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DOE-RGL-77-004

17 February 78

(Revised)

MANAGEMENT PLAN
Risk-Analysis Methodology
Contract EC-77-C-03-1470

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Prepared for
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Office of Conservation
Department of Energy

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I. PROJECT OBJECTIVES

The ultimate objective of this contract (project) is to devise risk analysis methodology for inclusion in the Threshold Screening Model used by the Buildings and Community Systems Division for the purpose of evaluating projects which are candidates for funding by that division.

The contract includes a review of the pertinent literature, discussions with individuals in industry, development of evaluation criteria, development and test of alternative approaches, evaluation of results, and preparation of a final report.

The key schedule objective is the development of a computerized methodology, including a user's manual by mid-April 1978, with a final report assessing the overall results by early August, 1978. The detailed schedule is provided in section V.

The cost objectives are two-fold. First, the cost objective for these contract efforts are \$37,316 (not including fee). Second, key criteria in the selection of risk analysis methodology are the long run costs of computer usage and data acquisition.

II. MANAGEMENT STRUCTURE

This project is under the technical control of the Buildings and Community Systems Division, with Dr. Joan Hock as the Technical Monitor. Contract administration is the responsibility of the San Francisco Operation. In addition, technical discussions are expected to be conducted with other individuals within the Department of Energy, both at Headquarters and several DOE National Laboratories (particularly Brookhaven and Oak Ridge).

Within DYNATREND, the effort is under the overall direction of the Energy and Transportation Systems Directorate, headed by Mr. A. J. Gravallese, Vice President. The Project Manager is Mr. Robert Roblin supported by Mr. Khalatbari and Mrs. Purcell, within the Energy and Transportation Systems Directorate. Mr. LePage, Manager of the Management Planning and Analysis Department within the Technical Operations Directorate, serves in a technical advisory role; other members of the professional staff within the company are also available for specific task assignments. Mr. John Gillies, Manager of Contracts, serves as the single point of contact for contract administration within DYNATREND. In the conduct of these efforts, close liaison will be maintained with the Threshold Screening Model efforts also being conducted by DYNATREND; Mr. Roblin is also the Project Manager for those efforts.

The interfaces and relationships between the organizations and individuals identified above are portrayed in Figure 1. There are several points which should be emphasized regarding Figure 1. First, DYNATREND employs the single point-of-contact approach for management communication between DOE and the company. Mr. Gillies is the sole authority for interfacing with the contracting officer, Mr. Tomihiro. Mr. Roblin is the single point of contact for technical matters, and interfaces with the DOE counterpart, Dr. Hock. Second, all contact with other individuals within DOE and DYNATREND will be arranged through the single points of contact for each organization.

III. TECHNICAL APPROACH

This section provides a definitive discussion of the technical approach which will be used in accomplishing the seven tasks identified in the Statement of Work. Detailed schedules are provided in Section V.

FIGURE 1. ORGANIZATIONAL RELATIONSHIPS

a. Task I - Detailed Program Plan

This Management Plan constitutes the output of Task I. An earlier version was submitted informally to Dr. Hock in early November 1977. Since that time, there have been certain clarifications and changes in direction which resulted in an approach which is somewhat modified from that contained in the initial submittal. These changes occurred as a consequence of the preliminary results of the literature survey and interviews with selected individuals at several firms in the private sector, as presented in a management meeting at DOE on 13 December 1977, and subsequent discussions with Dr. Hock.

Briefly, the literature review indicated that there did not exist a readily available model or novel methodology which could be adopted by DOE/BCS to assess the risk(s) associated with the wide range (scope technology, applications, and development/marketing organizations) of individual RDD projects or portfolio(s) of projects. The initial discussions with knowledgeable individuals in the private sector indicated that quantitative risk analysis modelling was generally used only to supplement management judgement and qualitative analysis; that there were no generally accepted risk parameters even within a single company; that each investment project candidate was evaluated separately using factors unique to its particular circumstance; and that in-house computerized models were generally considered proprietary and would not be made available to DOE since the models constituted what could be considered a "competitive edge". Since these attitudes were prevalent even in reasonably cooperative individuals, it was felt that further discussions with the private sector would not yield directly useful results and, hence, were not warranted. As a consequence of the above, it was agreed to place emphasis on the evaluation and test of commercially available risk analysis models, of the Monte Carlo type.

