 pCi/l. When significantly lower radiation levels are achievable-- such as would appear to be the case with the Marline/UMETCO tentative design proposed for the Swanson site--technologies to achieve reduced levels could be required.

3. It is also recommended that legislation specify that both the above numerical standards and the ALARA principle are to be applied to the sum of the radiation emissions from all components of a uranium mine-mill-tails complex. Current NRC authority does not include radiation from mines yet the analyses of the Swanson site show that the mine is the source of more than 90% of the radiation dose to some receptor locations. As Dr. Douglas Chambers of SENES Inc. has remarked, radiation does not know which part of the complex it has come from. He has recommended the inclusion of radiation from the mine within the state standard. From a uranium complex operator's standpoint there could also be an advantage from the all inclusive, or "bubble", approach recommended here. Within the "bubble" of the project area, the operator would have flexibility about balancing radiation from the mine or the mill or the tailings facility as long as the sum end result outside the "bubble" at the nearest residence was in compliance with state standards. As a next step, regulations and monitoring specifications need to be developed that deal not only with the mine-mill-tails complex but also with satellite mines and/or multiple complexes within an area.

In addition to the above dosage standards, the Task Force also recommends that two environmental based standards be set as state policy by the legislature. Because, (a) if Virginia were to have an operating uranium mine and mill, the state would be the first net precipitation state to do so, (b) because of the

importance of protecting the state's ground and surface waters, (c) because of the difficulty of early detection and later cost effective correction of degraded groundwaters, and (d) because there is no prior domestic experience with the type of uranium operation that is likely in Virginia's setting, it is recommended that protection of ground or surface waters be specifically addressed in legislation. It should also be noted that federal policies in this area are in flux and that if the state relied wholly on federal guidance, it is not clear what level of protection the state would be assured of.

4. The Task Force recommends that the legislature reaffirm the principle behind the state's current nondegradation policy and adopt into law a nondegradation of groundwater policy with respect to the uranium industry with its unique radiation and other characteristics and direct that this policy be applied strictly and without exception or variance. Although allowable under current law no other industry in the state has been granted a social and economic variance to the nondegradation policy and it is felt that such a strict application of the law is called for with regard to uranium expressly. The staff of the State Water Control Board has proposed language in its list of potential performance standards (see appendix G) intended to accomplish this:

"There shall be no degradation of groundwater or surface waters via groundwater from any portion of a uranium operation. Specifically there shall be no leakage, leaching or migration of contaminants from any uranium mining, milling or tailings operation such that the natural groundwater quality beneath any such operation is degraded to any level above the natural groundwater quality. There shall be no allowance for contaminating of up to the safe drinking water standard or any level of groundwater quality above natural quality."

This recommendation is made notwithstanding the results of the computer modelling techniques that were employed by Marline/Umetco and the state's consultants and which could be

interpreted to suggest that the health risks associated with the amount and type of seepage that the company proposed are minimal. It is felt that there is a sufficient lack of actual operating experience in a setting like Virginia's that this very cautious approach is called for and justified. While the federal approach goes in the direction of establishing which specific hazardous constituents would be controlled for non-degradation purposes, a consistent federal position has yet to be established or applied so that results can be judged.

The recommended strict non-degradation policy calls for a technology that would provide greater protection than that envisioned in the Swanson studies to date. One technology could be a double liner and leachate collection system which the Virginia Department of Health has called for in its proposed performance standards (see appendix G) and which is recommended below. Such a liner approach would likely be necessary both for the tailings pile itself and waste rock piles where the wastes have above threshold quantities of constituents like Radium 226. The EPA has recently (1983) proposed that subgrade ore/waste rock containing in excess of 5pCi/g be listed as "hazardous waste" under the Resource Conservation and Recovery Act and can be regulated as such. Reliance on such an approach, or some other effective technology, could achieve the recommended strict non-degradation of groundwater policy subject to further review by State Water Control Board staff. Because of uncertainty about whether the NRC will adopt the proposed EPA standards for hazardous waste land disposal facilities for uranium mill

tailings facilities, we recommend that the statute include the following provisions.

5. That the uranium tailings facility comply with the performance and design standards applicable to hazardous waste land disposal facilities. That the EPA recommended level of 5pCi/gram for Radium 226 be established as a threshold value for treating uranium waste rock piles as hazardous waste land disposal facilities as well. Pursuant to these proposed directives, the Director of the State Water Control Board and the Commissioner of Health would need to work closely on the matter of liner design, specifications and groundwater protection.

