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

OCT 10 1991

MEMORANDUM TO: File

FROM: Philip M. Altomare
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: SYSTEMS ENGINEERING AND SYSTEMATIC REGULATORY ANALYSIS TRAINING MATERIALS

Enclosed for the file record are the primary documents used in the following training:

1. Systems Engineering Training,

   Course Presented by G. P. Jones, Ph.D. and P. C. Gardiner, Ph.D., University of Southern California,

   Course given on February 13 and 14, and on May 22 and 23, 1991, at the NRC Headquarters Office;

2. Systematic Regulatory Analysis Training,

   Course presented by T. Romine and P. Mackin, Center for Nuclear Waste Regulatory Analyses;

   Management course review presented on June 5 and 6, 1991;

   Staff training conducted on June 18 and 19, 1991.

Sign-in sheets and attendance lists for these training sessions are also enclosed.

Philip M. Altomare
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated on the shelf

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cc on shelf

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NAME:PAltomare/cr	:JHolonich	:	:	:	:
Date:10/16/91	:10/16/91	:	:	:	:

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Attendees List

SYSTEMS ENGINEERING TRAINING
February 13 and 14, 1991

NRC

Phil Altomare
Bernard M. Bordenick
John Bradbury
David Brooks
Pauline Brooks
John T. Buckley
Joe Bunting
Donald L. Chery
David M. Dancer
Mark Delligatti
Daniel Fehringer
William Ford
Shirley Fortuna
Dinesh Gupta
Kenneth Kalman
Keith McConnell
Mysore Nataraja
Robert Neel
Jeffrey Pohle
King Stablein
Barbara Stiltenpole
Naiem Tanious
John S. Trapp
Tilak R. Verma
Rick Weller
Rex Wescott
Marian Zobler

CNWRA

Pat LaPlante
Ted Romine

Presentation by G.P. Jones, Ph.D. and P.C. Gardiner, Ph.D.

ENCLOSURE

Attendees List

SYSTEMS ENGINEERING TRAINING
May 22 and 23

NRC

Tae Ahn
Ron Ballard
Bill Belke
Robert Carlson
Richard Codell
Neil Coleman
Jim Conway
Norman Eisenberg
Joe Holonich
Kenneth Hooks
Charles Interrante
Patty Jehle
Robert Johnson
Philip S. Justus
Janet Kotra
Harold Lafevre
Michael Lee
John Linehan
Donald J. Loosley
James Park
Jerry Pearing
John Peshel
August Spector

CNWRA

John Latz
Pat Macklin
Ted Romine
Steve Spector
Gerry Stirwalt

Presentation by G.P. Jones, Ph. D. and P.C. Gardiner, Ph. D.

Attendees List

SYSTEMATIC REGULATORY ANALYSIS MANAGEMENT REVIEW
June 5 and 6, 1991

NRC	CNWRA
Phil Altomare	John Latz
Ron Ballard	Wes Patrick
Dave Brooks	J. Russell
Seth Coplan	A. Chawdry
Joe Holonich	P. Nair
Robert Johnson	S. Spector
John Linehan	R. Johnson
Joe Youngblood	
Jerome Pearring	
Shirley Fortuna	
Stu Treby	
Janice Moore	

Presentation by Pat Mackin, CNWRA.

Attendees List

SYSTEMATIC REGULATORY ANALYSIS STAFF TRAINING
June 18, 1991

NRC

Tae Ahn
Bill Belke
Pauline Brooks
Richard Codell
Neil Coleman
Julia Corrado
David Dancer
William H. Ford
Kenneth Hooks
Philip Justus
Ken Kalman
Michael Lee
Harold Lefevre
Mysore Nataraja
Robert G. Neel
Jerome Pearring
Naiem Tanious
John Trapp
Rex Wescott

CNWRA

Patrick LaPlante
Mike Miklas, Jr.
Chuck Schoepe
G.L. Stirwalt
Gordon Wittmeyer

Presentation by Pat Mackin, CNWRA and Ted Romine, CNWRA.

Attendees List

SYSTEMATIC REGULATORY ANALYSIS STAFF TRAINING
COMPLIANCE DETERMINATION STRATEGY SPECIFIC
June 19, 1991

NRC	CNWRA
Tae Ahn	Mike Miklass, Jr.
Pauline Brooks	Chuck Schoepe
Neil Coleman	G.L. Stirwalt
David Dancer	Gordon Wittmeyer
Ken Kalman	
Michael Lee	
Harold Lefevre	
Mysore Natarja	
Robert Neel	
Jerry Pearring	
Naiem Tenious	
John Trapp	
Joe Youngblood	

Presentation by Ted Romine, CNWRA and Pat Mackin, CNWRA.

DRAFT GUIDANCE FOR

CDS TYPE SELECTION

DRAFT

GUIDANCE FOR SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY) FOR A REGULATORY REQUIREMENT (APRIL 26, 1991, DRAFT)

A. PURPOSE

This guidance is for evaluating Regulatory Requirements (RRs) to select the appropriate type of License Application (LA) review strategy for the Yucca Mountain site. The type of LA review strategy is also referred to as the type of Compliance Determination Strategy (CDS). The type of CDS selected will be used in the future to guide the preparation of the CDS and associated compliance determination methods (CDMs), which taken together will comprise the LA Review Plan.

The type of CDS selected is considered an initial selection and will be updated periodically as new information and understanding are obtained. This initial selection relies primarily on the experience and judgment of those making the selection. These initial judgments eventually should be supplemented by results of iterative performance assessments.

B. STEPS FOR SELECTING THE TYPE OF LA REVIEW STRATEGY

1. Assign selection team of NRC and CNWRA staff for subject area to be evaluated (e.g., subjects of three examples).

2. Identify Regulatory Requirements (RRs) for subject area to be evaluated.

3. Read selection guidance and complete selection training.

4. Obtain and become generally familiar, as needed, with background information pertinent to the RR.

5. Evaluate RR using the selection criteria and use the results to select type of review (i.e., type of CDS). Document the selection and rationale on an evaluation/selection worksheet (see Appendix A). A rationale should only be given for the high risk and highest risk RRs since the rationales for the other types are more clear cut and defined in some cases. For these, identify the key adverse effects and key technical uncertainties that are the reason for the risk of non-compliance.

6. Based on the evaluation/selection worksheets prepare the following tables:

List of key adverse effects on compliance
List of key technical uncertainties
List of type of review (i.e., type of CDS) for each RR

7. Conduct an integration review of all the worksheets and tables, revise accordingly, and document completion of review. This review should focus on resolving inconsistencies among the worksheets and tables. This includes a check for the use of a consistent set of key adverse effects and key technical uncertainties. Furthermore, related RRs should have the same set of key adverse effects and key technical uncertainties.

8. Conduct a technical review of the results, revise accordingly, and document completion of the review on the worksheet.

9. Prepare a report including a summary of the selection method, summary of selection results, the tables from step 6, and the evaluation/selection worksheets.

10. Conduct a management review of the report, revise accordingly, and document completion of review by concurrence.

C. RESPONSIBILITY

1. Selection Group

The Selection Group will be made up of appropriate NRC technical staff, CNWRA technical advisors, and an NRC Project Manager. The Selection Group is responsible for preparing for and conducting the selection activities in steps 2, 3, 4, 5, 7 and supporting as needed steps 6, 8, 9, and 10. The NRC Project Manager is not responsible for managing the individuals, but for setting up and coordinating meetings, facilitating all steps, and conducting steps 6 and 9.

2. HLWM Section Leaders

The HLWM Section Leaders are responsible for conducting the technical review in step 8 and provide support as needed.

3. HLWM Division Directors and Branch Chiefs

The HLWM Division Directors and Branch Chiefs are responsible for assigning the NRC staff who will participate in the selection group(s). They are also responsible for the management review of the report in step 10.

4. CNWRA

As appropriate, CNWRA management will assign CNWRA advisors to the Selection Group(s). The CNWRA will conduct a technical review/comment of the worksheets and tables in support of step 8 in parallel with the HLWM Section Leader review. The CNWRA management will also conduct a review in parallel with the HLWM Division Director and Branch Chief review conducted in accordance with step 10.

D. BACKGROUND INFORMATION

Selection group members should be generally familiar with the relevant sections of the following documents:

1. CNWRA RR/REOP report
2. Statement of considerations for 10 CFR Part 60
3. Rationale and staff analysis of comments on proposed rule 10 CFR Part 60, NUREG-0804
4. DOE's Site Characterization Plan (licensing strategies to resolve issues in ch. 8)
5. NRC staff's Site Characterization Analysis
6. Key site-specific topics listed under each review guide in the NRC staff's SCP Review Plan
7. Identified regulatory and institutional uncertainties in CNWRA 90-003 and SECY-90-207, Enclosure 5
8. Technical position topics listed in Enclosure 8 of SECY-88-285
9. Issued staff technical positions and staff positions
10. Major issues at the Yucca Mountain site listed in SECY-87-137.
11. Others identified by selection group

E. SELECTION CRITERIA

Criteria to select the appropriate type of LA review (i.e., type of CDS) for each RR are listed on Table 1 and described below. The corresponding type of review is named in parenthesis and described in section F.

1. LA RELATED (ACCEPTANCE REVIEW)

These are RRs for which DOE must demonstrate compliance with in its LA or RRs which directly affect the content or submittal of the LA. These are also the RRs that would be addressed in the staff's compliance review of the LA and for which findings will be made in the staff's Safety Evaluation Report. Appendix B identifies the LA related RRs consistent with the draft LA Format and Content Regulatory Guide. This list should be used in evaluating the RRs for this criterion.

Excluded from this type would be RRs not related to the LA, whether DOE RRs (e.g., Site Characterization Plan requirements in 10 CFR 60.16 and 10 CFR 60.17), NRC RRs (e.g., review of site characterization activities in 10 CFR 60.18 and construction authorization in 10 CFR 60.31), or other procedural RRs (e.g., participation of State governments and Indian Tribes in 10 CFR 60 Subpart C.)

2. LA PROCEDURAL RELATED (PROCEDURAL REVIEW)

These are RRs related to the LA but only procedural in nature, i.e., not related to radiological safety or waste isolation (e.g., filing LA in 10 CFR 60.22 or LA completeness requirement in 10 CFR 60.24 (a)).

3. RADIOLOGICAL SAFETY OR WASTE ISOLATION RELATED (SAFETY REVIEW)

These are RRs for which compliance is necessary to make a safety determination for construction authorization as defined in 10 CFR 60.31. These include those RRs which embody Subparts E, G, H, and I as well as 10 CRF 60.21 which address descriptions of the repository required in 10 CFR 60.31.

4. HIGH POTENTIAL RISK OF NON-COMPLIANCE (DETAILED SAFETY REVIEW AND COMPARISON TO CONFIRMATIORY ANALYSES)

These RRs are the subset of all the Safety or Waste Isolation Related RRs for which there is a high potential risk of non-compliance with the accompanying potential for non-compliance with one or more of the performance objectives in 10 CRF 60.111, 112, or 113.

The high potential risk of non-compliance comes from the existence of either key adverse effects or key technical uncertainties.

Key adverse effects are those site conditions (e.g., some potentially adverse conditions from 10 CFR 60.122), repository induced conditions (e.g., thermomechanical effects), human activities, or site characterization activities (e.g., penetrations of Calico Hills) that could be so adverse that they are judged to pose a high potential risk of non-compliance.

Similarily, key technical uncertainties are those technical uncertainties that could be so significant that they are judged to pose a high potential risk of non-compliance. Technical uncertainties exist where there is lack of certitude as to how to demonstrate compliance. Appendix C further discusses technical uncertainties and gives examples of the types of technical uncertainties.

5. HIGHEST POTENTIAL RISK OF NON-COMPLIANCE (COMPARISON TO INDEPENDENT CONFIRMATORY ANALYSES AND TESTS)

These RRs, a subset of the RRs that pose a high potential risk of non-compliance, pose the highest potential risk because the risk is judged to be the most difficult to reduce. Therefore, there might be a high residual risk of non-compliance because very little can be done to reduce the risk, or compensate for the risk using, for example, favorable site conditions or engineered features.

F. TYPES OF LA REVIEW

1. ACCEPTANCE REVIEW

This review is to determine if the LA is complete and acceptable for docketing the LA and conducting the compliance review in an effective and timely manner. This is not a review to determine adequacy.

2. PROCEDURAL REVIEW

This review is for adequacy of the compliance demonstrations of the procedural requirement in the LA.

3. SAFETY REVIEW

This review is for the determination of the adequacy of the compliance demonstrations and associated system descriptions in the LA. The focus of this review is primarily on the LA itself, although some references might also be reviewed if they contain essential compliance demonstration information. Generally, however, the detailed information supporting the compliance demonstrations in the LA references will not be the focus of this level of review.

4. DETAILED SAFETY REVIEW AND COMPARISON TO CONFIRMATORY ANALYSES

This review is an expansion or extension of the safety review in that it is a detailed review of the adequacy of selected detailed information supporting the compliance demonstration in the LA (i.e.,"vertical slice" reviews of information). Specifically, detailed reviews would focus on the level(s) of detail appropriate for the assessment of the key adverse effect or key technical uncertainty and how the key adverse effect and key technical uncertainty are reduced, compensated for or remedied.

The detailed safety review should be supplemented, as needed, by comparing some LA analyses to analyses conducted by the staff of specific key adverse effects or key technical uncertainties. Such confirmatory analyses might range from simple calculations to complex numerical models. However, in any case, these methods

would not be developed by the staff. Instead, the staff would use methods developed by DOE or other parties that have been reviewed and found acceptable by the staff. While this type of strategy requires the staff to obtain and become proficient in using a particular method, it does not require the extensive resources needed if the staff were to develop its own independent method.

5. COMPARISON TO INDEPENDENT CONFIRMATORY ANALYSES AND TESTS

This type of review further supplements the detailed safety review by comparing some of the LA analyses to analyses conducted by the staff using methods independently developed by the staff. Such confirmatory analyses could focus on all or a part of a specific key adverse effect or key technical uncertainty.

This type of review might also further supplement the detailed safety review by confirming some of the LA data or descriptions of conditions or processes by comparing to data collected by the staff or the understanding of conditions and processes obtained by the staffs own investigations (e.g., results of Research program). It should be emphasized, however, that data collected by the staff or analyses conducted by the staff are for confirmatory purposes and are not a substitute for data or analyses that DOE should be providing to support its compliance demonstration in the LA.

G. DOCUMENTATION

The following documents will be prepared:

1. Evaluation/selection worksheets (see Appendix D for examples)

2. List of key adverse effects on compliance

3. List of key technical uncertainties

4. List of RRs and related types of review

5. Report giving results

TABLE 1: TYPES OF LA REVIEW STRATEGIES AND CORRESPONDING SELECTION CRITERIA TO APPLY TO REGULATORY REQUIREMENTS

TYPE OF LA REVIEW (TYPE OF CDS)	SELECTION CRITERIA
Acceptance Review (1)	LA Related
Compliance Review	
Procedural Review (2)	LA Procedural Related
Safety Review (3)	Radiological Safety or Waste Isolation Related
Detailed Safety Review & Comparison to Confirmatory Analyses (4)	High Potential Risk of Non-compliance *
Comparison to Independent Confirmatory Analyses and Tests (5)	Highest Potential Risk of Non-compliance--most difficult to reduce risk or highest residual risk

* The existence of either adverse effects (site related, repository related, human activity related or site characterization activity related) or technical uncertainties that are judged to pose high potential risks of non-compliance with one or more of the performance objectives. Because of their significance to performance these are refered to as key adverse effects and key technical uncertainties.

APPENDIX A

WORKSHEET FOR EVALUATING AND SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY)

RR PASS ID NUMBER:

RR TOPIC:

PRIMARY 10 CFR PART 60 CITATION:

DATE SELECTION/INTEGRATION COMPLETED:

DATE TECHNICAL REVIEW AND REVISION COMPLETED:

SELECTION GROUP MEMBERS:

TECHNICAL REVIEWERS:

EVALUATION/SELECTION

Answer each of the following questions and select the applicable type of LA review.

Selection Criteria		Applicable Type of Review
1. Is the RR LA related?	Yes	Acceptance Review, go to 2
	No	No LA review
2. Is the RR LA procedural related?	Yes	Procedural Review
	No	Go to 3
3. Is the RR radiological safety or waste isolation related?	Yes	Safety Review, go to 4
	No	Stop
4. Is there a high potentail risk of non-compliance with RRT and one or more performance objectives?	Yes	Detailed Safety Review and Comparison to Confirmatory Analyses, go to 5
	No	Safety Review

5. Is there the highest potential risk of non-compliance with RRT and one or more performance objectives	Yes	Comparison to Independent Confirmatory Analyses and Tests
	No	Detailed Safety Review

List type(s) of selected LA reviews:

RATIONALE AND REFERENCES

Give the key adverse effects or key technical uncertainties which were the reason for the RR to be a high or highest risk of non-compliance. Include title, description, justification, and references.

