ORNL/SUB--80/40430/5

DE85 005594

REVIEW AND EVALUATION OF NASAP PROLIFERATION ASSESSMENT ACTIVITIES

FINAL REPORT

January 9, 1981

J. E. Hammelman
D. A. Outlaw

Prepared by

Science Applications, Inc.
1710 Goodridge Drive
McLean, Virginia 22102

Under Contract Number ORNL-40X-40430C

Prepared for

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

Operated by

Union Carbide Corporation

For the

U.S. Department of Energy

Contract: W-7405-eng-26

DISCLAIMER

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

Assessing proliferation resistance of nuclear power alternatives was central to the Nonproliferation Alternative System Assessment Program (NASAP). Assessment efforts were made by several organizations associated with NASAP. These efforts produced papers and documents which assisted the NASAP program understand the many facets of the proliferation problem and carry out its responsibilities of providing R&D guidance.

This report briefly reviews these papers to document the chronology of the process, to observe the evolution of the assessment effort and to identify additional efforts which might be appropriate even though NASAP is complete.

II. OVERVIEW

There were nine major papers or documents prepared for the NASAP proliferation assessment effort. These were prepared by personnel from five organizations and spanned a three-year time frame. The efforts produced proliferation resistance attributes, proliferation resistance methodologies and proliferation resistance design criteria and overall proliferation resistance judgments. The organizations preparing the papers or documents and the timing are presented in Figure 1. The figure shows the more concentrated effort in 1977 with continued effort through 1980. The following paragraphs will briefly discuss each of these efforts in chronological order using the codes (ANL-1, DOE-1, etc.) established in Figure 1.

It should be noted that other efforts of proliferation resistance evaluation were performed outside the program and are not discussed in this paper. These outside efforts were examined by NASAP for useful concepts and data. When any were found, they were incorporated into the NASAP effort.