6. The Task Force recommends also that the legislature establish a strict prohibition of process water discharge from a uranium mill and/or tailings facility in order to protect the state's surface waters. The Swanson site proposal of Marline/Umetco envisions no process water from either the mill or tailings discharge. A closed recycling mill circuit along with tailings with a moisture content of 25% maximum by weight were proposed and accepted in the pathways analyses and the risk assessment conducted by the state. Since process water will contain significant levels of radionuclide and chemical contaminants it is important that the prohibition of their discharge be made explicit by the state. Federal policy allows a mill discharge under situations where precipitation exceeds evaporation. Such an exception is not occasioned in the dry climate of the western U.S. nor would it have particular significance if it did apply. However, in a climate like that in Virginia it is felt that such an exception is inappropriate.

7. In order to add necessary powers to regulate the uranium mine component of a mine-mill-tailings complex it is recommended that an explicit authority on uranium mining be adopted as part of a comprehensive statute on uranium mining, millings and tailings management activity.. Neither existing coal or minerals other than coal laws are adequate with respect to uranium. The coal mining law does contain many features, however, which could be usefully applied to uranium. A draft of such a law has been undertaken by the Division of Legislative Services which has been closely following the work of the Task Force. That draft law reflects many of the features of Virginia's coal mining law.

The above standards are aimed at protecting the health, safety and welfare of the citizens of the Commonwealth. To

assure that these standards are fully adequate to accomplish this purpose, it is essential that financial guarantees and/or penalties be required in the law as well as liability provisions to protect citizens from possible losses or damage.

8. To assure the Commonwealth that the handling of uranium tailings will be completed as envisioned in plans and permits, operations must be required to post financial guarantees for that purpose. In the event of a failure to complete the closure and decommissioning of the facility as planned, the state would have the resources to complete the task. NRC requires such guarantees, or surety funds, as should the state. While the procedures to be followed with respect to these surety funds need to be developed both during agreement negotiation and the promulgation of regulations, legislation is needed to make certain that this need is met. The Task Force recommends that legislation be explicit on this requirement.

9. To assure that state agencies have adequate enforcement leverage, the Task Force recommends that mandatory fines for violations be imposed and that legislation spell out that fines are mandatory. Staff of the State Water Control Board have proposed (see Appendix G) that "non-compliance with water quality standards, discharge limitations or other permit conditions shall be punishable by civil penalties of \$10,000 per day". Similar needs for enforcement capability have been expressed by other agencies.

10. While fines deal with immediate compliance concerns, in the long term funds must also be available to protect the public. Post closure monitoring and maintenance activity may run many years beyond the time when the uranium complex has ceased operation. The long half life of the radioactivity in the tailings means that long term care must be assured. NRC procedures at the present time call for a \$250,000 fund by the operation for this purpose. Legislation should establish the requirement for a fund with long term monitoring and maintenance as its purpose, but the state should further examine the dollar amount needed in such a fund as pointed out in the Tayloe Murphy Institute's cost/benefit study.

Since the uranium industry is new and has many unique characteristics that set it apart from other extractive

industries, special legislative treatment languages is in order with respect to liability for this industry.

11. The Task Force recommends that a strict liability approach for operators of uranium activities be taken by the state and that this be established by statute. Several state agencies (the DMLR, the Agriculture Department and the SWCB) have proposed performance standards that reflect this view (see appendix G). They address items such as damage or loss of crops or water. Since liability involves legal issues that go beyond the normal competence and charge of the state agencies represented on the Task Force, specific language is not suggested by the Task Force. It is the recommendation of the Task Force that strict liability provisions should be developed and incorporated in any statute considered by the state legislature as it judges whether or under what conditions to lift the current ban on uranium activity in the state. It is recommended that determination of liability be judged by the courts rather than administrative agencies with the possible exception of replacements for water supply sources.

#### D. Legislative Guidance for Subsequent Actions

##### 1. Regulations and Performance Standards

Several ingredients will be necessary to develop regulations pursuant to legislation that includes the provisions above. The NRC provides model regulations to states working toward agreement. NRC, in developing an agreement package with the state, will compare what is proposed to the model to determine equivalency. The provisions that Virginia's own agencies feel are especially significant also need to be included. The regulatory concepts put forward thus far by these state agencies should be viewed as an important and necessary beginning of a more fully developed regulatory program for the state. The state's consultant reports also need to be considered. Particularly noteworthy is that dosage and health risk conclusions are dependent upon the design and operational

procedures currently proposed by Marline/Umetco. The Rogers, Golden & Halpern report in particular outlines the features of the company proposal that are considered crucial to the results obtained. These kinds of features should be an essential component in a checklist of items to be included in future studies, regulations and licenses. The EIS, which NRC will expect this state to prepare for each license or significant modification thereto, will also yield site specific mitigation measures that would be included as permit or license conditions.