APPEN X B

LA RELATED RRs (*)

PASSID	CITATION	PRIMARY	TOPIC
*RR0001	10CFR60 131 (b) (1)	Y	Important to Safety - Natural Phenomena and Environmental Conditions
	10CFR60 130	N	Important to Safety - Natural Phenomena and Environmental Conditions
*RR0002	10CFR60 111 (b) (1)	Y	Retrievability of Waste
	10CFR60 111 (b) (3)	N	Retrievability of Waste
	10CFR60 46 (a)	N	Retrievability of Waste
	10CFR60 46 (a) (1)	N	Retrievability of Waste
	10CFR60 131 (b) (7)	N	Retrievability of Waste
	10CFR60 131 (b) (10) *	N	Retrievability of Waste
	10CFR60 132 (a)	N	Retrievability of Waste
	10CFR60 133 (c)	N	Retrievability of Waste
	10CFR60 133 (e) (1)	N	Retrievability of Waste
	10CFR60 133 (i)	N	Retrievability of Waste
	10CFR60 135 (b) *	N	Retrievability of Waste
	10CFR60 111 (a)	N	Retrievability of Waste
*RR0003	10CFR60 133 (e) *	Y	Design for Safe Underground Operations and Rock Movement
	10CFR60 130	N	Design for Safe Underground Operations and Rock Movement
	10CFR60 131 (b) (9)	N	Design for Safe Underground Operations and Rock Movement
	30CFR Chapter I Subchapter D	N	Design for Safe Underground Operations and Rock Movement
	30CFR Chapter I Subchapter E	N	Design for Safe Underground Operations and Rock Movement
	30CFR Chapter I Subchapter N	N	Design for Safe Underground Operations and Rock Movement
*RR0004	10CFR60 111 (a)	Y	Radiation Exposures and Releases
	10CFR60 130	N	Radiation Exposures and Releases
	10CFR60 131 (a) *	N	Radiation Exposures and Releases
	10CFR60 131 (b) (1)	N	Radiation Exposures and Releases
	10CFR60 131 (b) (2)	N	Radiation Exposures and Releases
	10CFR60 131 (b) (3) *	N	Radiation Exposures and Releases
	10CFR60 131 (b) (4) *	N	Radiation Exposures and Releases
	10CFR60 131 (b) (5) *	N	Radiation Exposures and Releases
	10CFR60 131 (b) (6)	N	Radiation Exposures and Releases
	10CFR60 131 (b) (7)	N	Radiation Exposures and Releases
	10CFR60 132 *	N	Radiation Exposures and Releases
	10CFR60 133 (a) (1)	N	Radiation Exposures and Releases
	10CFR60 133 (c)	N	Radiation Exposures and Releases
	10CFR60 133 (g)	N	Radiation Exposures and Releases
	10CFR60 133 (g) (1)	N	Radiation Exposures and Releases
	10CFR60 133 (g) (3)	N	Radiation Exposures and Releases
	40CFR191 03 (a) *	N	Radiation Exposures and Releases
	10CFR20 1 (c)	N	Radiation Exposures and Releases
	10CFR20 105 (a)	N	Radiation Exposures and Releases
	10CFR20 105 (b) *	N	Radiation Exposures and Releases
	10CFR20 106 (a)	N	Radiation Exposures and Releases
	10CFR20 106 (e)	N	Radiation Exposures and Releases
	10CFR20 Appendix B	N	Radiation Exposures and Releases
*RR0034	10CFR60 130	Y	Design Bases Consistent With Site Characterization
*RR0035	10CFR60 131 (a) *	Y	Radiological Protection
	10CFR60 130	N	Radiological Protection
	10CFR60 131 (b) (1)	N	Radiological Protection
	10CFR60 131 (b) (2)	N	Radiological Protection
	10CFR60 131 (b) (3) *	N	Radiological Protection
	10CFR60 131 (b) (4) *	N	Radiological Protection
	10CFR60 131 (b) (5) *	N	Radiological Protection
	10CFR60 131 (b) (6)	N	Radiological Protection
	10CFR60 131 (b) (7)	N	Radiological Protection

PASSID	CITATION	PRIMARY	TOPIC
* RR0035	10CFR60 132 *	N	Radiological Protection
	10CFR60 133 (a) (1)	N	Radiological Protection
	10CFR60 133 (c)	N	Radiological Protection
	10CFR60 133 (g)	N	Radiological Protection
	10CFR60 133 (g) (1)	N	Radiological Protection
	10CFR60 133 (g) (3)	N	Radiological Protection
	10CFR60 111 (a)	N	Radiological Protection
	10CFR20 101 (a)	N	Radiological Protection
	10CFR20 103 *	N	Radiological Protection
	10CFR20 APPENDIX B	N	Radiological Protection
* RR0037	10CFR60 131 (b) (2)	Y	Important to Safety - Dynamic Effects
	10CFR60 130	N	Important to Safety - Dynamic Effects
	10CFR60 133 (a) (2)	N	Important to Safety - Dynamic Effects
	10CFR60 133 (e) (2)	N	Important to Safety - Dynamic Effects
RR0050	10CFR60 15 *	Y	Site Characterization Program
	42USC 10133 (c) (2) *	N	Site Characterization Program
RR0052	10CFR60 16	Y	Site Characterization Plan
	10CFR60 17 *	N	Site Characterization Plan
	10CFR60 23	N	Site Characterization Plan
	42USC 10132 (a)	N	Site Characterization Plan
	10CFR60 18 (e)	N	Site Characterization Plan
RR0054	10CFR60 18 (g)	Y	Site characterization semiannual reports and onsite inspections
	10CFR60 18 (h)	Y	Site characterization semiannual reports and onsite inspections
* RR0055	10CFR60 121 (a) *	Y	Land Ownership and Control
* RR0056	10CFR60 121 (b)	Y	Water Rights and Controls Outside the Controlled Area
	10CFR60 121 (c) *	Y	Water Rights and Controls Outside the Controlled Area
	10CFR60 43 (b) (5)	N	Water Rights and Controls Outside the Controlled Area
	10CFR60 46 (a) (3)	N	Water Rights and Controls Outside the Controlled Area
RR0063	10CFR60 33 (a)	Y	Amendment of the Construction Authorization
	10CFR60 22 *	N	Amendment of the Construction Authorization
	10CFR60 32 (d) (1)	N	Amendment of the Construction Authorization
	10CFR60 21 (a)	N	Amendment of the Construction Authorization
	10CFR60 24 *	N	Amendment of the Construction Authorization
RR0066	10CFR60 42 (b)	Y	Commission Request for Information
	10CFR60 42 (b) (2)	Y	Commission Request for Information
	10CFR60 42 (b)	N	Commission Request for Information
	10CFR60 42 (b) (1)	N	Commission Request for Information
	10CFR60 43 (b) (6)	N	Commission Request for Information
	42USC 2233 (b)	N	Commission Request for Information
	42USC 2233	N	Commission Request for Information
RR0067	10CFR60 44 (a) (1) *	Y	Changes, Tests, and Experiments
	10CFR60 44 (b)	N	Changes, Tests, and Experiments
	10CFR60 44 (a) (2) *	N	Changes, Tests, and Experiments
	10CFR20 APPENDIX D	N	Changes, Tests, and Experiments
RR0068	10CFR60 45 (a)	Y	Application for Amendment of a License
	10CFR60 21 (a)	N	Application for Amendment of a License
	10CFR60 22 *	N	Application for Amendment of a License
	10CFR60 24 *	N	Application for Amendment of a License

PASSID	CITATION	PRIMARY	TOPIC
RR0070	10CFR60 46 *	Y	Actions Requiring Amendment and Rules for Application
	10CFR60 45 (a)	N	Actions Requiring Amendment and Rules for Application
RR0071	10CFR60 51 *	Y	License Amendment for Permanent Closure
	10CFR60 45 (a)	N	License Amendment for Permanent Closure
	10CFR60 21 (a)	N	License Amendment for Permanent Closure
	10CFR60 22 *	N	License Amendment for Permanent Closure
RR0072	10CFR60 52 (a)	Y	Application To Terminate License
	10CFR60 52 (b)	Y	Application To Terminate License
	10CFR60 45 (a)	N	Application To Terminate License
RR0073	10CFR60 22 *	Y	Filing License Application and EIS
	10CFR60 21 (a)	N	Filing License Application and EIS
	10CFR60 4 (a)	N	Filing License Application and EIS
	10CFR60 24 *	N	Filing License Application and EIS
	10CFR51 67 *	N	Filing License Application and EIS
* RR0074	10CFR60 21 *	Y	License Application and Content
	10CFR60 23	N	License Application and Content
	10CFR60 24 (a)	N	License Application and Content
* RR0080	10CFR60 131 (b) (9)	Y	Important To Safety - Mining Regulations
	10CFR60 130	N	Important To Safety - Mining Regulations
	30CFR Chapter I Subchapter B	N	Important To Safety - Mining Regulations
	30CFR Chapter I Subchapter N	N	Important To Safety - Mining Regulations
* RR0081	10CFR60 131 (b) (10) *	Y	Important To Safety - Shaft Conveyances
	10CFR60 130	N	Important To Safety - Shaft Conveyances
* RR0082	10CFR60 132 (d)	Y	Design of Waste Treatment Facility
* RR0083	10CFR60 133 (a) (2) *	Y	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 130	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 131 (a)	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 131 (a) (4)	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 131 (b) (3) *	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 133 (d)	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 133 (g)	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 133 (g) (1)	N	Design to Prevent Underground Floods, Fires, and Explosions
	10CFR60 135 (c) (3)	N	Design to Prevent Underground Floods, Fires, and Explosions
* RR0084	10CFR60 133 (b)	Y	Underground Design Flexibility
	10CFR60 15 (c) (4)	N	Underground Design Flexibility
	10CFR60 17	N	Underground Design Flexibility
	10CFR60 17 (c)	N	Underground Design Flexibility
	10CFR60 130	N	Underground Design Flexibility
* RR0085	10CFR60 133 (d)	Y	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (a) (2)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c) (1)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c) (2)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c) (3)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c) (4)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c) (5)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 122 (c) (6)	N	Design to Control Underground Water or Gas Intrusion
	10CFR60 133 (a) (2)	N	Design to Control Underground Water or Gas Intrusion

PASSID	CITATION	PRIMARY	TOPIC
* RR0086	10CFR60 133 (g)	Y	Design of Underground Ventilation Normal Operations and Accident Conditions
	10CFR60 133 (g) (2)	Y	Design of Underground Ventilation Normal Operations and Accident Conditions
	10CFR60 130	N	Design of Underground Ventilation Normal Operations and Accident Conditions
	10CFR60 131 (b) (5) *	N	Design of Underground Ventilation Normal Operations and Accident Conditions
* RR0087	10CFR60 137	Y	Design for Performance Confirmation Program Implementation
	10CFR60 15 (c)	N	Design for Performance Confirmation Program Implementation
	10CFR60 15 (c) (4)	N	Design for Performance Confirmation Program Implementation
	10CFR60 74 *	N	Design for Performance Confirmation Program Implementation
	10CFR60 140 *	N	Design for Performance Confirmation Program Implementation
	10CFR60 141 *	N	Design for Performance Confirmation Program Implementation
	10CFR60 142 *	N	Design for Performance Confirmation Program Implementation
	10CFR60 143 *	N	Design for Performance Confirmation Program Implementation
* RR0088	10CFR60 131 (b) (3) *	Y	Important to Safety - Fires and Explosions
	10CFR60 130	N	Important to Safety - Fires and Explosions
* RR0089	10CFR60 131 (b) (4) *	Y	Important to Safety - Emergency Capability
	10CFR60 130	N	Important to Safety - Emergency Capability
* RR0090	10CFR60 131 (b) (5) *	Y	Important to Safety - Utility Services
	10CFR60 130	N	Important to Safety - Utility Services
* RR0091	10CFR60 131 (b) (6)	Y	Important to Safety - Inspection, Testing, and Maintenance
	10CFR60 130	N	Important to Safety - Inspection, Testing, and Maintenance
* RR0092	10CFR60 131 (b) (7)	Y	Important to Safety - Criticality Control
	10CFR60 130	N	Important to Safety - Criticality Control
* RR0093	10CFR60 131 (b) (8)	Y	Important to safety - instrument and control
	10CFR60 130	N	Important to safety - instrument and control
* RR0094	10CFR60 133 (g)	Y	Separation of Underground Facility Ventilation
	10CFR60 133 (g) (3)	Y	Separation of Underground Facility Ventilation
	10CFR60 130	N	Separation of Underground Facility Ventilation
* RR0096	10CFR60 133 (g)	N	Control Releases from Underground Facility
	10CFR60 133 (g) (1)	Y	Control Releases from Underground Facility
	10CFR20 101 (a)	N	Control Releases from Underground Facility
	10CFR20 103 (a) (1)	N	Control Releases from Underground Facility
	10CFR20 103 (a) (2)	N	Control Releases from Underground Facility
	10CFR20 103 (b) (1)	N	Control Releases from Underground Facility
	40CFR191 03 (a)	N	Control Releases from Underground Facility
	10CFR60 111 (a)	N	Control Releases from Underground Facility
* RR1001	10CFR60 112	Y	System Performance After Permanent Closure
	40CFR191 13 (a) *	N	System Performance After Permanent Closure
	40CFR191 15	N	System Performance After Permanent Closure
	40CFR191 16 *	N	System Performance After Permanent Closure
	40CFR191 APPENDIX A *	N	System Performance After Permanent Closure
* RR1002	10CFR60 113 (a) (1) (i)	Y	EBS Performance after Permanent Closure
	10CFR60 113 (a) (1) (i) (A)	Y	EBS Performance after Permanent Closure
	10CFR60 113 (a) (1) (ii)	N	EBS Performance after Permanent Closure
	10CFR60 113 (a) (1) (ii) (A)	N	EBS Performance after Permanent Closure
	10CFR60 113 (b) *	N	EBS Performance after Permanent Closure
	10CFR60 133 (a) (1)	N	EBS Performance after Permanent Closure
	10CFR60 133 (f)	N	EBS Performance after Permanent Closure

PASSID	CITATION	PRIMARY	TOPIC
*RR1002	10CFR60 133 (h)	N	EBS Performance after Permanent Closure
	10CFR60 133 (i)	N	EBS Performance after Permanent Closure
	10CFR60 135	N	EBS Performance after Permanent Closure
	10CFR60 135 (a) (1)	N	EBS Performance after Permanent Closure
	10CFR60 135 (a) (2)	N	EBS Performance after Permanent Closure
	10CFR60 135 (b) (1)	N	EBS Performance after Permanent Closure
	10CFR60 135 (b) (2)	N	EBS Performance after Permanent Closure
	10CFR60 135 (b) (4)	N	EBS Performance after Permanent Closure
	10CFR60 135 (c)	N	EBS Performance after Permanent Closure
	10CFR60 135 (c) (1)	N	EBS Performance after Permanent Closure
	10CFR60 135 (c) (2)	N	EBS Performance after Permanent Closure
	10CFR60 135 (c) (3)	N	EBS Performance after Permanent Closure
	10CFR60 140 (a) (2)	N	EBS Performance after Permanent Closure
	10CFR60 143 *	N	EBS Performance after Permanent Closure
*RR1003	10CFR60 113 (a) (1) (i)	Y	EBS Release of Radionuclides After Permanent Closure
	10CFR60 113 (a) (1) (i) (B)	Y	EBS Release of Radionuclides After Permanent Closure
	10CFR60 113 (a) (1) (ii)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 113 (a) (1) (ii) (B)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 113 (b) *	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 113 (c)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 133 (a) (1)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 133 (e) (2)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 133 (f)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 133 (h)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 135 (a) *	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 135 (b) (1)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 135 (b) (2)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 135 (b) (4)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 135 (c) *	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 140 (a)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 140 (a) (2)	N	EBS Release of Radionuclides After Permanent Closure
	10CFR60 143 *	N	EBS Release of Radionuclides After Permanent Closure
*RR2000	10CFR60 113 (a) (2)	Y	Groundwater Travel Time
	10CFR60 112	N	Groundwater Travel Time
	10CFR60 113 (b)	N	Groundwater Travel Time
	10CFR60 113 (c)	N	Groundwater Travel Time
*RR2001	10CFR60 122 (a) (1)	Y	Favorable Conditions
	10CFR60 122 (b) *	Y	Favorable Conditions
	10CFR60 112	N	Favorable Conditions
	10CFR60 113 *	N	Favorable Conditions
*RR2002	10CFR60 122 (a) (2) *	Y	Adverse Condition -Flooding
	10CFR60 122 (c)	Y	Adverse Condition -Flooding
	10CFR60 122 (c) (1)	Y	Adverse Condition -Flooding
	10CFR60 112 *	N	Adverse Condition -Flooding
	10CFR60 113 *	N	Adverse Condition -Flooding
	10CFR60 122 (b) *	N	Adverse Condition -Flooding
*RR2003	10CFR60 122 (a) (2) *	Y	Adverse Condition - Human Activity Affecting Groundwater
	10CFR60 122 (c)	Y	Adverse Condition - Human Activity Affecting Groundwater
	10CFR60 122 (c) (2)	Y	Adverse Condition - Human Activity Affecting Groundwater
	10CFR60 21 (c) (13)	N	Adverse Condition - Human Activity Affecting Groundwater
	10CFR60 112 *	N	Adverse Condition - Human Activity Affecting Groundwater
	10CFR60 113 *	N	Adverse Condition - Human Activity Affecting Groundwater
	10CFR60 122 (b) *	N	Adverse Condition - Human Activity Affecting Groundwater