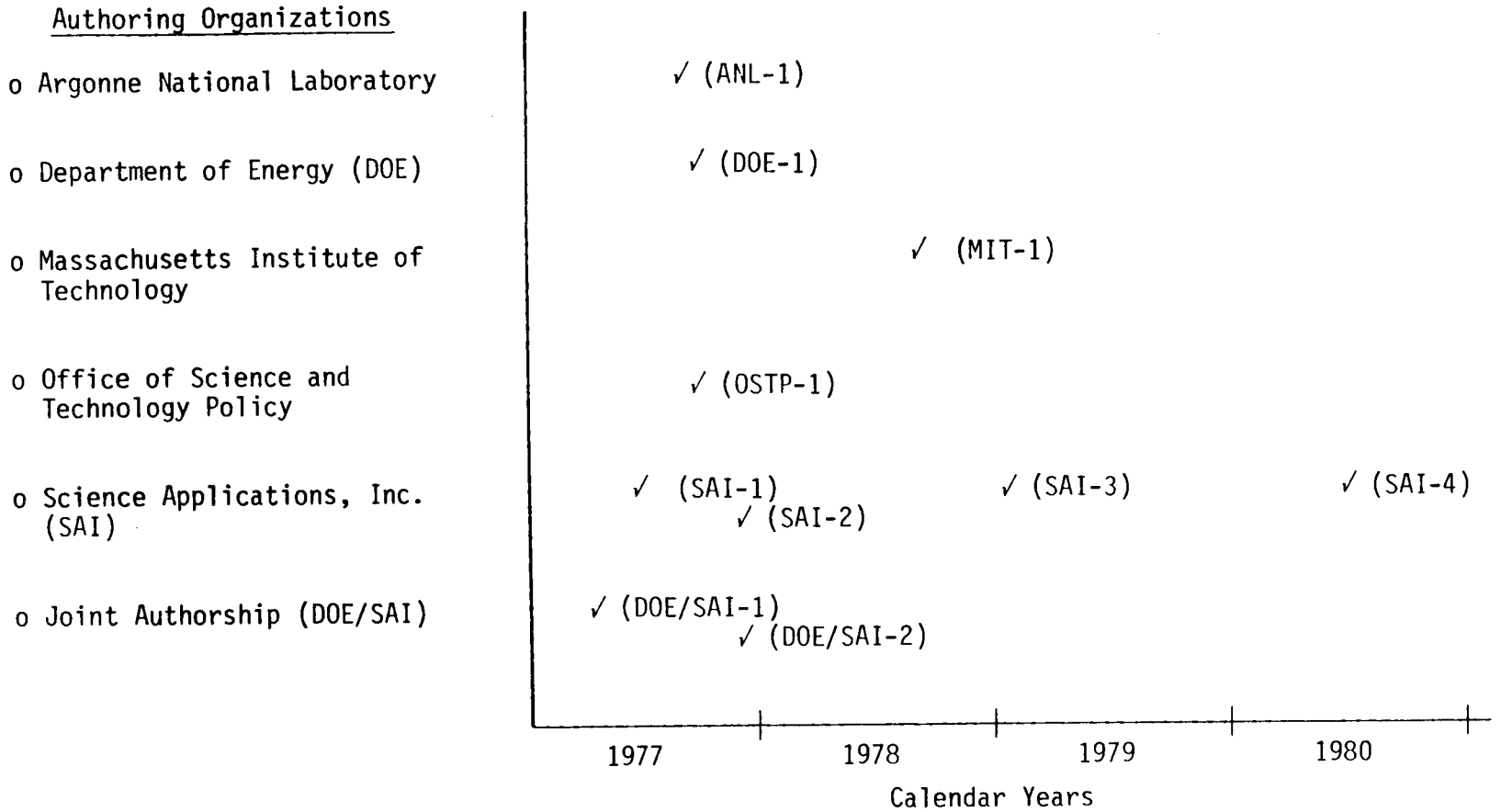

Figure 1

Chronological Order of Various Proliferation Resistance Efforts.

III. REVIEW OF PROLIFERATION RESISTANCE EVALUATION EFFORT

This section provides a brief review of the papers and documents prepared for the NASAP proliferation resistance evaluation effort. The review is presented in the chronological order of the papers and serves to illustrate two major facts:

1. The assessment effort evolved from an analytical nature to a more useful subjective nature built on the concensus of a broad-based advisory group.

2. Spin-offs from the assessment effort provided subsystem design guidance and overall proliferation management guidelines.

DOE/SAI-1

This early 1977 effort was the first proliferation resistance methodology and utilized the quantitative analytical concepts of the Department of Energy's (DOE) Nuclear Energy Assessments Office along with the input data estimates and calculational support of Science Applications, Inc. (SAI). The approach, called Charm, assigned empirical values to assessment factors and combined the factors in a formula to give an overall risk index. This work was useful in demonstrating that (1) some relevant factors were missing from methodology and (2) a quantitative analytical method which relied on necessarily subjective or uncertain input data would be difficult to use successfully in the proliferation resistance evaluation effort. It led to an acknowledgement of shortcomings of numerical analytical methods which later effort attempted to address.

SAI-1

The second major effort at proliferation resistance methodology development was presented by Science Applications, Inc., in a June 15, 1977, report. It recognized and accounted for the shortcomings of the first assessment effort (DOE/SAI-1) by establishing a more complete list of proliferation resistance indicators or factors. While it did not provide a rigorous method for combining the factors into a single index, the effort was still targeted toward a final product of fuel cycle rank ordering. As such it was backing

away from the quantitative analysis goal of the first proliferation evaluation effort, but still hoped to find a method for rank-ordering alternatives.

ANL-1

A proliferation resistance assessment by Arnonne National Laboratory was presented in July of 1977. The effort did not follow the analytical path of previous efforts but used a basic assumption that "fuel reprocessing, when done exclusively in internationally safeguarded sites, presents no incremental proliferation risk compared to the once-through fuel cycle." This assumption led to conclusions which detailed how internationally managed and controlled sites might carry out the activities of fuel recycling and uranium enrichment. Material which left the site and had chemically separable fissile material would be protected by radiation barriers of 1000 rem/hr at 1 meter.

Some problems existed with the effort and as a result they were not fully accepted. The major problems were:

1. They did not address R&D facilities or operations, a major area of proliferation concern.

2. They relied heavily on the successful international management and control of sensitive facilities. In fact, this is expected to be difficult to achieve because sovereign nations will not place themselves in positions which reduce future options without significant short term gains. Furthermore, by relying on institutional measures for control of sensitive technologies, no discrimination among the fuel cycle technical alternatives was made. Therefore all technologies were felt to be equally acceptable.

3. They arrived at their judgment without any rigorous identification or analysis of technical and political variables.

This effort acknowledged the subjectivity of the proliferation resistance analysis and therefore went immediately to the author's perception of the answer. Its major shortcoming was that its answer did not have a properly based concensus.