This plan, therefore, will therefore place primary emphasis on the work remaining to be done, with a brief description of the effort accomplished to date.

b. Task II - Review of Existing Risk Analysis Practices

The purpose of this task is to take advantage of prior efforts in the development of risk analysis methodologies from a theoretical point of view and to identify the practices and attitudes of the private sector in implementing risk analysis procedures. There are two principal benefits to this task. One is to assure that all available methodologies are considered. The other is to assure that the methodologies ultimately selected for use by BCS are compatible with the practices of the private sector.

This task is subdivided into three subtasks, each of which is described below.

- (1) Literature Review - Keyword computer searches from several data bases were conducted, resulting in the identification of several hundred reports. Based on the abstracts provided, about one hundred of the most relevant reports were reviewed in detail. In addition, a manual search of relevant professional journals was conducted. About fifty additional journal articles were identified and reviewed in detail. The literature review focused on both the theoretical aspects of risk analysis mathematical modeling and the practices of industry and government in applying risk analysis techniques.

The results of the literature review will be provided in the formal report for Task II.

- (2) Interviews and Discussions. - A list of twenty candidate individuals within the private sector was identified. Several of these individuals were contacted and interviews conducted at Dupont, Imperial Chemical, and General Foods. The agenda and lists of questions are provided in Figures 2 and 3. As previously noted, the initial interviews were not encouraging, and further efforts in this direction were curtailed.
- (3) Preparation of Task II Report - The results of the literature search and interviews will be documented in a formal report, which will present a balanced assessment of the state of the art of risk analysis methodology and its implementation by the private sector. The report will be submitted in late February, 1978.

c. Task III - Selection of Sample Projects

The purpose of this task is to select cases from those existing in the BCS portfolio of candidate projects for use in testing potential risk analysis methodologies, including data collection techniques. The contract statement of work requires that at least ten cases be selected; however, due to a shortage of funds, less than ten cases may be selected.

Close coordination with Dr. Hock will be effected in the selection of the sample cases. Emphasis will be placed on selecting projects (cases) for which data is likely to be easily made available and the contractor cooperative.

Also required in this task is the definition of the data requirements for each methodology. These requirements will be identified by a special data input form, which will include explicit instructions to assist in the completion of the form. Meetings will be held with DOE/BCS project managers to explain the objectives and procedures to be used. Follow-up assistance on a one-on-one basis will be provided.

Risk Analysis Methodology Interviews

1. Nature of investments on which risk analysis is used.
 - a. Size of investment
 - b. Type
 - New Plant/Equipment
 - Product R&D
 - Cost-saving (such as energy saving)
2. Evaluation Criteria used
 - a. Rate of Return
 - b. Payback
 - c. Net Present Value
 - d. Other(s)
3. Models Used
 - a. Stochastic simulation
 - b. Three point estimates
 - pessimistic
 - most likely
 - optimistic
 - c. Other(s)
 - d. Related models
4. Data sources
 - a. Costs
 - b. Market penetration
5. Special Issues
 - a. Use of existing assets
 - full
 - partial (incremental)
 - b. Organizational participation

FIGURE 2. AGENDA

1. Under what circumstances is risk analysis conducted? Does this vary with the size or nature of the investment?
2. What are the principal investment criteria used and why? Are there fixed screening (threshold) values? How are projects ranked?
3. What mathematical techniques are used?
4. What are the most important variables in the analysis?
5. How are market penetration forecasts developed? How accurate have they been? How are competitor reactions factored in?
6. How are non-incremental investments handled (i.e., use of existing assets for another product)?
7. How are development costs and time handled?
8. How are risk results (probability distributions) used in selecting the annual investment portfolio?
9. How are exogenous factors identified and evaluated? (Examples, formation of OPEC cartel, government regulation, etc.)
10. How are future energy prices taken into account?
11. How are risk results validated/verified?
12. How is data collected?
13. Which stage of the investment receives the greatest emphasis and care?
 - R&D cost/time
 - Production costs
 - Pricing/market penetration
14. Is the return in the user investment in your product a factor in the analysis? in the market penetration forecast?
15. To what extent are sensitivity analyses conducted and how are the results used?

FIGURE 3. DETAILED INTERVIEW QUESTIONS

d. Task IV - Risk Analysis Methodology Evaluation Criteria

The purpose of this task is to develop criteria by which candidate risk analysis methodologies may be evaluated.

A preliminary set of evaluation criteria has been developed and is presented in Figure 4. These criteria will be further definitized and modified as the study progresses. The definitized draft criteria will be formally submitted to DOE for review; suggested changes will be incorporated and a final set of evaluation criteria published.