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*RR2004	10CFR60 122 (a) (2) *	Y	Adverse Condition-Change Surface Groundwater
	10CFR60 122 (c)	Y	Adverse Condition-Change Surface Groundwater
	10CFR60 122 (c) (3)	Y	Adverse Condition-Change Surface Groundwater
	10CFR60 122 (b) *	N	Adverse Condition-Change Surface Groundwater
	10CFR60 112 *	N	Adverse Condition-Change Surface Groundwater
	10CFR60 113 *	N	Adverse Condition-Change Surface Groundwater
*RR2005	10CFR60 122 (a) (2) *	Y	Adverse Condition - Deformation Affecting Groundwater
	10CFR60 122 (c)	Y	Adverse Condition - Deformation Affecting Groundwater
	10CFR60 122 (c) (4)	Y	Adverse Condition - Deformation Affecting Groundwater
	10CFR60 112 *	N	Adverse Condition - Deformation Affecting Groundwater
	10CFR60 113 *	N	Adverse Condition - Deformation Affecting Groundwater
	10CFR60 122 (b) *	N	Adverse Condition - Deformation Affecting Groundwater
*RR2006	10CFR60 122 (a) (2) *	Y	Adverse Condition - Changes to Hydrology
	10CFR60 122 (c)	Y	Adverse Condition - Changes to Hydrology
	10CFR60 122 (c) (5)	Y	Adverse Condition - Changes to Hydrology
	10CFR60 112 *	N	Adverse Condition - Changes to Hydrology
	10CFR60 113 *	N	Adverse Condition - Changes to Hydrology
	10CFR60 122 (b) *	N	Adverse Condition - Changes to Hydrology
*RR2007	10CFR60 122 (a) (2) *	Y	Adverse Condition - Changes In Hydrology Due to Climatic Conditions
	10CFR60 122 (c)	Y	Adverse Condition - Changes In Hydrology Due to Climatic Conditions
	10CFR60 122 (c) (6)	Y	Adverse Condition - Changes In Hydrology Due to Climatic Conditions
	10CFR60 122 (b) *	N	Adverse Condition - Changes In Hydrology Due to Climatic Conditions
	10CFR60 112 *	N	Adverse Condition - Changes In Hydrology Due to Climatic Conditions
	10CFR60 113 *	N	Adverse Condition - Changes In Hydrology Due to Climatic Conditions
*RR2008	10CFR60 122 (a) (2) *	Y	Adverse Condition-Groundwater Conditions Affecting The Engineered Barrier System
	10CFR60 122 (c)	Y	Adverse Condition-Groundwater Conditions Affecting The Engineered Barrier System
	10CFR60 122 (c) (7)	Y	Adverse Condition-Groundwater Conditions Affecting The Engineered Barrier System
	10CFR60 122 (b) *	N	Adverse Condition-Groundwater Conditions Affecting The Engineered Barrier System
	10CFR60 112 *	N	Adverse Condition-Groundwater Conditions Affecting The Engineered Barrier System
	10CFR60 113 *	N	Adverse Condition-Groundwater Conditions Affecting The Engineered Barrier System
*RR2009	10CFR60 122 (a) (2) *	Y	Adverse Condition-Geochemical
	10CFR60 122 (c)	Y	Adverse Condition-Geochemical
	10CFR60 122 (c) (8)	Y	Adverse Condition-Geochemical
	10CFR60 122 (b) *	N	Adverse Condition-Geochemical
	10CFR60 112 *	N	Adverse Condition-Geochemical
	10CFR60 113 *	N	Adverse Condition-Geochemical
*RR2010	10CFR60 122 (a) (2) *	Y	Adverse Condition - Groundwater not Reducing
	10CFR60 122 (c)	Y	Adverse Condition - Groundwater not Reducing
	10CFR60 122 (c) (9)	Y	Adverse Condition - Groundwater not Reducing
	10CFR60 112 *	N	Adverse Condition - Groundwater not Reducing
	10CFR60 113 *	N	Adverse Condition - Groundwater not Reducing
	10CFR60 122 (b) *	N	Adverse Condition - Groundwater not Reducing
*RR2011	10CFR60 122 (a) (2) *	Y	Adverse Condition - Dissolutioning
	10CFR60 122 (c)	Y	Adverse Condition - Dissolutioning
	10CFR60 122 (c) (10)	Y	Adverse Condition - Dissolutioning
	10CFR60 112 *	N	Adverse Condition - Dissolutioning
	10CFR60 113 *	N	Adverse Condition - Dissolutioning
	10CFR60 122 (b) *	N	Adverse Condition - Dissolutioning
*RR2012	10CFR60 122 (a) (2) *	Y	Adverse Condition - Structural Deformation
	10CFR60 122 (c)	Y	Adverse Condition - Structural Deformation

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* RR2012	10CFR60 122 (c) (11)	Y	Adverse Condition - Structural Deformation
	10CFR60 122 (b) *	N	Adverse Condition - Structural Deformation
	10CFR60 112 *	N	Adverse Condition - Structural Deformation
	10CFR60 113 *	N	Adverse Condition - Structural Deformation
* RR2013	10CFR60 122 (a) (2) *	Y	Adverse Condition-Earthquakes
	10CFR60 122 (c)	Y	Adverse Condition-Earthquakes
	10CFR60 122 (c) (12)	Y	Adverse Condition-Earthquakes
	10CFR60 122 (b) *	N	Adverse Condition-Earthquakes
	10CFR60 112 *	N	Adverse Condition-Earthquakes
	10CFR60 113 *	N	Adverse Condition-Earthquakes
* RR2014	10CFR60 122 (a) (2) *	Y	Adverse Condition - Earthquakes with Tectonic Processes
	10CFR60 122 (c)	Y	Adverse Condition - Earthquakes with Tectonic Processes
	10CFR60 122 (c) (13)	Y	Adverse Condition - Earthquakes with Tectonic Processes
	10CFR60 112 *	N	Adverse Condition - Earthquakes with Tectonic Processes
	10CFR60 113 *	N	Adverse Condition - Earthquakes with Tectonic Processes
	10CFR60 122 (b) *	N	Adverse Condition - Earthquakes with Tectonic Processes
* RR2015	10CFR60 122 (a) (2) *	Y	Adverse Condition-Higher Magnitude Earthquakes
	10CFR60 122 (c)	Y	Adverse Condition-Higher Magnitude Earthquakes
	10CFR60 122 (c) (14)	Y	Adverse Condition-Higher Magnitude Earthquakes
	10CFR60 122 (b) *	N	Adverse Condition-Higher Magnitude Earthquakes
	10CFR60 112 *	N	Adverse Condition-Higher Magnitude Earthquakes
	10CFR60 113 *	N	Adverse Condition-Higher Magnitude Earthquakes
* RR2016	10CFR60 122 (a) (2) *	Y	Adverse Condition-Igneous Activity
	10CFR60 122 (c)	Y	Adverse Condition-Igneous Activity
	10CFR60 122 (c) (15)	Y	Adverse Condition-Igneous Activity
	10CFR60 122 (b) *	N	Adverse Condition-Igneous Activity
	10CFR60 112 *	N	Adverse Condition-Igneous Activity
	10CFR60 113 *	N	Adverse Condition-Igneous Activity
* RR2017	10CFR60 122 (a) (2) *	Y	Adverse Condition - Extreme Erosion
	10CFR60 122 (c)	Y	Adverse Condition - Extreme Erosion
	10CFR60 122 (c) (16)	Y	Adverse Condition - Extreme Erosion
	10CFR60 122 (b) *	N	Adverse Condition - Extreme Erosion
	10CFR60 112 *	N	Adverse Condition - Extreme Erosion
	10CFR60 113 *	N	Adverse Condition - Extreme Erosion
* RR2018	10CFR60 122 (a) (2) *	Y	Adverse Condition-Naturally Occurring Materials
	10CFR60 122 (c)	Y	Adverse Condition-Naturally Occurring Materials
	10CFR60 122 (c) (17) *	Y	Adverse Condition-Naturally Occurring Materials
	10CFR60 21 (c) (13)	N	Adverse Condition-Naturally Occurring Materials
	10CFR60 112	N	Adverse Condition-Naturally Occurring Materials
	10CFR60 113 *	N	Adverse Condition-Naturally Occurring Materials
	10CFR60 122 (b) *	N	Adverse Condition-Naturally Occurring Materials
* RR2019	10CFR60 122 (a) (2) *	Y	Adverse Condition - Mining for Resources
	10CFR60 122 (c)	Y	Adverse Condition - Mining for Resources
	10CFR60 122 (c) (18)	Y	Adverse Condition - Mining for Resources
	10CFR60 122 (b) *	N	Adverse Condition - Mining for Resources
	10CFR60 112 *	N	Adverse Condition - Mining for Resources
	10CFR60 113 *	N	Adverse Condition - Mining for Resources
	10CFR60 21 (c) (13)	N	Adverse Condition - Mining for Resources
* RR2020	10CFR60 122 (a) (2) *	Y	Adverse Condtion - Drilling
	10CFR60 122 (c)	Y	Adverse Condtion - Drilling

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* RR2020	10CFR60 122 (c) (19)	Y	Adverse Condtion - Drilling
	10CFR60 21 (c) (13)	N	Adverse Condtion - Drilling
	10CFR60 112 *	N	Adverse Condtion - Drilling
	10CFR60 113 *	N	Adverse Condtion - Drilling
	10CFR60 122 (b) *	N	Adverse Condtion - Drilling
* RR2021	10CFR60 122 (a) (2) *	Y	Adverse Condition-Complex Engineering Measures
	10CFR60 122 (c)	Y	Adverse Condition-Complex Engineering Measures
	10CFR60 122 (c) (20)	Y	Adverse Condition-Complex Engineering Measures
	10CFR60 112 *	N	Adverse Condition-Complex Engineering Measures
	10CFR60 113 *	N	Adverse Condition-Complex Engineering Measures
	10CFR60 122 (b) *	N	Adverse Condition-Complex Engineering Measures
* RR2022	10CFR60 122 (a) (2) *	Y	Adverse Condition-Geomechanical Properties of Underground Openings
	10CFR60 122 (c)	Y	Adverse Condition-Geomechanical Properties of Underground Openings
	10CFR60 122 (c) (21)	Y	Adverse Condition-Geomechanical Properties of Underground Openings
	10CFR60 112 *	N	Adverse Condition-Geomechanical Properties of Underground Openings
	10CFR60 113 *	N	Adverse Condition-Geomechanical Properties of Underground Openings
	10CFR60 122 (b) *	N	Adverse Condition-Geomechanical Properties of Underground Openings
* RR2023	10CFR60 122 (a) (2) *	Y	Adverse Condition-Water Table Rise
	10CFR60 122 (c)	Y	Adverse Condition-Water Table Rise
	10CFR60 122 (c) (22)	Y	Adverse Condition-Water Table Rise
	10CFR60 112 *	N	Adverse Condition-Water Table Rise
	10CFR60 113 *	N	Adverse Condition-Water Table Rise
	10CFR60 122 (b) *	N	Adverse Condition-Water Table Rise
* RR2024	10CFR60 122 (a) (2) *	Y	Adverse Condition - Perched Water
	10CFR60 122 (c)	Y	Adverse Condition - Perched Water
	10CFR60 122 (c) (23)	Y	Adverse Condition - Perched Water
	10CFR60 122 (b) *	N	Adverse Condition - Perched Water
	10CFR60 112 *	N	Adverse Condition - Perched Water
	10CFR60 113 *	N	Adverse Condition - Perched Water
* RR2025	10CFR60 122 (a) (2) *	Y	Adverse Condition-Gaseous Radionuclides
	10CFR60 122 (c)	Y	Adverse Condition-Gaseous Radionuclides
	10CFR60 122 (c) (24)	Y	Adverse Condition-Gaseous Radionuclides
	10CFR60 112 *	N	Adverse Condition-Gaseous Radionuclides
	10CFR60 113 *	N	Adverse Condition-Gaseous Radionuclides
	10CFR60 122 (b) *	N	Adverse Condition-Gaseous Radionuclides
RR3001	10CFR60 3 (a)	Y	License to Receive or Possess
	10CFR60 7 *	N	License to Receive or Possess
RR3002	10CFR60 3 (b)	Y	Authorization Required for Construction
	10CFR60 22 *	N	Authorization Required for Construction
	10CFR60 31 *	N	Authorization Required for Construction
RR3005	10CFR60 9 (a) *	Y	Prohibited Discrimination
	10CFR60 9 (e)	N	Prohibited Discrimination
* RR3006	10CFR60 10 *	Y	Completeness and Accuracy of Information
RR3012	10CFR60 71 (a)	Y	Records and Reports (DOE)
	10CFR60 71 (b)	N	Records and Reports (DOE)
	10CFR60 72 *	N	Records and Reports (DOE)
RR3013	10CFR60 73 *	Y	Reports of Deficiencies

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RR3013	10CFR20 Appendix D *	N	Reports of Deficiencies
* RR3014	10CFR60 74 *	Y	Tests and Performance Confirmation Program
	10CFR60 140 *	N	Tests and Performance Confirmation Program
	10CFR60 141 *	N	Tests and Performance Confirmation Program
	10CFR60 142 *	N	Tests and Performance Confirmation Program
	10CFR60 143 *	N	Tests and Performance Confirmation Program
* RR3017	10CFR60 152	Y	QA Implementation
	10CFR60 150	N	QA Implementation
	10CFR50 Appendix B *	N	QA Implementation
	10CFR60 151	N	QA Implementation
* RR3018	10CFR60 160	Y	General Requirements for Trained and Certified Personnel
* RR3019	10CFR60 161	Y	Training and Certification Program
* RR3020	10CFR60 162	Y	Physical Requirements
* RR3021	10CFR60 I	Y	Emergency Planning Criteria

Number ASSID No.	Primary Text (10CFR60)	RR TOPIC
R0053	60.18(c)	SITE CHARACTERIZATION PLAN/ACTIVITIES - NRC REVIEW, COMMENTS, AND ANALYSIS
R0061	60.31 *	REVIEW OF LICENSE APPLICATION AND ENVIRONMENTAL IMPACT STATEMENT
R0062	60.32 *	CONDITIONS OF CONSTRUCTION AUTHORIZATION
R0064	60.33(b)	NRC AMENDMENT OF CONSTRUCTION AUTHORIZATION
R0065	60.41 *	NRC STANDARDS FOR ISSUANCE OF A LICENSE
R0069	60.45(b)	LICENSE AMENDMENTS - REVIEW AND APPROVAL
R0076	60.52(b)	TERMINATION OF LICENSE
R3004	60.6	EXEMPTION FROM REGULATION REQUIREMENTS
R3007	60.61	PROVISION OF INFORMATION
[illegible]	60.63 (c)	PROPOSAL REVIEW
R3010	60.64	NOTICE TO STATES
R3011	60.65	STATE/TRIBE REPRESENTATIVES

APPENDIX C

REVIEW DRAFT

WHITE PAPER

19 April 1991

Subject: Clarification of the Term "Technical Uncertainty"

Purpose:

To provide clarification of the meaning and application of the term "technical uncertainty".

Background:

In Technical Operating Procedure (TOP) 001-02, Attachment A (Program Architecture Relational Database Content and Development), technical uncertainty is defined as a "lack of certitude as to (1) how to demonstrate (DOE action) or determine (NRC action) compliance, (2) how to acceptably reduce a previously identified technical uncertainty, or (3) how to obtain the requisite information for either purpose". The contents of TOP-001-02 were approved by an NRC letter to the Center for Nuclear Waste Regulatory Analyses dated 15 February 1990 and titled "Technical Operating Procedure (TOP) 001-02 Under the Waste Systems Engineering and Integration Program Element Under Contract No. NRC-02-88-005".

During the time since TOP 001-02 was published, the term "technical uncertainty" has been addressed within many forums in the High Level Waste (HLW) Program. In an effort to deal with a range of sources and contexts for technical uncertainties, various authors have assigned modifiers (for example, high-order, low-order and key) or developed different "categories", "types" and "characteristics" to further refine the definition. There is general agreement that the most important technical uncertainties should be related to a specific performance or design related objective.

Concern has arisen that use of the term technical uncertainty has become confused.