OSTP-1

A report by the Office of Science and Technology Policy grouped reactor systems into different categories with apparent nonproliferation similarities. It developed four categories, these being briefly

1. Systems which are most ideal from a nonproliferation viewpoint such as the molten salt reactor

2. Systems which involve current types of technology such as the LWR-OT

3. Systems which involve proliferation barriers adequate to require construction of new reactor, reprocessing or enrichment facilities

4. Systems which place reliance on institutional barriers and therefore could cover any technology.

This approach also bypassed the analytical effort and went directly to personal perception for grouping of fuel cycle systems. Like the ANL effort, it did not provide an identification and analysis of technical and political factors which supported its judgments about grouping into proliferation resistant categories. Its judgment was too narrowly based in just OSTP.

DOE-1

A draft DOE paper dated August 31, 1977, examined facets of the proliferation problem. It looked at (1) general actions to reduce the attractiveness of proliferation effort, (2) the use of benchmarks for judging fuel cycle alternatives, (3) institutional arrangements to increase the difficulty of a proliferation effort, and (4) actions to reduce the fuel cycle vulnerability to terrorism.

The report explicitly concluded that the area of proliferation resistance assessment required the use of subjective factors and consequently any conclusions would be subjective. It recommended that an interagency working group be assembled to discuss proliferation resistance and develop, if possible, a concensus on the topic.

SAI-2

This was an attempt in November of 1977 at modification of the June 1977 methodology for the evaluation of proliferation resistance. The report reidentified parameters or factors which were to be used for proliferation resistance assessment but further backed away from the goal of providing a final rank ordering of fuel cycle alternatives. These factors did, however, provide the basis for the assessments sponsored by NASAP, and for the U.S. contribution to the INFCE working groups.

DOE/SAI-2

This effort built upon the previous assessment in that it used the established assessment factors but it went further and attempted to draw conclusions or make assessments. It also suggested design approaches which would result in more proliferation resistant systems. The exact impact of these design approaches on the overall system proliferation resistance was unknown but the effect was felt to be positive, i.e., implementing these approaches would increase proliferation resistance. This paper was important because it showed that a concensus was building for the assessment factors, it suggested the types of systems that were acceptable and it also started to make definitive statements about methods to increase the proliferation resistance of nuclear fuel cycles.

MIT-1

Graduate students and the faculty of Massachusetts Institute of Technology prepared a methodology for assessing proliferation resistance of alternative fuel cycles in September, 1978. The attributes of cost, weapon development time, inherent difficulty, weapons material and warning time were combined using the principles of Multiattribute Decision Analysis to produce the methodology.

The use of this methodology outside this study was not extensive because it required subjective judgments and therefore rendered the results uncertain and suspect. It appeared to demonstrate conclusively that quantitative methods could not be exactly applied to the proliferation resistance assessment problem.

SAI-3

Another effort was presented by SAI in the early part of 1979. This paper carried further the design guidance started in DOE/SAI-2. It presented guidance on spiking and suggested that if spiking is to be used it should be $\sim$10 R/hr at 1 meter in order to require remote processing and $\sim$2500 R/hr at 1 meter in order to deter material theft.

This effort was an assessment spin-off and was significant in that it pointed out a way to improve proliferation resistance. Rather than addressing

the larger problem of system proliferation resistance assessment, this effort selected a specific characteristic of a subsystem and set specific performance standards relative to the characteristic. This was one of the few such subsystem development or design requirements established by NASAP. This approach, if implemented, would be effective in lowering proliferation resistance of future nuclear energy options.

SAI-4

The last effort in the proliferation resistance area was completed by SAI in June of 1980. This paper addressed the overall issue of dealing with proliferation threats and actions. It provided an organization for dealing with the many technical and institutional issues associated with proliferation. It, like the previous SAI paper, was a spin-off from the assessment effort. It drew on the assessment to identify the types of action which could be done to help manage the proliferation problem and then worked to place them in a larger structure.

This completes the review of the various assessment-related papers and documents prepared for NASAP. It shows the evolution that occurred from a more analytical approach to a more subjective approach. It also shows the development of spin-off activities which are useful beyond the immediate assessment needs of NASAP.

IV. CONCLUSIONS

Based on the review of the history of proliferation resistance assessment and related efforts, two conclusions appear appropriate.

1. The evolution of the evaluation effort to find the limits of analytical ability was necessary. The fact that it did evolve testifies to the serious and dedicated effort which was made by program participants. A similar evolution should be expected for other complex political-technical analytical problems.

2. The spin-offs, design criteria and overall proliferation risk management approach are useful even after the completion of NASAP. They are aids in dealing with a real problem of proliferation resistance even though the problem may not lend itself to complete quantification. If any future work is to be done in the area of proliferation resistance, it should be focused on these areas.