It would be appropriate for the legislature, following establishment of the broad but essential policies recommended above to request that the UTF continue through agreement negotiation, prelicensing study and the issuance of the state's first source material license. State agencies would develop and promulgate regulations taking into consideration the NRC model legislation, the input of the UTF member state agencies and the state consultants and to make provision for the preparation of an EIS for each license, permit, or significant modification thereof-either for a mine-mill-tails complex or for a satellite mine to an existing mill-tail facility. Changes as well as initial conditions should be addressed. For example, once a license/permit specifies that a particular mill process (i.e. alkaline) is to be used and environmental evaluations on that basis have been undertaken, a request to change the process to an acidic mill system would be a significant change requiring environmental reassessment and a different set of permit conditions. The details of such a system would need to be worked out during the development of

regulations and agreement negotiations pursuant to legislative direction to address this matter.

It would also be appropriate for the legislature to direct that an application, environmental impact review, inspection, surety and long-term maintainance fee schedule be developed which will result in fees not less than those charged in connection with NRC licensing and not more than the costs to the state of the particular activity.

## 2. Recommended Appropriation

In order to develop and promulgate regulations for the uranium industry and to negotiate agreement with NRC, additional funds will be necessary during 1985 and during the 1986-1988 biennium. In the interim, any funds remaining from this year's activity could be reassigned for purposes of initiating NRC agreement negotiation. These monies will go for additional required equipment and/or staff and to retain experts to advise state agencies during agreement negotiation and during the development and promulgation of regulations. Initially the heaviest burden will fall on the Health Department though each other UTF member agency will also be involved in the regulatory agreement development process. In the longer term where attention shifts to monitoring and long term surveillance, the DMME would carry the greatest load. Specific requests and justifications by each agency will occur during the states normal budgeting and review process. It should be emphasized that, while funds for new programs are scarce, underfunding of the state regulatory effort could undermine estimates of risk which assume an active and vigilant role by state regulatory agencies.

## VI. Options Considered but not Recommended

In arriving at the above recommendations the Uranium Task Force considered or identified a variety of options which were not chosen. The following section briefly outlines these options and comments upon them.

### A. Non-Agreement Status

Non-agreement, wherein the NRC would issue the source material license, was seen as having one significant advantage. A more experienced entity would deal with the complex subjects involved in uranium activity and the state would not need to devote its energies or funds to this task. The disadvantage would be that the proposed more stringent state standard could not be established and more importantly, consideration of radiation from the mine would be handled in a fragmented regulatory scheme. Other procedures and practices tailored to the state would also be less easily implemented.

Hybrid schemes such as concurrent authority or memoranda of agreement are potentially more complicated with the possibility that measures would be unpredictable and/or inconsistent over several national administrations.

### B. Administrative Strategy

A single agency with sole authority to conduct all phases of regulating the uranium industry is a possibility which is appealing because it achieves maximum coordination. The need for such a superagency or uranium czar, however, is not apparent unless NRC later finds the state's proposed scheme unacceptable or unless a large number of uranium operations appeared in the state in the future. If a single authority were deemed

necessary, the Governor or Secretary of Commerce and Resources could designate a high level person to oversee the administrative arrangements recommended by the Task Force without altering its other important features.

#### C. Health Standards

Standards more restrictive than the 25mrem/yr and 1 pCi/l recommended could be set with correspondingly lower risks than those proposed. Alternatively, the existing federal standards could be maintained. See the risk assessment part of this report (Table 3) for the relation between alternate dose levels and risks.

#### D. Limit Area Where Uranium Mining Would Be Allowed

We believe that Virginia must assume that proposals for uranium development might emerge from other parts of the state if the moratorium on mining is lifted. If this should occur, and there is physical evidence that potentially exploitable deposits of uranium exist elsewhere, then the powers of agencies and/or local government to prohibit this development, if it is felt to be inappropriate, need clarification. Some have suggested that state legislative approval should be required for any uranium development outside of Pittsylvania County, if it is approved anywhere. Existing coal mining legislation has provisions for the DMME to declare particular areas "unsuitable" for mining under certain conditions. Some feel that local governments should have the local option to permit or not permit uranium development.