Discussion:

The definition of technical uncertainty in TOP 001-02 is broad enough to allow its application to the full spectrum of technical issues. Technical uncertainties (in contrast to institutional and regulatory uncertainties) stem from data and/or techniques required to reach a conclusion as to whether a particular regulatory requirement has been met. A technical uncertainty considers the question of "how to" or "how well to" do something. The associated regulatory requirement is most often performance based, but it does not have to be.

Technical uncertainties can be considered as belonging to one of

three general types based on technical source, namely: data, model, or future states (Reference 1, see Table 1). In general, the method chosen to reduce a technical uncertainty will be related to its technical source. The many variations and refinements which have arisen for the term within the HLW Program all fit within the scope of the original definition and the general types of technical uncertainty shown in Table 1 (Table 1 contains examples and is not meant to be exhaustive).

Technical uncertainties are generated during the development of compliance determination methods, technical review components or uncertainty reduction methods; or they may be identified directly from technical review of DOE plans, designs and results of investigations.

Attempts to categorize, by their nature, imply judgments. Judgments, by their nature, will result in disagreements. To minimize confusion concerning technical uncertainties, categorization beyond the approved definition and the three general types in Table 1 should be avoided.

Nevertheless, it is necessary to recognize the source and priority of a technical uncertainty as well as such factors as technical difficulty, relationship to performance objectives or design criteria and required timelines for uncertainty reduction in order to focus resources and schedules for uncertainty reduction. Such elaborations on the specifics of any technical uncertainty are compatible with the approved definition.

Conclusions:

The NRC-approved definition of technical uncertainty in TOP 001-02 is adequate.

There are three general types of technical uncertainty based on technical source: data, model and future states. Consideration of the type may be useful in developing methods for reduction of technical uncertainties.

The priority a technical uncertainty and its relationship to such factors as technical difficulty and performance or design criteria are important considerations in focusing resources and schedules for uncertainty reduction. Any description of technical uncertainties should include these factors. However, developing new names for such uncertainties should be avoided.

Reference

1. Taylor, James M., (DRAFT) STAFF'S APPROACH FOR DEALING WITH UNCERTAINTIES IN IMPLEMENTING THE EPA HLW STANDARDS (WITS 8900236), June 20, 1990

TABLE 1
TECHNICAL UNCERTAINTY TYPES

TECHNICAL SOURCE	TECHNICAL UNCERTAINTY TYPES (examples only)
Data	o Statistical uncertainty (e.g., small sample size, large dispersion in sample priorities) o Degree to which test conditions reproduce the actual conditions o Measurement uncertainty (e.g., instrument sensitivity, error, drift, human error) o Data logging and upkeep o Accuracy of data derived from analogs o Data reduction uncertainties o Data applicability uncertainty (data acquisition conditions vs conditions being analyzed) o Interpolation/extrapolation uncertainty o Uncertainty re impact of assumptions or simplifications o Theory uncertainties (e.g., applicability, inherent idealizations/simplifications) o Unknown processes or interactions of processes o Unknown variability of properties/processes
Model	o Incomplete/inaccurate understanding of processes being modeled o Uncertainty re impact of assumptions or simplifications o Application of model beyond its range of applicability o Theory uncertainties (e.g., applicability, inherent idealizations/simplifications) o Unknown processes or interactions of processes o Unknown variability of properties/processes o Mathematical uncertainties o Software reliability
Future States	o Predictive uncertainties (e.g., unknown repeatability of periodic processes, unpredictable processes or interactions of processes) o Uncertainties re future human behavior (e.g., political stability, societal norms) o Future value uncertainties (e.g., future resource value)

EXAMPLE 1

~~APPENDIX A~~

WORKSHEET FOR EVALUATING AND SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY)

RR PASS ID NUMBER: RR0052

RR TOPIC: SITE CHARACTERIZATION PLAN

PRIMARY 10 CFR PART 60 CITATION: 10CFR60.16

DATE SELECTION/INTEGRATION COMPLETED: 4/18/91

DATE TECHNICAL REVIEW AND REVISION COMPLETED:

SELECTION GROUP MEMBERS: R. Johnson

TECHNICAL REVIEWERS:

EVALUATION/SELECTION

Answer each of the following questions and select the applicable type of LA review.

Selection Criteria		Applicable Type of Review
1. Is the RR LA related?	Yes	Acceptance Review, go to 2
	No ✓	No LA review ✓
2. Is the RR LA procedural related?	Yes	Procedural Review
	No	Go to 3
3. Is the RR radiological safety or waste isolation related?	Yes	Safety Review, go to 4
	No	Stop
4. Is there a high potentail risk of non-compliance with RRT and one or more performance objectives?	Yes	Detailed Safety Review and Comparison to Confirmatory Analyses, go to 5
	No	Safety Review

5. Is there the highest potential risk of non-compliance with RRT and one or more performance objectives	Yes	Comparison to Independent Confirmatory Analyses and Tests
	No	Detailed Safety Review

List type(s) of selected LA reviews:

No LA Review

RATIONALE AND REFERENCES

Give the key adverse effects or key technical uncertainties which were the reason for the RRT to be a high or highest risk of non-compliance. Include title, description, justification, and references.

None required

EXAMPLE 2

~~APPENDIX A~~

WORKSHEET FOR EVALUATING AND SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY)

RR PASS ID NUMBER: RR0073

RR TOPIC: FILING LICENSE APPLICATION AND EIS

PRIMARY 10 CFR PART 60 CITATION: 10 CFR 60.22

DATE SELECTION/INTEGRATION COMPLETED: 4/18/91

DATE TECHNICAL REVIEW AND REVISION COMPLETED:

SELECTION GROUP MEMBERS: R. Johnson

TECHNICAL REVIEWERS:

EVALUATION/SELECTION

Answer each of the following questions and select the applicable type of LA review.

Selection Criteria		Applicable Type of Review
1. Is the RR LA related?	Yes ✓	Acceptance Review, go to 2 ✓
	No	No LA review
2. Is the RR LA procedural related?	Yes ✓	Procedural Review ✓
	No	Go to 3
3. Is the RR radiological safety or waste isolation related?	Yes	Safety Review, go to 4
	No ✓	Stop ✓
4. Is there a high potentail risk of non-compliance with RRT and one or more performance objectives?	Yes	Detailed Safety Review and Comparison to Confirmatory Analyses, go to 5
	No	Safety Review

5. Is there the highest potential risk of non-compliance with RRT and one or more performance objectives	Yes	Comparison to Independent Confirmatory Analyses and Tests
	No	Detailed Safety Review

List type(s) of selected LA reviews:

1 Acceptance Review
2 Procedural Review

RATIONALE AND REFERENCES

Give the key adverse effects or key technical uncertainties which were the reason for the RRT to be a high or highest risk of non-compliance. Include title, description, justification, and references.

None required

EXAMPLE 3

~~APPENDIX A~~

WORKSHEET FOR EVALUATING AND SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY)

RR PASS ID NUMBER: RR2017

RR TOPIC: ADVERSE CONDITION - EXTREME EROSION

PRIMARY 10 CFR PART 60 CITATION: 10CFR60.122(a), 10CFR60.122(c), 10CFR60.122(c)(16)

DATE SELECTION/INTEGRATION COMPLETED: 4/18/91

DATE TECHNICAL REVIEW AND REVISION COMPLETED:

SELECTION GROUP MEMBERS: R. Johnson

TECHNICAL REVIEWERS:

EVALUATION/SELECTION

Answer each of the following questions and select the applicable type of LA review.

Selection Criteria		Applicable Type of Review
1. Is the RR LA related?	Yes ✓	Acceptance Review, go to 2 ✓
	No	No LA review
2. Is the RR LA procedural related?	Yes	Procedural Review
	No ✓	Go to 3 ✓
3. Is the RR radiological safety or waste isolation related?	Yes ✓	Safety Review, go to 4
	No	Stop
4. Is there a high potentail risk of non-compliance with RRT and one or more performance objectives?	Yes	Detailed Safety Review and Comparison to Confirmatory Analyses, go to 5
	No ✓	Safety Review ✓

5. Is there the highest potential risk of non-compliance with RRT and one or more performance objectives	Yes	Comparison to Independent Confirmatory Analyses and Tests
	No	Detailed Safety Review

List type(s) of selected LA reviews:

1 Acceptance Review

3 Safety Review

RATIONALE AND REFERENCES

Give the key adverse effects or key technical uncertainties which were the reason for the RRT to be a high or highest risk of non-compliance. Include title, description, justification, and references.

None required

EXAMPLE 4

~~APPENDIX A~~

WORKSHEET FOR EVALUATING AND SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY)

RR PASS ID NUMBER: RR2016

RR TOPIC: ADVERSE CONDITION - IGNEOUS ACTIVITY

PRIMARY 10 CFR PART 60 CITATION: 10CFR60.122(a)(2), 10CFR60.122(c), 10CFR60.122(c)(15)

DATE SELECTION/INTEGRATION COMPLETED: 4/18/91

DATE TECHNICAL REVIEW AND REVISION COMPLETED:

SELECTION GROUP MEMBERS: R. Johnson

TECHNICAL REVIEWERS:

EVALUATION/SELECTION

Answer each of the following questions and select the applicable type of LA review.

Selection Criteria		Applicable Type of Review
1. Is the RR LA related?	Yes ✓	Acceptance Review, go to 2 ✓
	No	No LA review
2. Is the RR LA procedural related?	Yes	Procedural Review
	No ✓	Go to 3 ✓
3. Is the RR radiological safety or waste isolation related?	Yes ✓	Safety Review, go to 4 ✓
	No	Stop
4. Is there a high potentail risk of non-compliance with RRT and one or more performance objectives?	Yes ✓	Detailed Safety Review and Comparison to Confirmatory Analyses, go to 5 ✓
	No	Safety Review

5. Is there the highest potential risk of non-compliance with RRT and one or more performance objectives

	Yes	Comparison to Independent Confirmatory Analyses and Tests
	No ✓	Detailed Safety Review ✓

List type(s) of selected LA reviews:

1 Acceptance Review

3 Safety Review

4 Detailed Safety Review and comparison to Confirmatory Analyses.

RATIONALE AND REFERENCES

Give the key adverse effects or key technical uncertainties which were the reason for the RRT to be a high or highest risk of non-compliance. Include title, description, justification, and references.

Key adverse effect

Title: Effects of volcanism

Description: Brief summary

Justification: Brief explanation of why volcanic activity causes a risk of non-compliance with performance objective 60.112.

Performance Objective(s)/RRT at risk: 10CFR60.112 (RR1001)

References

Key technical uncertainty

Title: Prediction of future volcanic activity

Description:

Justification:

Performance Objective(s)/RRT at Risk: 10CFR60.112 (RR1001)

Include other key adverse effects or key technical uncertainties as appropriate.

DRAFT

CDS DEVELOPMENT

PROCEDURE

DRAFT

GUIDANCE FOR DEVELOPING COMPLIANCE DETERMINATION STRATEGIES
(May 21, 1991, DRAFT)

A. PURPOSE

This guidance is for developing the compliance determination strategy (CDS) for a subject regulatory requirement (RR). The CDS developed is considered an initial CDS which will be updated periodically as new information and understanding are obtained.

B. STEPS FOR DEVELOPING COMPLIANCE DETERMINATION STRATEGIES

1. Assign CDS Development Group of either NRC staff, CNWRA staff, or combination of NRC and CNWRA staff as appropriate for CDS(s) to be developed.

2. Read CDS development guidance and complete training.

3. Obtain and become generally familiar, as needed for CDS development, with background information pertinent to the RR--CDS.

4. Develop the CDS based on the previously selected type of CDS and associated rationale.

The CDS should identify and describe the type(s) of License Application review for the subject regulatory requirement. The CDS should NOT include descriptions of pre-licensing activities. The CDS description should include the scope and approach of the reviews and confirmatiory tests or analyses (if appropriate) to be used by the NRC and Center staff to review the License Application and determine compliance with the subject regulatory requirement. Reviews, tests, and analyses should be identified that are appropriate for the specific nature of the subject regulatory requirement, the type(s) of CDS selected, the key adverse effects or key technical uncertainties that are the basis for the type(s) of CDS selected, and the methods to remedy or compensate for the key adverse effects or key technical uncertainties. The overall CDS description should be subdivided into descriptions of each type of CDS selected for the subject regulatory requirement (i.e., type 2, 3, 4, and 5). No CDS needs to be developed for the acceptance review (type 1) since a standard strategy will be developed and documented in the LARP that is applicable for all regulatory requirements. In the individual descriptions, the applicable specific reviews, tests, or analyses should be identified. The specific reviews should indicate generally what information will be reviewed. The CDS is NOT intended to describe specifically HOW (i.e., step-by-step procedure) the reviews, tests, or analyses are to be performed. It is intended, rather, to bound and guide the subsequent development of the technical review components (TRCs) and compliance determination methods (CDMs). The compliance

determination methods will describe how the review for compliance determination will be performed, including the details of the method (as in an NRC Standard Review Plan review procedures) and associated acceptance or compliance determination criteria.

It is anticipated that CDS development groups will discuss a wide range of information including potential TRCs or CDMs as they formulate the CDS; however, these discussions will not be documented as part of the CDS.

See Appendix A for two examples of a CDS description.

5. Prepare a rationale for the CDS developed. This should not repeat the rationale for type selection. Rather, it should explain as needed the basis for the specific scope and approach to reviews, analyses, or tests. For example, justifications should be given for why certain tests will be needed to address whatever key adverse effect has been identified for the subject regulatory requirement. Include any references that need to be cited to support the rationale. See Appendix A for two examples of a CDS rationale.

6. Conduct a technical review of the results, revise accordingly, and document completion of the review.

7. Conduct a management review of the results, revise accordingly, and document completion of the review.

C. RESPONSIBILITY

1. CDS Development Group

The CDS Development Group will be made up of either NRC staff, CNWRA staff, or a combination of NRC staff and CNWRA staff acting as advisors. The CDS Development Group is responsible for developing the CDS and supporting rationale as identified in steps 2-5 and supporting as needed steps 6 and 7.

2. HLWM Section Leaders

The HLWM Section Leaders are responsible for conducting the technical review in step 6 and provide support as needed.

3. HLWM Division Directors and Branch Chiefs

The HLWM Division Directors and Branch Chiefs are responsible for assigning the NRC staff who will participate in the CDS development group. They are also responsible for the management review of the CDS and rationale in step 7.

4. CNWRA

As appropriate, CNWRA management will assign CNWRA advisors to the CDS Development Group or fully staff the group if they are directed to do so by NRC. The CNWRA will conduct a technical review/comment of the CDS and rationale in support of step 6 in parallel with the HLWM Section Leader review. The CNWRA management will also conduct a review in parallel with the HLWM Division Director and Branch Chief review conducted in accordance with step 7.

D. BACKGROUND INFORMATION

CDS Development Group members should be generally familiar with the sections of the background documents relevant to type selection (see section D of April 26, 1991 draft guidance for selecting the type of LA review strategy).

E. DOCUMENTATION

The CDS and rationale should be documented following the examples in Appendix A. It is recognized that CDS and rationale also will be loaded into the PASS data base when completed.

APPENDIX A: EXAMPLES FOR RETRIEVABILITY AND NATURAL RESOURCES

DRAFT

GUIDANCE FOR DEVELOPING COMPLIANCE DETERMINATION STRATEGIES
(May 21, 1991, DRAFT)

A. PURPOSE

This guidance is for developing the compliance determination strategy (CDS) for a subject regulatory requirement (RR). The CDS developed is considered an initial CDS which will be updated periodically as new information and understanding are obtained.

B. STEPS FOR DEVELOPING COMPLIANCE DETERMINATION STRATEGIES

1. Assign CDS Development Group of either NRC staff, CNWRA staff, or combination of NRC and CNWRA staff as appropriate for CDS(s) to be developed.

2. Read CDS development guidance and complete training.

3. Obtain and become generally familiar, as needed for CDS development, with background information pertinent to the RR--CDS.

4. Develop the CDS based on the previously selected type of CDS and associated rationale.

The CDS should identify and describe the type(s) of License Application review for the subject regulatory requirement. The CDS should NOT include descriptions of pre-licensing activities. The CDS description should include the scope and approach of the reviews and confirmatiory tests or analyses (if appropriate) to be used by the NRC and Center staff to review the License Application and determine compliance with the subject regulatory requirement. Reviews, tests, and analyses should be identified that are appropriate for the specific nature of the subject regulatory requirement, the type(s) of CDS selected, the key adverse effects or key technical uncertainties that are the basis for the type(s) of CDS selected, and the methods to remedy or compensate for the key adverse effects or key technical uncertainties. The overall CDS description should be subdivided into descriptions of each type of CDS selected for the subject regulatory requirement (i.e., type 2, 3, 4, and 5). No CDS needs to be developed for the acceptance review (type 1) since a standard strategy will be developed and documented in the LARP that is applicable for all regulatory requirements. In the individual descriptions, the applicable specific reviews, tests, or analyses should be identified. The specific reviews should indicate generally what information will be reviewed. The CDS is NOT intended to describe specifically HOW (i.e., step-by-step procedure) the reviews, tests, or analyses are to be performed. It is intended, rather, to bound and guide the subsequent development of the technical review components (TRCs) and compliance determination methods (CDMs). The compliance

determination methods will describe how the review for compliance determination will be performed, including the details of the method (as in an NRC Standard Review Plan review procedures) and associated acceptance or compliance determination criteria.