In addition to the evaluation criteria per se, the procedure to be used in conducting the evaluation will be documented. This procedure will identify the specific steps to be taken and the sequence of their performance. Of particular importance, the means of collecting evaluation data (such as computer costs) for each candidate methodology will be identified.

e. Task V - Development of Risk Analysis Models

The purpose of this task is to define, program (in FORTRAN IV) and debug risk analysis models consistent with the existing BCS Threshold Evaluation System.

The single point estimates currently used in the Threshold/Screening Model do not provide a means of defining risk, at least in terms of the potential probability distribution of screening criteria results. However, the existing system does provide a baseline for comparison of other methodologies in terms of computer, data acquisition and other resource costs.

- Required Data Volume
- Computer Costs
- Compatibility with BCS Threshold Model
- Compatibility with wide range, nature of BCS projects
- Useability for sensitivity analyses without requiring additional input data
- Accuracy of results
- Identification of major components of risk results
- Ease of understanding by laymen
 - model
 - Results
- Compatibility with portfolio analysis and project funding decision process

FIGURE 4. PRELIMINARY RISK ANALYSIS METHODOLOGY
EVALUATION CRITERIA

DYNATREND intends to place a subcontract with ECON, Inc., in support of this task, as well as Tasks VI and VII. ECON will assist in the identification and evaluation of three commercially available risk analysis models of the Monte Carlo type, including one developed by that firm. The subcontractor will provide descriptive material on each of the three models, such material to include summaries of input data requirements, model characteristics and features, and output reports. Data will also be provided on other pertinent parameters such as applicable computer type, running time and operating and acquisition costs in compliance with GSA TSP regulations for the acquisition of computer software, and the identification of the typical users and applications for each candidate software package.

The relative merits of each commercial package will be compared and discussed with the DOE Technical Monitor, and the most suitable model selected. The subcontractor will then support DYNATREND in the development of suitable modifications to enable computation of risk profiles and parameters consistent with those employed in the Threshold/Screening Model; specifically, the following are required:

1. Twenty-five year time horizon (to year 2000).
2. Computation of aggregate energy savings in physical (BTU) and dollar units versus time, discounted at 10% and undiscounted, using energy price scenarios for gas, oil, coal and electricity supplied by DYNATREND.
3. Computation of the five threshold screening* criteria in the following forms:
 - a. Mean
 - b. Standard deviation
 - c. 90% confidence interval
 - d. Distribution, cumulated at 10% intervals or less
 - e. Probability that variable will $\geq$ cutoff value.

* The threshold screening criterial includes the following items:

- a. IRR to user (consumer) based on 1978 energy prices
- b. Payback period to user based on 1978 energy prices
- c. NPV (aggregate energy savings) -
NPV (Federal investment)
- d. NPV (aggregate energy savings) - NPV (Federal
and private RDD investment)
- e. NPV (accelerated aggregate energy savings) -
NPV (Federal RDD investment)

NOTES: (1) Items (a) and (b) include consideration of depreciation tax shield for commercial user, but not residential; (2) NPV uses 10% discount rate.

- 4. Federal and private RDD funding and private investment in plant/equipment/working capital must be kept separate.

Under another contract, DYNATREND has modified the existing Threshold/ Screening Model to incorporate a Monte Carlo capability based on use of the beta distribution. The modified model uses the primary computational algorithm of the existing model to compute the values of the project screening criteria for each sample. However, the Monte Carlo model includes the capability of defining a beta distribution using three point estimates provided for each variable. Each beta distribution is then randomly sampled to determine the value to be used by the computation of the screening criteria value for each run,

using the existing algorithm. The Monte Carlo version includes the following features:

- Stochastic development times and correlated development dollars. Development times includes fractions of a year. (The existing model can only use integer values).
- Adjustment of market penetration (units in use) as a function of RDD development time, including interpolation for fractional years.
- Adjustment of market penetration values for variations in ROI to the hardware user, computed on the basis of the random values generated from sampling the beta distributions for each variable used to compute ROI. The adjustment is linearly proportional to the ratio of the random sample based value to the ROI value obtained using the nominal (most likely) value used in the Threshold/Screening Model.
- Report containing risk profile for each screening criteria as well as summary statistics (mean, standard deviation, and probability out-off value will be exceeded).