We offer no specific recommendation beyond noting that the Division of Legislative Services draft bill includes language on an "unsuitability" requirement.

#### E. Further Study

On a topic as complex as uranium mining there is always room to study the matter further. In fact, further studies will be required of Marline/Umetco in preparation for and during the licensing phase if the state allows their application to go forward. The state could wait for the results of further liner studies and more specific tailings facility designs with alternate technologies, for instance, as a base for its legislative decision. Some additional costs would be associated with such a delay which might be offset by the more specific knowledge that would be gained. Some may feel that additional study is worthwhile, but the Task Force members feel that adequate information is available to support a legislative determination to lift, or not to lift the moratorium on uranium mining. Additional studies or technical analyses will provide little critical information for this type of decision.

Another potential benefit of delay could be that NRC/EPA positions and standards would become clarified or that new technology would develop during this period. A more certain world market for uranium might develop and the U.S. import restrictions debates might have concluded in the future.

#### F. Non-approval of Uranium in Virginia

If Virginia gives the go ahead to uranium mining and a mine-mill-tail complex goes into operation, it will be the first eastern state to do so. Virginia could decide not to lift the

current ban. Various technical, economic, political and/or philisophical bases might be cited by opponents not withstanding the risk assessment and cost/benefit studies completed this year and the propsed performance standards and administrative strategy for managing risks.

## **VII. Appendices**

### **Explanatory Note**

The appendices listed below served as the background information and rationale for the decisions and recommendations made in this report. Several of these appendices, with the exception of Appendix G, have been distributed to members of the US/UAG and the general public at previous meetings. Therefore, they have not been attached to the report as it will be distributed on October 1, 1984. They will, however, be available from the Division of Legislative Services, Richmond, Virginia. Appendix G has been attached. To obtain copies of the remaining appendices please contact:

Dr. Bernard Caton  
Division of Legislative Services  
General Assembly Bldg., 2nd Floor  
P.O. Box 3-AG  
Richmond, VA 23208  
(804) 786-3591

The following is a listing and brief description of what is included in each of the appendices.

**A. Risk Assessment** -- Includes the complete report from SENES Consultants, Ltd. which presents an evaluation of the potential radiological risks associated with uranium development at the proposed Swanson facility in Pittsylvania County, Virginia.

**B. Cost-Benefit Analysis** -- Includes the complete report from the Tayloe Murphy Institute, University of Virginia which presents an evaluation of the quantifiable economic costs and benefits associated with the proposed Swanson facility in Pittsylvania County, Virginia.

**C. Review of the Marline/Umetco Technical Summary --**

Includes the full report from Rogers, Golden and Halpern covering topics included in Appendices E and D, as well as a complete review of the PABLM computer model input parameters utilized in the 1984 pathway analyses and an overall review of the Marline/Umetco Technical Summary.

**D. Evaluation of Clays --** Includes a report and a literature review conducted by Dr. J.C. Parker and others at the Virginia Polytechnic Institute and University as well as memoranda on this subject from RG&H and SENES Ltd. Certain sections of the RG&H "Review of the Marline/Umetco Technical Summary and Supporting Memoranda" should be consulted for additional information. In addition, Technical Memoranda Numbers 1,2,3,6 and 10 of the MUC Technical Summary should also be consulted.

**E. Ore and Waste Rock Analysis --** Includes reports from Stanley S. Johnson, Chief Geologist, Division of Mineral Resources describing the protocol and the results of ore and waste rock analyses. It also includes Memoranda from Rogers, Golden and Halpern on these analyses. The Marline Technical Summary and 1984 Supplement should also be reviewed for information on this subject, specifically Technical Memoranda Number 9. In addition, Technical Memoranda Number 4 describes the techniques and results of the leachability tests referred to in section IV.B. of this report.

**F. 1983 Report of the Agreement--Nonagreement**

**Subcommittee of the UAG --** Includes the complete report of this subcommittee which addresses the various agreement and non-agreement options with the Nuclear Regulatory Commission for state participation in the regulation of uranium mill and tailings management facilities. This report also includes estimated cost figures associated with the agreement option.

Appendix G may be obtained from Bernard Caton (see p. 61 for address).