It is anticipated that CDS development groups will discuss a wide range of information including potential TRCs or CDMs as they formulate the CDS; however, these discussions will not be documented as part of the CDS.

See Appendix A for two examples of a CDS description.

5. Prepare a rationale for the CDS developed. This should not repeat the rationale for type selection. Rather, it should explain as needed the basis for the specific scope and approach to reviews, analyses, or tests. For example, justifications should be given for why certain tests will be needed to address whatever key adverse effect has been identified for the subject regulatory requirement. Include any references that need to be cited to support the rationale. See Appendix A for two examples of a CDS rationale.

6. Conduct a technical review of the results, revise accordingly, and document completion of the review.

7. Conduct a management review of the results, revise accordingly, and document completion of the review.

C. RESPONSIBILITY

1. CDS Development Group

The CDS Development Group will be made up of either NRC staff, CNWRA staff, or a combination of NRC staff and CNWRA staff acting as advisors. The CDS Development Group is responsible for developing the CDS and supporting rationale as identified in steps 2-5 and supporting as needed steps 6 and 7.

2. HLWM Section Leaders

The HLWM Section Leaders are responsible for conducting the technical review in step 6 and provide support as needed.

3. HLWM Division Directors and Branch Chiefs

The HLWM Division Directors and Branch Chiefs are responsible for assigning the NRC staff who will participate in the CDS development group. They are also responsible for the management review of the CDS and rationale in step 7.

4. CNWRA

As appropriate, CNWRA management will assign CNWRA advisors to the CDS Development Group or fully staff the group if they are directed to do so by NRC. The CNWRA will conduct a technical review/comment of the CDS and rationale in support of step 6 in parallel with the HLWM Section Leader review. The CNWRA management will also conduct a review in parallel with the HLWM Division Director and Branch Chief review conducted in accordance with step 7.

D. BACKGROUND INFORMATION

CDS Development Group members should be generally familiar with the sections of the background documents relevant to type selection (see section D of April 26, 1991 draft guidance for selecting the type of LA review strategy).

E. DOCUMENTATION

The CDS and rationale should be documented following the examples in Appendix A. It is recognized that CDS and rationale also will be loaded into the PASS data base when completed.

APPENDIX A: EXAMPLES FOR RETRIEVABILITY AND NATURAL RESOURCES

EXAMPLE

CDS TYPE SELECTION WORKSHEET

APPENDIX A

WORKSHEET FOR EVALUATING AND SELECTING THE TYPE OF LA REVIEW STRATEGY (I.E., COMPLIANCE DETERMINATION STRATEGY)

RR PASS ID NUMBER: RA 0002

RR TOPIC: RETRIEVABILITY OF WASTE

PRIMARY 10 CFR PART 60 CITATION: 10 CFR 60 111(b)(1)

DATE SELECTION/~~INTEGRATION~~ COMPLETED: 4/26/91

DATE TECHNICAL REVIEW AND REVISION COMPLETED:

SELECTION GROUP MEMBERS: O.T. ROMINE P. MACKIN
E. TSCHOEPE R. WILBUR

TECHNICAL REVIEWERS:

EVALUATION/SELECTION

Answer each of the following questions and select the applicable type of LA review.

Selection Criteria		Applicable Type of Review
1. Is the RR LA related?	Yes ✓	Acceptance Review, go to 2
	No	No LA review
2. Is the RR LA procedural related?	Yes	Procedural Review
	No ✓	Go to 3
3. Is the RR radiological safety or waste isolation related?	Yes ✓	Safety Review, go to 4
	No	Stop
4. Is there a high potentail risk of non-compliance with RRT and one or more performance objectives?	Yes	Detailed Safety Review and Comparison to Confirmatory Analyses, go to 5
	No ✓	Safety Review

5. Is there the highest potential risk of non-compliance with RRI and one or more performance objectives

Yes	Comparison to Independent Confirmatory Analyses and Tests
No	Detailed Safety Review

List type(s) of selected LA reviews:

ACCEPTANCE REVIEW

SAFETY REVIEW

RATIONALE AND REFERENCES

Give the key adverse effects or key technical uncertainties which were the reason for the RR to be a high or highest risk of non-compliance. Include title, description, justification, and references.

NONE

CDS SYNOPSIS FORMAT

(UNDER DEVELOPMENT)

COMPLIANCE DETERMINATION STRATEGY SYNOPSIS

OBJECTIVE

The Compliance Determination Strategy (CDS) is intended to identify and describe the type(s) of License Application review to be performed for the subject Regulatory Requirement. The CDS is NOT to include descriptions of pre-licensing activities. The CDS description is to include the scope and approach of the reviews and confirmatory test or analyses (if appropriate) to be used by the NRC and Center staff to review the License Application and determine compliance with the subject regulatory requirement. The CDS text is NOT intended to describe specifically HOW (i.e., step-by-step procedure) the reviews, analyses or tests are to be performed. It is intended, rather, to bound and guide the subsequent development of the compliance determination method(s) to be used for each regulatory element of proof and, as applicable, each technical review component (TRC). The Compliance Determination Methods, when developed, will describe how the review for compliance determination will be performed, including the details of the method (as in an NRC Standard Review Plan review procedure) and associated acceptance or compliance determination criteria.

The format and content of the CDS Synopsis are as follows:

[RR PASS ID Number "Flush Right" in a header on all pages] RRxxxx

COMPLIANCE DETERMINATION STRATEGY SYNOPSIS

[TOPIC OF THE REGULATORY REQUIREMENT]

LINEAGE

Regulatory Requirement (RR) Primary Regulatory Text Citation(s)
[see TOP-001-02, Att. A, Sec 3.5a, pg A14]
Format is: 10 CFR 60.131(a)(1)

RRxxxx/NS0001 -- [Topic of the NRC Compliance Determination Strategy (NS) -- see TOP-001-02, Att. A, Sec TBD, pg TBD]
Topic example: Detailed safety review of underground facility design and operations model [NOTE -- Absolute limit is 80 characters]

STRATEGY (LA REVIEW) TYPE

NRC Compliance Determination Strategy (LA Review) Type
[see TOP-001-02, Att. A, Sec TBD, pg TBD]
Format is: Type 4: Acceptance review and detailed safety review & comparison to confirmatory analyses

Rationale for Strategy (LA Review) Types 3, 4 and 5

- o Brief description of the characteristics of the regulatory requirement (e.g., indicate that it is procedural for DOE, or NRC "self-regulation," or safety/isolation related. Indicate that there are or are not key adverse effects and/or key technical uncertainties associated with the RR. Identify any other unusual aspects of the subject RR that influenced the selection of the strategy type.)
- o For Type 3: an explanation of the basis for the determination that Types 4 and 5 are inappropriate.
- o For Types 4 and 5: the title and brief description of any key adverse effects (aspects of the site, design, or operations related to this RR that produce high risks of noncompliance), the potential risk that each represents, the evidence and logic that support each contention of risk, and the performance objectives or criteria that are in jeopardy. For Type 5, also explain why the key adverse affect is most difficult to remedy or compensate for (i.e., why, therefore, it leads to highest risk of non-compliance).
- o For Types 4 and 5: the title and brief description of key technical uncertainties and the potential impacts/risks associated with each, the logic that supports each perception of risk, and the performance objectives that are in jeopardy. For Type 5, also explain why the key technical uncertainty is most difficult to remedy or compensate for (i.e., why, therefore, it leads to highest risk of non-compliance).
- o Any reasons, criteria, assumptions and other bases for the above responses to the questions that are not presented above.
- o Germane and positive comments or general observations (optional).
- o Denote references used by inserting "(Reference n0)" immediately after material obtained from another document.
- o End the Rationale with the name(s) of contributing analyst(s) and the date of the analysis.

[see TOP-001-02, Att. A, Sec TBD, pg TBD, for additional guidance]

Reference(s) for Strategy (LA Review) Type Rationale

- o A list of references by number in the order cited above.
- o For each reference, the NRC RIDS number, the Center Technical Document Index (TDI) number, OR the Center correspondence control number. NOTE: **These are the allowable input reference identifiers. The output synopsis report will provide the appropriate standard reference information from the NUDOC or TDI computer records.**
- o For each reference, the beginning and ending page numbers of the specifically relevant material.

[see TOP-001-02, Att. A, Sec TBD, pg TBD, for additional guidance]

COMPLIANCE DETERMINATION STRATEGY

[Reviews, analyses and tests are to be identified that are appropriate for the specific nature of the subject regulatory requirement, the type(s) of CDS selected, and the methods to remedy or compensate for the key adverse effects or key technical uncertainties. The overall CDS description is to be subdivided into descriptions of each type of CDS selected for the subject regulatory requirement (i.e., Type 2, 3, 4, and 5). In these

individual descriptions, the applicable specific reviews, analyses or tests are to be identified and associated with specific regulatory elements of proof of the subject regulatory requirement. The specific descriptions are to indicate in general terms what License Application information will be reviewed and the general nature of the supporting material necessary to verify the technical adequacy of that information.]

Compliance Determination Strategy Text

- o Begin with lead-in phrase such as: "The NRC will pursue a License Application review strategy for this regulatory requirement that is comprised of the following:"

  - In a numbered list, a brief description of each type of review as tailored for the strategy for NRC determination of compliance with the subject REOP set. Specific reviews, tests, models, etc may be identified if (a) they are standard practice (e.g., design or readiness reviews), (b) they now exist or (c) they are described in current NRC or CNWRA plans. Begin with the least comprehensive/demanding type of review and order the descriptions by increasing comprehensiveness. Each description will identify the specific REOP(s) to which it applies. Consideration is to be given ONLY to the strategy for LA review (i.e., the post-application submittal period).

Rationale for Strategy

- o For strategy types 3, 4 and 5, the rationale, criteria, assumptions and other bases for decisions made in developing or selecting the specific strategy for the subject REOP's. Do not repeat the above Rationale for Strategy (LA Review) Type. Rather, explain the basis for the specific scope and approach chosen. For example, justifications should be given for the use of certain tests to address a key adverse effect that has been identified for the subject REOP.
- o Germane and positive comments or general observations (optional).
- o Denote references used by inserting "(Reference n0)" immediately after material obtained from another document.
- o End the Rationale with the name(s) of contributing analyst(s) and the date of the analysis.

[see TOP-001-02, Att. A, Sec TBD, pg TBD, for additional guidance]

Reference(s) for Strategy Rationale

- o List and number references in order cited above.
- o Include for each reference the NRC RIDS number, the Center Technical Document Index (TDI) number, OR the Center correspondence control number. NOTE: **These are the allowable input reference identifiers. The output synopsis report will provide the appropriate standard reference information from the NUDOC or TDI computer records.**
- o Include for each reference the beginning and ending page numbers of the specifically relevant material.

[see TOP-001-02, Att. A, Sec TBD, pg TBD, for additional guidance]

EXAMPLE RR SYNOPSIS

RR0002

RETRIEVABILITY OF WASTE

REGULATORY REQUIREMENT SYNOPSIS

RETRIEVABILITY OF WASTE

TABLE OF CONTENTS

REGULATORY REQUIREMENT SYNOPSIS

RETRIEVABILITY OF WASTE

REQUIREMENTS

Regulatory Requirement Citations

Primary Regulatory Text Citation

10CFR60 111 (b) (1)	January 1990

Potential Uncertainties

PASS Identification Number: RR0002/UN0001
Topic: Facilitate Versus Not Prevent Waste Retrieval

Associated Regulatory Text Citations

10CFR60 111 (b) (3)	January 1990
10CFR60 46 (a)	January 1990
10CFR60 46 (a) (1)	January 1990
10CFR60 131 (b) (7)	January 1990
10CFR60 131 (b) (10) *	January 1990
10CFR60 132 (a)	January 1990
10CFR60 133 (c)	January 1990
10CFR60 133 (e) (1)	January 1990
10CFR60 133 (i)	January 1990
10CFR60 135 (b) *	January 1990

Referenced Regulatory Text Citations

10CFR60 111 (a)	January 1990

The full texts of the above listed Regulatory Texts are included in the section entitled "Regulatory Requirement Texts and Rationales."

Regulatory Elements of Proof

RR0002/PS0001 -- Retrievability of Waste

DOE SHALL DEMONSTRATE THAT:

RR0002/EP0100 -- Design for Waste Retrieval Option

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED TO PRESERVE THE OPTION OF WASTE RETRIEVAL THROUGHOUT THE PERIOD DURING WHICH WASTES ARE BEING EMPLACED AND, THEREAFTER, UNTIL THE COMPLETION OF A PERFORMANCE CONFIRMATION PROGRAM AND COMMISSION REVIEW OF THE INFORMATION OBTAINED FROM SUCH A PROGRAM. TO SATISFY THIS OBJECTIVE, THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT ANY OR ALL OF THE EMPLACED WASTE COULD BE RETRIEVED ON A REASONABLE SCHEDULE STARTING AT ANY TIME UP TO 50 YEARS AFTER WASTE EMPLACEMENT OPERATIONS ARE INITIATED, UNLESS A DIFFERENT TIME PERIOD IS APPROVED OR SPECIFIED BY THE COMMISSION. THIS DIFFERENT TIME PERIOD MAY BE ESTABLISHED ON A CASE-BY-CASE BASIS CONSISTENT WITH THE EMPLACEMENT SCHEDULE AND THE PLANNED PERFORMANCE CONFIRMATION PROGRAM. FOR PURPOSES OF THIS PARAGRAPH, A REASONABLE SCHEDULE FOR RETRIEVAL IS ONE THAT WOULD PERMIT RETRIEVAL IN ABOUT THE SAME TIME AS THAT DEVOTED TO CONSTRUCTION OF THE GEOLOGIC REPOSITORY OPERATIONS AREA AND THE EMPLACEMENT OF WASTES. {10 CFR 60.111(b)(1) & 10 CFR 60.111(b)(3)}

RR0002/EP0200 -- Design for Retrieval - 50-Year Period

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT ANY OR ALL OF THE EMPLACED WASTE CAN BE RETRIEVED ON A REASONABLE SCHEDULE STARTING AT ANY TIME UP TO 50 YEARS AFTER WASTE EMPLACEMENT OPERATIONS ARE INITIATED. {A Portion of 10 CFR 60.111(b)(1)}

RR0002/EP0300 -- Design for Waste Retrieval - Other Retrievability Period

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT ANY OR ALL OF THE EMPLACED WASTE CAN BE RETRIEVED ON A REASONABLE SCHEDULE IN A DIFFERENT TIME PERIOD IF APPROVED OR SPECIFIED BY THE COMMISSION. {A Portion of 10 CFR 60.111(b)(1)}

RR0002/EP0400 -- License Amendment - Actions Interfering with Retrieval

UNLESS EXPRESSLY AUTHORIZED IN THE LICENSE, AN AMENDMENT OF THE LICENSE HAS BEEN OBTAINED WITH RESPECT TO ANY ACTION WHICH WOULD MAKE EMPLACED HIGH-LEVEL RADIOACTIVE WASTE IRRETRIEVABLE OR WHICH WOULD SUBSTANTIALLY INCREASE THE DIFFICULTY OF RETRIEVING SUCH EMPLACED WASTE. {10 CFR 60.46(a)(1)}

RR0002/EP0500 -- Protection Against Radiation Exposures and Releases of Radioactive Material

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT UNTIL PERMANENT CLOSURE HAS BEEN COMPLETED, RADIATION EXPOSURES AND RADIATION LEVELS, AND RELEASES OF RADIOACTIVE MATERIALS TO UNRESTRICTED AREA, WILL AT ALL TIMES BE MAINTAINED WITHIN THE

LIMITS SPECIFIED IN PART 20 OF THIS CHAPTER AND SUCH GENERALLY APPLICABLE ENVIRONMENTAL STANDARDS FOR RADIOACTIVITY AS MAY HAVE BEEN ESTABLISHED BY THE ENVIRONMENTAL PROTECTION AGENCY. {10 CFR 60.111(a)}

RR0002/EP0600 -- Design of Stystems for Nuclear Criticality Safety

ALL SYSTEMS FOR PROCESSING, TRANSPORTING, HANDLING, STORAGE, RETRIEVAL, EMPLACEMENT AND ISOLATION OF RADIOACTIVE WASTE ARE DESIGNED TO ENSURE THAT A NUCLEAR CRITICALITY ACCIDENT IS NOT POSSIBLE UNLESS AT LEAST TWO UNLIKELY, INDEPENDENT, AND CONCURRENT OR SEQUENTIAL CHANGES HAVE OCCURRED IN THE CONDITIONS ESSENTIAL TO NUCLEAR CRITICALITY SAFETY. EACH SYSTEM IS DESIGNED FOR CRITICALITY SAFETY UNDER NORMAL AND ACCIDENT CONDITIONS. THE CALCULATED EFFECTIVE MULTIPLICATION FACTOR (keff) IS SUFFICIENTLY BELOW UNITY TO SHOW AT LEAST A 5% MARGIN, AFTER ALLOWANCE FOR THE BIAS IN THE METHOD OF CALCULATION AND THE UNCERTAINTY IN THE EXPERIMENTS USED TO VALIDATE THE METHOD OF CALCULATION. {10 CFR 60.131(b)(7)}