The model is limited to consideration of "new" technology projects only, since it was developed on a "proof of concept" basis. However, extension of the model to include "substitute" technology and to incorporate the remainder of the existing model would not be a major effort. (It is noted that the Monte Carlo version of the existing Threshold/Screening Model was developed and tested on DYNATREND's in-house mini-computer, and, was, therefore, constrained to machine limitations which are not applicable to the existing system.)

f. Task VI - Risk Analysis Methodology Evaluation

Using the data for the projects gathered under Task III, the candidate models (one commercial and the Monte Carlo version of the existing Threshold/Screening Model) developed in Task V will be evaluated. Statistics will be gathered for each of the evaluation criteria developed in Task IV. The results will be analyzed using a comparative matrix approach. One issue requiring clarification is whether weighting factors ought to be applied to each evaluation criterion in order to arrive at a single "number" for each of the candidate risk analysis methodologies; this issue will be discussed with DOE/BCS.

The results of the evaluation will be discussed with DOE/BCS representatives in an informal briefing, to develop a firm consensus regarding the best methodology to adopt for use by BCS.

g. Task VII - Preparation of Final Report

This task will document the entire study, including a summary of data reported independently (such as the Task II, III, and IV reports). The final report will describe the methodology used, present all significant results, and present the findings and recommendations. All input data and detailed results will be provided in appendix form in a separate volume.

The report will be oriented toward a lay audience and will include substantial use of graphic presentation material to supplement the text. An executive summary will be provided. If desired, a formal presentation of results will be made.

h. Technical Reviews

Technical reviews will be conducted at approximately monthly intervals, or as requested by the DOE/BCS Technical Monitor. Technical direction received during such reviews will be documented in conference records.

IV. WORK BREAKDOWN STRUCTURE (WBS)

The project summary WBS is not applicable. The contract WBS is provided in Figure 5, and is used as the basis for management planning and control.

V. MANAGEMENT CONTROL

The general management approach and control procedures have been thoroughly discussed in the Management Plan for operation of the DOE/BCS Threshold Screening Model (DYNATREND number DOE-RAR-77-009 dated 4 Nov 77) submitted under contract EC-77-C-03-1469. Therefore, this section will present only those items which differ.

a. Contract Schedule and Major Milestones

Figure 6 identifies the current schedule and major contract milestones. Several of the initial milestones are late, due to personnel turnover problems and a study re-assessment conducted in the December-January time frame. The schedule of Figure 6 includes the revised plan resulting from the study reassessment and represents a high confidence approach to meeting the contract objectives within the allotted time.

FIGURE 5. CONTRACT WORK BREAKDOWN STRUCTURE

FIGURE 6. MILESTONE SCHEDULE

b. Contract Costs

The expenditure plan associated with the schedule of Figure 6 is presented in Figure 7. Both incremental and cumulative costs are presented, with the former in italics. All costs are fully loaded with overhead and G&A, but not fee. Actuals through the end of December are provided.

c. Reporting Requirements

All reports required by contract are identified in the schedule of Figure 6. To enable close coupling of work performance with actual costs incurred, it is proposed to submit monthly reports ten days after the dates shown in the head of the columns in Figure 7, which are consistent with DYNATREND accounting periods.

All reports submitted will comply with the format requirements established by DOE.

d. Project Status Reviews

Informal project status reviews will be conducted at approximately monthly intervals, or as required by the DOE/BCS Technical Monitor. Internal project status reviews are conducted bi-weekly between the project manager and his supervisor, with formal review by senior management personnel conducted no less than quarterly.

VI. GOVERNMENT-OWNED PROPERTY, FACILITIES AND MATERIAL

DYNATREND will utilize data processing services provided by Litton Computer Services under direct contract with DOE. No other GFE is expected.

TASK	Actuals as of 1-1-78	Jan '78 1-29-78	Feb '78 2-27-78	Mar '78 4-3-78	Apr '78 5-1-78	May '78 5-29-78	TOTAL
I. Program Mgt Plan	\$ 1,744						\$ 1,744
II. Literature Review	7,844						7,844
III. Sample Project Selection, Data Collection	1,684		770	730			3,184
IV. Evaluation Criteria	1,629						1,629
V. Model Development	8,331	504	3,000	4,000			15,835
VI. Model Evaluation					4,000	2,500	6,500
VII. Final Report						580	580
TOTALS	21,232	504	3,770	4,730	4,000	3,080	\$37,316

FIGURE 7. TIME-PHASED BUDGET

VII. TEST PLAN

Not applicable.

VIII. SECURITY PLAN

Not applicable.

IX. OTHER PERTINENT PLANS, SYSTEMS, AND PROCEDURES

Not Applicable.