RR0002/EP0700 -- Shaft Conveyances Used in Radioactive Waste Handling

HOISTS IMPORTANT TO SAFETY ARE DESIGNED TO PRECLUDE CAGE FREE FALL, HOISTS IMPORTANT TO SAFETY ARE DESIGNED WITH A RELIABLE CAGE LOCATION SYSTEM, LOADING AND UNLOADING SYSTEMS FOR HOISTS IMPORTANT TO SAFETY ARE DESIGNED WITH A RELIABLE SYSTEM OF INTERLOCKS THAT WILL FAIL SAFELY UPON MALFUNCTION, AND HOISTS IMPORTANT TO SAFETY ARE DESIGNED TO INCLUDE TWO INDEPENDENT INDICATORS TO INDICATE WHEN WASTE PACKAGES ARE IN PLACE AND READY FOR TRANSFER. {10 CFR 60.131(b)(10)}

RR0002/EP0800 -- Design of Surface Facilities for Retrieved Waste

SURFACE FACILITIES IN THE GEOLOGIC REPOSITORY OPERATIONS AREA ARE DESIGNED TO ALLOW SAFE HANDLING AND STORAGE OF WASTES AT THE GEOLOGIC REPOSITORY OPERATIONS AREA, WHETHER THESE WASTES ARE ON THE SURFACE BEFORE EMPLACEMENT OR AS A RESULT OF RETRIEVAL FROM THE UNDERGROUND FACILITY. {10 CFR 60.132(a)}

RR0002/EP0900 -- Design of Underground Facility to Permit Retrieval

THE UNDERGROUND FACILITY IS DESIGNED TO PERMIT RETRIEVAL OF WASTE IN ACCORDANCE WITH THE PERFORMANCE OBJECTIVES OF 10 CFR 60.111. {10 CFR 60.133(c)}

RR0002/EP1000 -- Design of Openings in the Underground Facility for Retrievability

OPENINGS IN THE UNDERGROUND FACILITY ARE DESIGNED SO THAT OPERATIONS CAN BE CARRIED OUT SAFELY AND THE RETRIEVABILITY OPTION

MAINTAINED. {10 CFR 60.133(e)(1)}

RR0002/EP1100 -- Design of Underground Facility for Thermal Loads

THE UNDERGROUND FACILITY IS DESIGNED SO THAT THE PERFORMANCE OBJECTIVES WILL BE MET TAKING INTO ACCOUNT THE PREDICTED THERMAL AND THERMOMECHANICAL RESPONSE OF THE HOST ROCK, AND SURROUNDING STRATA, GROUNDWATER SYSTEM. {10 CFR 60.133(i)}

RR0002/EP1200 -- Design of Waste Package - Reactive Materials

THE WASTE PACKAGE WILL NOT CONTAIN EXPLOSIVE OR PYROPHORIC MATERIALS OR CHEMICALLY REACTIVE MATERIALS IN AN AMOUNT THAT COULD COMPROMISE THE ABILITY OF THE UNDERGROUND FACILITY TO CONTRIBUTE TO WASTE ISOLATION OR THE ABILITY OF THE GEOLOGIC REPOSITORY TO SATISFY THE PERFORMANCE OBJECTIVES. {10 CFR 60.135(b)(1)}

RR0002/EP1300 -- Design of the Waste Package - Free Liquids

THE WASTE PACKAGE DOES NOT CONTAIN FREE LIQUIDS IN AN AMOUNT THAT COULD COMPROMISE THE ABILITY OF THE WASTE PACKAGES TO ACHIEVE THE PERFORMANCE OBJECTIVES RELATING TO THE CONTAINMENT OF HLW (BECAUSE OF CHEMICAL INTERACTIONS OR FORMATION OF PRESSURIZED VAPOR) OR RESULT IN SPILLAGE AND SPREAD OF CONTAMINATION IN THE EVENT OF WASTE PACKAGE PERFORATION DURING THE PERIOD THROUGH PERMANENT CLOSURE. {10 CFR 60.135(b)(2)}

RR0002/EP1400 -- Design of Waste Package for Containment During Retrieval

WASTE PACKAGES ARE DESIGNED TO MAINTAIN WASTE CONTAINMENT DURING TRANSPORTATION, EMPLACEMENT, AND RETRIEVAL. {10 CFR 60.135(b)(3)}

RR0002/EP1500 -- Waste Package Identification

A LABEL OR OTHER MEANS OF IDENTIFICATION WILL BE PROVIDED FOR EACH WASTE PACKAGE. THE IDENTIFICATION WILL NOT IMPAIR THE INTEGRITY OF THE WASTE PACKAGE AND WILL BE APPLIED IN SUCH A WAY THAT THE INFORMATION WILL BE LEGIBLE AT LEAST TO THE END OF THE PERIOD OF RETRIEVABILITY. EACH WASTE PACKAGE IDENTIFICATION WILL BE CONSISTENT WITH THE WASTE PACKAGE'S PERMANENT WRITTEN RECORDS. {10 CFR 60.135(b)(4)}

Rationale for Logical Relationships of Regulatory Elements of Proof Set

The primary regulatory text regarding retrievability of waste is supported by several associated regulations that address retrievability, including radiation protection, nuclear criticality safety, waste handling conveyances, surface and underground facilities, and waste package design. Since each of these associated regulations are required to ensure that the

performance objectives can be met, they are a grouping of "AND" statements. A logical "OR" is imbedded within the primary text where an alternative retrievability period may be approved or specified by the Commission. R. L. Wilbur, 11 June 1990 The discussion of retrievability of waste is complicated by ambiguous language and misinterpreted definitions. To provide consistency in this document, the following definitions are given to assist reviewers and analysts: Retrieval Time = Estimated time to accomplish the actual retrieval operations, once they commence. Retrievability Period = Time at commencement of retrieval operations + Retrieval Time Commencement of Retrieval = From commencement of emplacement (theoretical earliest time) up to 50 years after commencement of emplacement (latest required time, per regulation). R.L. Wilbur, 15 October 1990

References for PS Logical Relationships Rationale

Overall Comments/Observations

NONE

APPENDIX. REGULATORY REQUIREMENT TEXTS AND RATIONALES

Included Regulatory Texts

Primary Regulatory Text

10CFR60 111 (b) (1) January 1990

(1) The geologic repository operations area shall be designed to preserve the option of waste retrieval throughout the period during which wastes are being emplaced and, thereafter, until the completion of a preformance confirmation program and Commission review of the information obtained from such a program. To satisfy this objective, the geologic repository operations area shall be designed so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the Commission. This different time period may be established on a case-by-case basis consistent with the emplacement schedule and the planned performance confirmation program.

Rationale for Selection as Primary

This is the only text in 10CFR60 which deals solely and generally with retrieval. Other texts either deal with retrieval along with other subjects in the course of addressing another major issue, or they refer to only limited aspects of retrieval, such as the design of openings in the underground facility, or radiation standards for restricted areas. This text mentions or implies engineering design, radiation safety, performance confirmation, retrieval schedule, backfilling, and permanent closure, which are the major issues involved in retrieval. Information in NUREG-0804 and NWPAA on retrieval deals with related, basic issues when it states that the ability to retrieve waste packages is to be incorporated into the design of the repository, but that it should not unnecessarily complicate, or dominate, the repository design. (References 10 and 20 of UN0001) R.L. Wilbur, 6 November 1989

Associated Regulatory Texts

10CFR60 111 (b) (3) January 1990

(3) For purposes of this paragraph, a reasonable schedule for retrieval is one that would permit retrieval in about the same time as that devoted to construction of the geologic repository operations area and the emplacement of wastes.

Rationale for Inclusion

This paragraph explains what is meant by "reasonable schedule" in paragraph 60.111(b)(1). D.S. Moulton, December 18, 1989

10CFR60 46 (a) January 1990

(a) Unless expressly authorized in the license, an amendment of the license shall be required with respect to any of the following activities:

10CFR60 46 (a) (1) January 1990

(1) Any action which would make emplaced high-level radioactive waste irretrievable or which would substantially increase the difficulty of retrieving such emplaced waste.

Rationale for Inclusion

The retrievability option is protected by requiring license amendment for any activities which would either preclude it or increase its difficulty. D. S. Moulton, 20 November 1989

10CFR60 131 (b) (7) January 1990

(7) Criticality control. All systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste shall be designed to ensure that a nuclear criticality accident is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system shall be designed for criticality safety under normal and accident conditions. The calculated effective multiplication factor (keff) must be sufficiently below unity to show at least a 5% margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

Rationale for Inclusion

This paragraph provides detail for paragraph 60.111(b) by setting forth design requirements for retrieval systems to prevent a nuclear criticality accident. R. L. Wilbur, 18 December 1989

10CFR60 131 (b) (10) * January 1990

(10) Shaft conveyances used in radioactive waste handling. (i) Hoists important to safety shall be designed to preclude cage free fall. (ii) Hoists important to safety shall be designed

with a reliable cage location system. (iii) Loading and unloading systems for hoists important to safety shall be designed with a reliable system of interlocks that will fail safely upon malfunction. (iv) Hoists important to safety shall be designed to include two independent indicators to indicate when waste packages are in place and ready for transfer.

Rationale for Inclusion

A means of conveyance to handle the waste is important to the retrievability process. While ramps are not discussed in the above regulatory text, the same provisions for safety regarding location, indication and safety interlocks implemented during emplacement of waste must apply. Therefore, this text is included. R.L. Wilbur, 9 October 1990

10CFR60 132 (a) January 1990

(a) Facilities for receipt and retrieval of waste. Surface facilities in the geologic repository operations area shall be designed to allow safe handling and storage of wastes at the geologic repository operations area, whether these wastes are on the surface before emplacement or as a result of retrieval from the underground facility.

Rationale for Inclusion

The design of surface facilities is required to allow safe handling and storage of retrieved wastes. D. S. Moulton, 6 November 1989

10CFR60 133 (c) January 1990

(c) Retrieval of waste. The underground facility shall be designed to permit retrieval of waste in accordance with the performance objectives of 60.111.

Rationale for Inclusion

This requirement lists permitting retrieval of waste as one of the design criteria for the underground facility. It ensures that the retrieval option will not be precluded by the design selected for the underground facility. R.L. Wilbur, 6 November 1989

10CFR60 133 (e) (1) January 1990

(1) Openings in the underground facility shall be designed so

that operations can be carried out safely and the retrievability option maintained.

Rationale for Inclusion

The design of openings in the underground facility is required to be made such that the retrievability option is maintained. The requirement ensures that the retrieval option will not be precluded by the design selected for the openings in the underground facility. D. S. Moulton, 6 November 1989

10CFR60 133 (i) January 1990

(i) Thermal loads. The underground facility shall be designed so that the performance objectives will be met taking into account the predicted thermal and thermomechanical response of the host rock, and surrounding strata, groundwater system.

Rationale for Inclusion

This requirement ensures that the retrievability option, a performance objective, is not precluded by predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system. Thermal loading must be evaluated regarding the effects on the waste package since emplacement. Thermal loading may also affect the time required to retrieve the emplaced waste. Thermal loading must be considered for the retrievability option so that structures, systems and components may be evaluated for use under the environmentally extreme conditions. R.L. Wilbur, 9 October 1990

10CFR60 135 (b) * January 1990

(b) Specific criteria for HLW package design -- (1) Explosive, pyrophoric, and chemically reactive materials. The waste package shall not contain explosive or pyrophoric materials or chemically reactive materials in an amount that could compromise the ability of the underground facility to contribute to waste isolation or the ability of the geologic repository to satisfy the performance objectives. (2) Free liquids. The waste package shall not contain free liquids in an amount that could compromise the ability of the waste packages to achieve the performance objectives relating to containment of HLW (because of chemical interactions or formation of pressurized vapor) or result in spillage and spread of contamination in the event of waste package perforation during the period through permanent closure. (3) Handling. Waste packages shall be designed to maintain waste containment during transportation, emplacement, and retrieval. (4) Unique identification. A label or other means of identification shall be provided for each waste package. The

identification shall not impair the integrity of the waste package and shall be applied in such a way that the information shall be legible at least to the end of the period of retrievability. Each waste package identification shall be consistent with the waste package's permanent written records.

Rationale for Inclusion

This requirement ensures that the waste package meets the following requirements. (1) Any chemically reactive materials in the waste package will not adversely compromise the integrity of the waste package thereby precluding the retrievability option. Explosive and pyrophoric materials within the waste packages could be a problem for retrievability because they could cause the waste packages to rupture and a ruptured waste package would be a potential hazard to personnel. (2) The waste packages do not contain any free liquids which would accelerate the chemical interactive processes and adversely compromise the integrity of the waste packages thereby precluding the retrievability option. (3) The waste packages can be handled during retrieval. (4) The waste package identification requirement places a retrieval-related design requirement on the labeling system for the waste packages. R.L. Wilbur, 9 October 1990

Referenced Regulatory Texts

10CFR60 111 (a) January 1990

(a) Protection against radiation exposures and releases of radioactive material. The geologic repository operations area shall be designed so that until permanent closure has been completed, radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20 of this chapter and such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency.

Rationale for Inclusion

The regulatory text cited above is the primary text of another regulatory requirement (See Regulatory Requirement RR0004) and is included in this one because it is cited by 10 CFR 60.133(c). R.L. Wilbur, 9 October 1990

Excluded Regulatory Texts

10CFR60 21 (c) (12) January 1990

(12) A description of plans for retrieval and alternate storage

of the radioactive wastes should the geologic repository prove to be unsuitable for disposal of radioactive wastes.

Rationale for Exclusion

This regulation was excluded from this Regulatory Requirement because it addresses plans for retrieval and storage that must appear in the Safety Analysis Report (SAR). Although the information is germane to the regulatory requirement, the contents of this regulatory text will be addressed in the Technical Review Components (TRC) R.L. Wilbur, 21 January 1991

10CFR60 111 (b) (2) January 1990

(2) This requirement shall not preclude decisions by the Commission to allow backfilling part or all of, or permanent closure of, the geologic repository operations area prior to the end of the period of design for retrievability.

Rationale for Exclusion

This regulatory text was considered then excluded from Regulatory Requirement RR0002, because the text does not place any requirements on the DOE. R.L. Wilbur, 26 March 1990

10CFR60 133 (e) (2) January 1990

(2) Openings in the underground facility shall be designed to reduce the potential for deleterious rock movement or fracturing of overlying or surrounding rock.

Rationale for Exclusion

This regulatory text was considered then excluded from Regulatory Requirement RR0002, because designing to reduce the potential for deleterious rock movement, or fracturing, may have no direct impact on the ultimate feasibility of waste retrieval. In summary, the overall design must permit retrieval despite any degree of movement and fracturing. R.L. Wilbur, 30 April 1990

Included Related Regulatory Text

None

Excluded Related Regulatory Text

None

Overall Comments/Observations

NONE

QA Status Information

RR0002 -- RETRIEVABILITY OF WASTE
QA Date: February 14, 1991

RR0002/UN0001 -- Facilitate Versus Not Prevent Waste Retrieval
QA Date: February 14, 1991

RR0002/PS0001 -- Retrievability of Waste
QA Date: February 14, 1991

RR0002/EP0100 -- Design for Waste Retrieval Option
QA Date: February 14, 1991

RR0002/EP0200 -- Design for Retrieval - 50-Year Period
QA Date: February 14, 1991

RR0002/EP0300 -- Design for Waste Retrieval - Other Retrievability Period
QA Date: February 14, 1991

RR0002/EP0400 -- License Amendment - Actions Interfering with Retrieval
QA Date: February 14, 1991

RR0002/EP0500 -- Protection Against Radiation Exposures and Releases of Radioactive Material
QA Date: February 14, 1991

RR0002/EP0600 -- Design of Stystems for Nuclear Criticality Safety
QA Date: February 14, 1991

RR0002/EP0700 -- Shaft Conveyances Used in Radioactive Waste Handling
QA Date: February 14, 1991

RR0002/EP0800 -- Design of Surface Facilities for Retrieved Waste
QA Date: February 14, 1991

RR0002/EP0900 -- Design of Underground Facility to Permit Retrieval
QA Date: February 14, 1991

RR0002/EP1000 -- Design of Openings in the Underground Facility for Retrievability
QA Date: February 14, 1991

RR0002/EP1100 -- Design of Underground Facility for Thermal Loads
QA Date: February 14, 1991

RR0002/EP1200 -- Design of Waste Package - Reactive Materials
QA Date: February 14, 1991

RR0002/EP1300 -- Design of the Waste Package - Free Liquids
QA Date: February 14, 1991

RR0002/EP1400 -- Design of Waste Package for Containment During Retrieval

QA Date: February 14, 1991

RR0002/EP1500 -- Waste Package Identification
QA Date: February 14, 1991

GLOSSARY

OF SRA TERMS

GLOSSARY OF PROGRAM ARCHITECTURE TERMS

The terms, abbreviations and acronyms defined below are the most widely used in the Program Architecture for the High-Level Waste Management regulatory process. This list does not include the definitions contained in the Nuclear Waste Policy Act or applicable regulations (e.g., 10 CFR Part 60).

CANDIDATE UNCERTAINTY (PAPD Step 4; TOP-001-02, Attachment A, Section 14)

A perceived, but unverified, insufficiency relative to a rule or a specific technical method. If confirmed, it is included as a "Potential Uncertainty" (see below).

CDM -- Compliance Determination Method(s) (see definition below)

CITATION

The alphanumeric identifier of a public law, statute or regulation, or a part thereof. For example, 42 U.S.C. 10133(b) and 10 CFR 60.131(a)(1).

COMPLIANCE DEMONSTRATION METHOD (PAPD Step 11; TOP-001-02, Attachment A, Section 10.1) PASS ID Code: DC

How the DOE plans to present and support its claim that each Regulatory Element of Proof has been met. It includes those test results and/or analyses, singly or in combination, that will be presented to the NRC. "Analyses" includes but is not limited to methodologies, models, codes, designs, consensus, certification, plans, procedures, and audits of records.

COMPLIANCE DETERMINATION METHODS (PAPD Step 7; TOP-001-02, Attachment A, Section 12) PASS ID Code: NC

How the NRC will determine that each REGULATORY ELEMENT OF PROOF has or has not been met. Includes those investigative or evaluative procedures, techniques, tests, methods, or any other modes of inquiry, or any combination thereof, that may be used within the context of the NRC regulatory program, to address each REGULATORY ELEMENT OF PROOF identified as necessary to determine compliance with a REGULATORY REQUIREMENT. This includes but is not limited to methodologies, models, codes, consensus, certification, audits of records, etc.

COMPLIANCE DETERMINATION STRATEGY (PAPD Step 7; TOP-001-02, Attachment A, Section 11) PASS ID Code: NS

The general approach or overall plan of the NRC for determination of compliance with the subject REGULATORY ELEMENTS OF PROOF set. Each Compliance Determination Strategy establishes the scope and depth of the NRC Compliance Determination program for a Regulatory Requirement. NRC options in each case range from Acceptance Review of the Safety Analysis Report to independent research, analysis and confirmation.

COMPLIANCE EVALUATION METHODS (PAPD Step 12; TOP-001-02, Attachment A, Section 10.2) PASS ID Code: CE

The assumed name for a process similar to Compliance Demonstration (above) that may be performed by one or more affected parties (e.g., the State of Nevada and/or a Tribe). Such an evaluation would be independent of the NRC licensing process. If provided to the NRC, a Compliance Evaluation will not be evaluated in the licensing sense; it may be reviewed on an ad hoc basis for informational purposes only.

COMPOSITE INFORMATION REQUIREMENT (PAPD Step 14; TOP-001-02, Attachment A, Section 22) PASS ID Code: CI

An INFORMATION REQUIREMENT constructed from, in general, the most demanding properties from a set of correlated, highly similar Individual INFORMATION REQUIREMENTS. A COMPOSITE INFORMATION REQUIREMENT is based on the principle that the acquisition of information to satisfy the COMPOSITE INFORMATION REQUIREMENT will acceptably satisfy the Individual INFORMATION REQUIREMENTS of the set. If the composite of the most demanding properties of a set exhibits technically infeasible magnitudes or mixes of conditions/parameters, the preferred solution is to divide the set into two or more sets.

COMPOSITE UNCERTAINTY (PAPD Step 10; TOP-001-02, Attachment A, Section 15) PASS ID Code: CU

An UNCERTAINTY constructed from, in general, the most demanding properties from a set of correlated, highly similar Individual NRC UNCERTAINTIES of the same type. A COMPOSITE UNCERTAINTY becomes the focus for NRC Uncertainty Reduction Method Analysis based on the principle that the resulting method will acceptably reduce the Individual UNCERTAINTIES of the set. If the composite of the most demanding properties of a set exhibits infeasible magnitudes or mixes of conditions/parameters, the preferred solution is to divide the set into two or more sets.

ONLY UNCERTAINTIES FOR WHICH THE NRC IS THE SOURCE MAY BE USED IN THE CONSTRUCTION OF A NRC COMPOSITE UNCERTAINTY.

CONTINGENCY METHOD

A backup or alternative to the preferred method. This may apply, for example, to DOE COMPLIANCE DEMONSTRATION METHODS, NRC COMPLIANCE DETERMINATION METHODS, UNCERTAINTY REDUCTION METHODS, and methods for satisfying INFORMATION REQUIREMENTS.

CPM -- Critical Path Method (network)

DOE COMPLIANCE DEMONSTRATION (see Compliance Demonstration)

ESSENTIAL EXPERTISE (PAPD Step 7; TOP-001-02, Attachment A, Section 12f)

The principal area(s) of expertise judged to be <u>essential</u> for actions related to an individual NRC COMPLIANCE DETERMINATION METHOD. (See Support Expertise for associated item.)

EVALUATION FINDINGS (PAPD Step 22; TOP-001-02, Attachment A, Section 8) PASS ID Code: EF

NRC staff judgment which reflects the merits of the Applicant's information to address the REGULATORY ELEMENTS OF PROOF and thus, the REGULATORY REQUIREMENT. EVALUATION FINDINGS are included in the Safety Evaluation Report prepared by the staff and submitted to the Licensing Board.

FUNCTION (OR SUBFUNCTION)

An action of the physical system that is necessary to accomplish the system mission. A subfunction is identified by decomposition of a parent function in response to a standard question without concern for other functions, location, relative importance, or other similar

factors. A subfunction is identified solely because it is "necessary" for the accomplishment of the parent function. The set of subfunctions is complete when all subfunctions "sufficient" for the accomplishment of the parent function have been identified.

FUNCTIONAL ANALYSIS

The systematic top-down decomposition of the physical system mission into its mission-dependent primary functions; then the functions into their subfunctions. The analysis identifies all functions necessary and sufficient to accomplish the system mission; i.e., all necessary and sufficient actions, and the sequences of required processes.

GENERIC

Relates to those waste management system characteristics or approaches that are in all significant respects independent of the specific location, properties and characteristics of the site. This includes, for example, the many surface facility layouts and the steps in the waste handling process that would be substantially the same for any selected site.

HIGH-LEVEL WASTE MANAGEMENT SYSTEM

The system for the disposal of high-level radioactive waste (including spent fuel) in accordance with the NWPA, as amended; i.e., in a manner that is environmentally acceptable and protects the public health and safety. The system includes the geologic repository, transportation system, and pre-emplacement packaging and interim storage capabilities that may be required.

INDIVIDUAL NRC PROGRAM (PAPD Steps 15b, 16 and 17; TOP-001-02, Attachment A, Section 23) PASS ID Code: IP

An "Individual NRC Program," for the purposes of Program Architecture, is the complete set of activities and associated resources necessary to accomplish one of the following:

1. Satisfy a single individual or COMPOSITE INFORMATION REQUIREMENT.
2. Implement and complete the reduction method(s) for a single individual or COMPOSITE UNCERTAINTY.
3. Implement and complete the set of COMPLIANCE DETERMINATION METHODS associated with a single REGULATORY REQUIREMENT.

INFORMATION REQUIREMENTS (PAPD Steps 8 and 13; TOP-001-02, Attachment A, Section 20) PASS ID Code: IR

Information required to execute a DOE COMPLIANCE DEMONSTRATION METHOD, a NRC COMPLIANCE DETERMINATION METHOD or a NRC UNCERTAINTY REDUCTION METHOD. Information used to execute a NRC COMPLIANCE DETERMINATION METHOD or a DOE COMPLIANCE DEMONSTRATION METHOD would be considered as evidence regarding compliance with the REGULATORY REQUIREMENT. This includes but is not limited to facts, test data, analyses, plans, procedures and/or records.

INSTITUTIONAL UNCERTAINTY (PAPD Step 4a; TOP-001-02, Attachment A, Section 14) PASS ID Code: UN

Lack of certitude regarding the roles, missions, actions, or schedules of agencies with REGULATORY REQUIREMENTS that affect the high-level waste regulatory program, their impacts, or their integration with the NRC regulatory program. INSTITUTIONAL UNCERTAINTIES are derivable <u>only</u> from REGULATORY REQUIREMENTS.

KEYWORDS

Individual words or brief phrases that concisely identify the important subjects contained in a record or set of records. Keywords are used to search large quantities of textual records to identify, locate and/or correlate significant treatments of a given subject. Keywords are restricted to those subjects that receive meaningful treatment in the record(s) of interest.

LINKAGE

A relationship between two or more records constructed in a PASS relational database table. Linkages may be one-to-one, one-to-many, many-to-one, or many-to-many.

LOGIC DIAGRAM (PAPD Steps 3a, 3b, and 7; TOP-001-02, Attachment A, Sections 5 (Background), 5.8, 6 (Background), 6.7, 11.8, 12 (Background and Content); Attachment C)

A graphic representation of the logical interrelationships between Program Architecture elements of the same type. Logic diagrams are developed, as a minimum for all REGULATORY ELEMENT OF PROOF sets, and for TECHNICAL REVIEW COMPONENT sets and COMPLIANCE DETERMINATION METHOD sets when an "OR" relationship exists. Logic diagrams are prepared in a binary format to provide an unambiguous representation.

MISSION (See SYSTEM MISSION)

NRC COMPOSITE UNCERTAINTY (PAPD Step 13; TOP-001-02, Attachment A, Section 21) PASS ID Code: CU

A COMPOSITE UNCERTAINTY that has been approved by the NRC in Step 15a together with the selection of the preferred UNCERTAINTY REDUCTION METHOD. (See Attachment A, Section 14, Background.)

NRC SELECTED UNCERTAINTY REDUCTION METHOD (see SELECTED UNCERTAINTY REDUCTION METHOD)

NWPA -- Nuclear Waste Policy Act of 1982, P.L. 97-425, 42 USCS 10101

NWPAA -- Nuclear Waste Policy Amendments Act of 1987, P.L. 100-203, 42 USCS 10172

OVERALL NRC PROGRAMS (PAPD Step 18; TOP-001-02, Attachment A, Section 24.1) PASS ID Code: TP

For the purposes of Program Architecture, an OVERALL NRC PROGRAM is the complete set of activities and associated resources necessary to accomplish <u>one</u> of the following:

1. Satisfy all NRC individual and COMPOSITE INFORMATION REQUIREMENTS identified for the High-Level Waste Management Program.
2. Implement and complete the reduction methods for all NRC individual and COMPOSITE UNCERTAINTIES identified for the High-Level Waste Management Program.
3. Implement and complete the COMPLIANCE DETERMINATION METHODS associated with all identified REGULATORY REQUIREMENTS for the High-Level Waste Management Program.
4. Implement and complete the performance of independent and/or confirmatory research relative to selected INFORMATION REQUIREMENTS, UNCERTAINTY REDUCTION METHODS and/or COMPLIANCE

DETERMINATION METHODS.

PA -- Program Architecture (see definition below)

PADB -- Program Architecture Relational Database (see definition below)

PAPD -- Program Architecture Process Diagram.

The diagram of the 22-step PA process (see CNWRA TOP-001, Figure 1).

PARENT

The next higher level element in the Program Architecture hierarchy of elements; the element from which the subject element was derived.

PASS -- Program Architecture Support System (see definition below)

PASS IDENTIFICATION NUMBER

A standardized two-letter PASS ID Code plus an index number that is assigned from blocks of numbers provided by the Center to the developers of Regulatory Requirements. It serves as a means to identify, relate and retrieve Regulatory Requirements and associated Program Architecture Database (PADB) records. The form for a Regulatory Requirement is always RRxxxx, where xxxx is a four-digit number with leading zeros, if necessary. For other PADB records, the form is always RRxxxx/YYxxxx, where YY is a standard, two-letter code for the type of record (e.g., EP for a Regulatory Element of Proof, UN for an Uncertainty).

POSTULATED UNCERTAINTY REDUCTION LANGUAGE (PAPD Step 15a; TOP-001-02, Attachment A, Section 18)

The presumed revision of a rule <u>if</u> the uncertainy identified in that rule were to be reduced through rulemaking. It should be noted that in postulating the revised language, no decision has been made on how to implement the reduction; e.g., rulemaking, technical position, or other NRC regulatory instrument.

PROGRAM ARCHITECTURE

The overall description of the Nuclear Regulatory Commission high-level waste (NRC-HLW) management regulatory program. It is a systematic computer-assisted approach to analysis of the regulator program including requirements, program planning and evaluation, and management. It is mission-oriented, requirements-based, and proactive; and it provides the basis for integration of all aspects of the NRC regulatory program under the NWPAA.

PROGRAM ARCHITECTURE RELATIONAL DATABASE

The repository for the principal information necessary to (1) provide guidance and consultation for Department of Energy (DOE) prelicensing plans and activities and (2) develop and execute the overall NRC regulatory program for NWPA waste management activities. It is made up of several data and text records whose number and, in some cases, content may change as amendments of the law, rulemaking, program changes or improved technical information dictate. Among the records are the complete texts of the applicable statutes and regulations; individual Regulatory Requirements; Regulatory Elements of Proof and Technical Review Components for such requirements; NRC Compliance Determination

Methods; Uncertainties; Uncertainty Reduction Methods; Information Requirements; schedules and costs; and summaries of Compliance Demonstration Methods planned by the DOE.

PROGRAM ARCHITECTURE SUPPORT SYSTEM

A computer-based system comprised of (1) the PA Relational Database, (2) the computer hardware and software necessary to construct, protect, interrogate and manage that database, and (3) the network hardware and software that allows controlled remote interrogation of the PADB and provides the interfaces with NUDOC, the Licensing Support System and other remote databases.

PURL -- Postulated Uncertainty Reduction Language (see definition above)

REGULATORY ELEMENTS OF PROOF (PAPD Step 3a; TOP-001-02, Attachment A, Section 5) PASS ID Code: EP

What must be demonstrated to support a conclusion that the REGULATORY REQUIREMENT has been met. REGULATORY ELEMENTS OF PROOF must be directly stated in the requirement itself. When a Potential REGULATORY or INSTITUTIONAL UNCERTAINTY exists and rulemaking is a potential uncertainty reduction method, the revised language of the affected rule must be postulated. When this occurs, the resulting POSTULATED UNCERTAINTY REDUCTION LANGUAGE (PURL) is developed as a part of the UNCERTAINTY REDUCTION METHOD (see below).

REGULATORY ELEMENTS OF PROOF INTEGRATION (PAPD Step 5; TOP-001-02, Attachment A, Section 7) PASS ID Code: PI

Identification of the Performance Assessment model or analysis to which the individual REGULATORY ELEMENTS OF PROOF or set will be linked to provide (or aid in providing) a satisfactory representation of system pre-closure or post-closure performance.

REGULATORY ELEMENTS OF PROOF SET (PAPD Step 3a; TOP-001-02, Attachment A, Section 5) PASS ID Code: PS

The complete group of REGULATORY ELEMENTS OF PROOF derived from a single REGULATORY REQUIREMENT.

REGULATORY TEXT (TOP-001-02, Attachment A, Section 2)

An element of a source statute or regulation at or above the lowest level to which an alphanumeric identifier has been assigned. Examples would include 42 U.S.C. 10133(b)(1)(A)(i) and 10 CFR 60.131(a)(1). Elements below this level lose their legal integrity.

REGULATORY REQUIREMENT (PAPD Step 2; TOP-001-02, Attachment A, Section 3) PASS ID Code: RR

A statement of a requirement pertaining to the NWPA High-Level Waste Management System, as quoted from one or more statutes, regulations, or other sources which have the force of law. Each such quotation is a complete REGULATORY TEXT. Thus, a REGULATORY REQUIREMENT is composed of one or more closely related REGULATORY TEXTS.

REGULATORY UNCERTAINTY (PAPD Step 4b; TOP-001-02, Attachment A, Section 14) PASS ID Code: UN

Lack of certitude as to what is meant by the REGULATORY REQUIREMENT or

its REGULATORY ELEMENTS OF PROOF, or the adequacy, completeness, and/or necessity of the requirement itself. REGULATORY UNCERTAINTY may stem from lack of clarity in the quoted statement, the omission of an essential requirement from the regulation, and/or the inclusion of requirements in the regulation that do not contribute to or detract from the regulatory program.

An inconsistency with the statute that constitutes the basis of authority for the regulation represents a REGULATORY UNCERTAINTY. A REGULATORY UNCERTAINTY is also created if a regulation exceeds its statutory authority. However, the omission from the regulation of a material part of the statute does not create an uncertainty since the statute is the senior document.

REGULATORY UNCERTAINTIES are derivable only from REGULATORY REQUIREMENTS and the logical interrelationships of REGULATORY ELEMENTS OF PROOF.

RELATED ISSUES (PAPD Steps 11 and 12; TOP-001-02, Attachment A, Section 4) PASS ID Code: RI

Issues defined by agencies other than NRC that are related in whole or in part to the subject REGULATORY REQUIREMENT.

REOP -- Regulatory Element(s) of Proof (see definition above)

RR -- Regulatory Requirement (see definition above)

SAFETY FUNCTIONS

System functions related to public or worker radiological health and safety; i.e., those functions that fit within the NRC regulatory charter.

SELECTED UNCERTAINTY REDUCTION METHOD (PAPD Step 15a; TOP-001-02, Attachment A, Section 19) PASS ID Code: NR

The result of an UNCERTAINTY REDUCTION METHOD ANALYSIS for an NRC individual UNCERTAINTY or COMPOSITE UNCERTAINTY. The resulting method includes the selected reduction method, the finalized PURL (where applicable), and the associated rationales and references. (Also referred to as UNCERTAINTY REDUCTION METHOD.)

SITE-SPECIFIC

Includes those system characteristics or approaches that to a significant degree are dependent on the properties and characteristics of the site; e.g., structural design for seismic characteristics, waste package material selection.

STATUTORY BASIS (PAPD Step 2; TOP-001-02, Attachment A, Section 3.5b)

The section of the authorizing statute that is the basis for the subject REGULATORY TEXT.

SUPPORT EXPERTISE (PAPD Step 7; TOP-001-02, Attachment A, Section 12g)

The principal area(s) of expertise judged to be <u>needed</u> in addition to the Essential Expertise for actions related to an individual NRC COMPLIANCE DETERMINATION METHOD.

SURFACE (As used in the Repository Functional Analysis)

"Surface", in this application, is intended to include potential near-surface facilities and/or equipment such as buried utility lines, foundations, bunkers, and shallow underground facilities.

SYSTEM MISSION

The purpose of the system; i.e., the specific end objective(s) the system is intended to accomplish.

TECHNICAL REVIEW COMPONENTS (PAPD Step 3b; TOP-001-02, Attachment A, Section 6) PASS ID Code: RC

TECHNICAL REVIEW COMPONENTS (TRC) are (1) the analytical results necessary to review a DOE DEMONSTRATION OF COMPLIANCE <u>and/or</u> to support a NRC DETERMINATION OF COMPLIANCE with an individual REGULATORY ELEMENT OF PROOF, and (2) the supporting material necessary to verify the technical adequacy of those analytical results.

The "technical adequacy" of results used for compliance demonstration and/or determination includes the validity and applicability of the method (e.g., the theory; investigative or analytical method; analytical uncertainties; model), and the adequacy of the data used (e.g., measurement techniques and instrumentation, measurement uncertainties, data collection procedures [including quality assurance provisions], realism of environment simulation, sample size, spatial and temporal distribution of measurements).

TECHNICAL REVIEW COMPONENTS SET (PAPD Step 3b; TOP-001-02, Attachment A, Section 6) PASS ID Code: TS

The group of TECHNICAL REVIEW COMPONENTS related to, and derived from, a single parent REGULATORY ELEMENT OF PROOF.

TECHNICAL UNCERTAINTY (PAPD Step 4c; TOP-001-02, Attachment A, Section 14) PASS ID Code: UN

Lack of certitude as to (1) how to demonstrate (DOE action) or determine (NRC action) compliance, (2) how to acceptably reduce a previously identified TECHNICAL UNCERTAINTY, or (3) how to obtain the requisite information for either purpose.

A TECHNICAL UNCERTAINTY is created by the absence of a defined and accepted means to resolve a technical program need. TECHNICAL UNCERTAINTIES are derivable from DOE COMPLIANCE DEMONSTRATION METHODS, NRC COMPLIANCE DETERMINATION METHODS, UNCERTAINTY REDUCTION METHODS and INFORMATION REQUIREMENTS.

TOPIC

The principal subject of a given PA element (e.g., REGULATORY REQUIREMENT, TECHNICAL REVIEW COMPONENT, COMPOSITE UNCERTAINTY).

TOTAL (NRC) PROGRAM (PAPD Step 20; TOP-001-02, Attachment A, Section 24.3) PASS ID Code: TP

The total NRC program for High-Level Waste Management. It includes the four Overall Programs (Information Requirements, Uncertainty Reduction, Compliance Determination, and Research). It is produced by the integration of the individual Regulatory Requirement Programs including their interactions, resources, and schedules. It is displayed in a set of CPM networks.

TRANSFER (As used in the Repository Functional Analysis)

The movement of waste within a given major facility that is attendant to the processes performed at that facility. (See TRANSPORT)

TRANSPORT (As used in the Repository Functional Analysis)

The transhipment of waste between major facilities by, for example, railcar or heavy truck. (See TRANSFER)

TRC -- Technical Review Components (see definition above)

UN -- Uncertainty (see definition below)

UNCERTAINTY (PAPD Step 4 and part of Steps 11 and 12; TOP-001-02, Attachment A, Section 14) PASS ID Code: UN

Generally, a perceived insufficiency relative to a rule or a specific technical method. There are three types of Uncertainties (all defined independently in this glossary): Institutional, Regulatory and Technical.

UNCERTAINTY REDUCTION METHOD (PAPD Step 15a; TOP-001-02, Attachment A, Section 18) PASS ID Code: NR

How an NRC individual or COMPOSITE TECHNICAL, INSTITUTIONAL or REGULATORY UNCERTAINTY will be reduced as determined by the UNCERTAINTY REDUCTION METHOD ANALYSIS. The resulting method includes the selected reduction method, the finalized PURL (where applicable), and the associated rationales and references. (Also referred to as the SELECTED UNCERTAINTY REDUCTION METHOD.)

UNCERTAINTY REDUCTION METHOD ANALYSIS (PAPD Step 15a; TOP-001-02, Attachment A, Section 18)

The synthesis, definition, evaluation, recommendation and review of alternative methods for reduction of a given NRC individual UNCERTAINTY or COMPOSITE UNCERTAINTY.

URM -- Uncertainty Reduction Method (see definition above)

EXAMPLE

TRC, CDM AND IR

PRELIMINARY
NOT RECONCILED WITH CDS

RC0420 -- Verification of a License Amendment
Parent Regulatory Element of Proof: EP0400

Evidence that an amendment to the license will be obtained with respect to any action which would make high-level radioactive waste irretrievable or which would substantially increase the difficulty of retrieving such emplaced waste. (TECHNICAL REVIEW COMPONENT)

RC0430 -- Analytical and Investigative Methods
Parent Regulatory Element of Proof: EP0400

Description and documentation of the analytical and/or the investigative methods used to develop each Technical Review Component, the rationale for using each of these methods, and evidence to support the contention that each of these methods is applicable. (TECHNICAL REVIEW COMPONENT)

RC0440 -- Verification of Data
Parent Regulatory Element of Proof: EP0400

Verification that data have been collected and/or qualified in accordance with an acceptable quality assurance program which meets the requirements of 10 CFR, Part 50, Appendix B. (TECHNICAL REVIEW COMPONENT)

EP0500 -- Protection Against Radiation Exposures and Releases of Radioactive Material

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT UNTIL PERMANENT CLOSURE HAS BEEN COMPLETED, RADIATION EXPOSURES AND RADIATION LEVELS, AND RELEASES OF RADIOACTIVE MATERIALS TO UNRESTRICTED AREA, WILL AT ALL TIMES BE MAINTAINED WITHIN THE LIMITS SPECIFIED IN PART 20 OF THIS CHAPTER AND SUCH GENERALLY APPLICABLE ENVIRONMENTAL STANDARDS FOR RADIOACTIVITY AS MAY HAVE BEEN ESTABLISHED BY THE ENVIRONMENTAL PROTECTION AGENCY. (10 CFR 60.111(a))

Technical Review Components for EP0500
TS0500 -- Radiation Protection Limits

DOE SHALL PROVIDE:

RC0510 -- Radiation Protection - NRC
Parent Regulatory Element of Proof: EP0500

Design drawings and analyses to show that radiation exposures, radiation levels, and releases of radioactive materials to unrestricted areas will be maintained within the limits of 10 CFR, Part 20, during the retrievability period. (TECHNICAL REVIEW COMPONENT)

PRELIMINARY
NOT RECONCILED WITH CDS

RC0440 -- Verification of Data

It is necessary to ensure that the appropriate quality assurance standards have been applied to assure proper design, evaluate analytical methods, and verify investigative data, and to provide confidence that the structures, systems, and components of the geologic repository can operate safely and meet the performance objectives. R.L. Wilbur, 15 October 1990

Rationale for Logical Relationships of Technical Review Components Set TS0500

Topic of TS0500 -- Protection Against Radiation Exposures and Releases of Radioactive Material

This TRC set is comprised of five individual TRCs configured in a logical "AND" and address the technical information required to accurately asses the design of the repository for radiation safety, radiation exposures, and releases of radioactive material to unrestricted areas. Two sets of limits are referenced in the Regulatory Element of Proof and only compliance with the most stringent standard will be required. R.L. Wilbur, 30 October 1990

Rationales for Individual Technical Review Components of TS0500

RC0510 -- Protection Against Radiation - NRC

Radiation exposures and releases of radioactive material to the environment must be limited at all times to those specifications listed in 10 CFR Part 20. It is recognized that this standard or the standard referenced in RC0520 below may differ in their requirements. Only compliance with the more rigid standard is required. R.L. Wilbur, 28 June 1990

RC0520 -- Protection Against Radiation - EPA

Radiation exposures and releases of radioactive material to the environment must conform to the environmental standards established by the Environmental Protection Agency. These may differ with those of 10 CFR Part 20, and compliance with the most rigid standard is required. R.L. Wilbur, 17 October 1990

RC0530 -- Analytical Methods for Radiation Exposures

The analytical methods used to show that radiation exposure and releases of radioactive materials to the environment during the retrievability period must be provided to evaluate the radiation safety of the retrievability option. R.L. Wilbur, 9 May 1990

PRELIMINARY
NOT RECONCILED WITH CDS

Rationale for Compliance Determination Method NC0500

10 CFR 60.111(a) requires that radiation exposure, radiation levels and releases of radioactive materials during retrieval be limited as per 10 CFR Part 20. Retrievability of waste is an option that may be undertaken prior to permanent closure. Therefore, compliance to 10 CFR 60.111(a) and the referenced 10 CFR Part 20 must be achieved. R.L. Wilbur, 6 July 1990

References for Compliance Determination Method Description and Rationale for NC0500

None

NC0510 -- Radiation Protection - NRC

Technically review DOE's design drawings and analyses to show that radiation exposures, radiation levels, and releases of radioactive materials to unrestricted areas are maintained within the limits of 10 CFR, Part 20.

Information Requirements for NC0510

IR0039 -- Worker Exposure to Radioactive Materials in Air

DOE's calculations of worker exposure to concentrations of radioactive materials in air at the GROA with allowance for any changes that may be produced by retrieval activities.

IR0040 -- Levels of Radiation at the Geologic Repository Operations Area

DOE's calculations of the levels of radiation at the GROA with allowance for any changes that may be produced by retrieval activities.

IR0041 -- Radioactivity in Effluents

DOE's calculations of the radioactivity in any effluents at the GROA with allowance for any changes that may be produced by retrieval activities.

Rationale for Compliance Determination Method NC0510

To determine the technical adequacy of DOE's design package, it is necessary to evaluate the drawings and calculations for the geologic repository operations area as they pertain to retrievability. The functional effectiveness of the design is then compared against the requirements set forth in 10 CFR Part 20. R.L. Wilbur, 31 October 1990

References for Compliance Determination Method Description and Rationale for NC0510

None

Rationales for Information Requirements of NC0510

IR0039 -- Worker Exposure to Radioactive Materials in Air

DOE's calculations of worker exposure to concentrations of radioactive materials in air at the GROA with allowance for any changes that may be produced by retrieval activities must be reviewed to ensure that the results of the calculations are within the radiological safety limits imposed by 10 CFR 20, Appendix B, Table I, Column 1. R.L. Wilbur, 31 May 1991

IR0040 -- Levels of Radiation at the Geologic Repository Operations Area

DOE's calculations of the levels of radiation at the GROA with allowance for any changes that may be produced by retrieval activities must be evaluated to ensure that releases of radioactive material remain within the limits imposed by 10 CFR 20, Appendix B, Table I, Column 1. R.L. Wilbur, 31 May 1991

IR0041 -- Radioactivity in Effluents

DOE's calculations of the radioactivity in any effluents at the GROA with allowance for any changes that may be produced by retrieval activities need to be reviewed to ensure that radionuclides do not percolate into the ground water and migrate to the unrestricted areas. The radioactive effluents must remain within the limits imposed by 10 CFR 20, Appendix B, Table I, Column 3. R.L. Wilbur, 31 May 1991

References for Information Requirements and Rationales

None

NC0520 -- Radiation Protection- EPA

Review DOE's design drawings and analyses to show that radiation exposures, radiation levels, and releases of radioactive materials to unrestricted areas are maintained within the generally applicable environmental standards for radioactivity during retrieval as established by the Environmental Protection Agency.

Information Requirements for NC0520

IR0042 -- Worker Exposure to Radioactive Materials in Air

HIERARCHY DIAGRAM

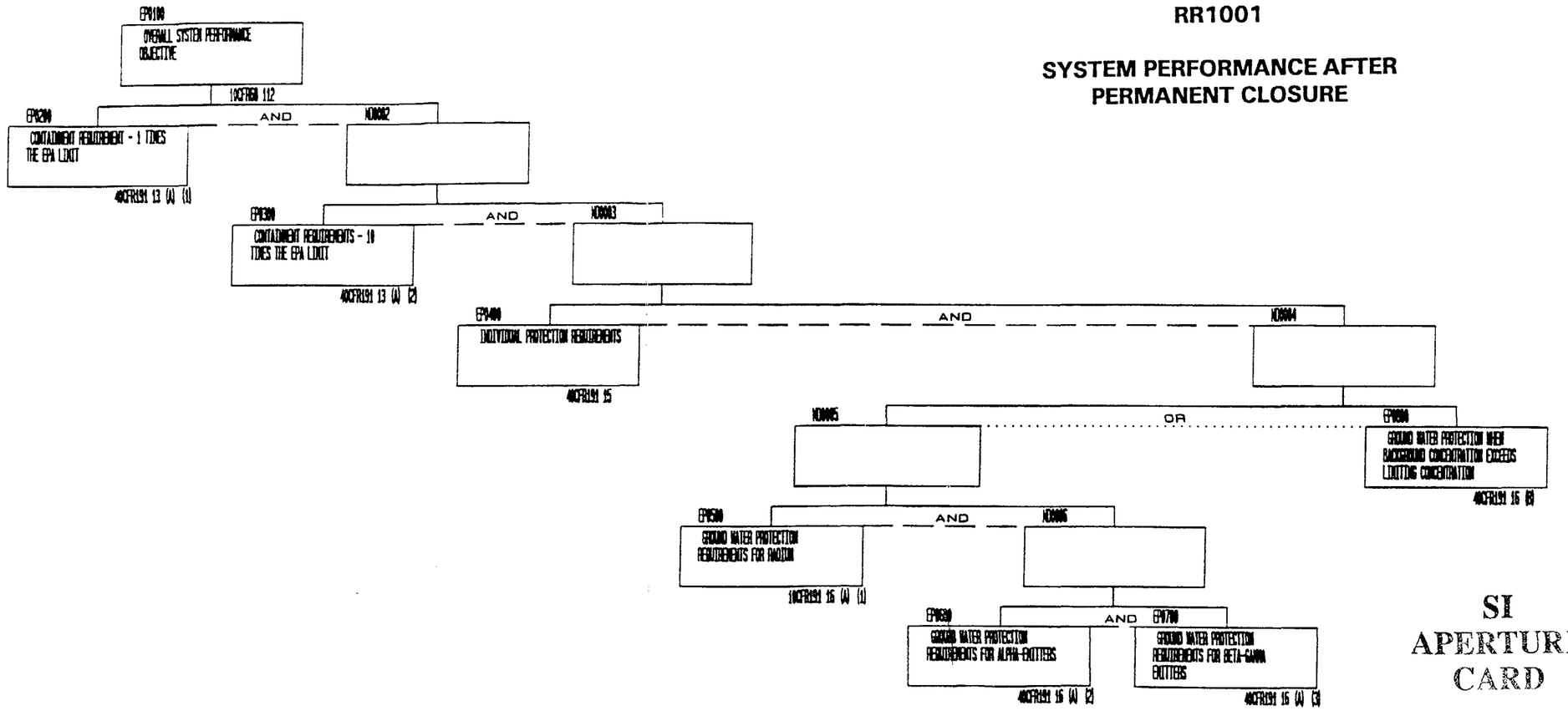
RR1001

SYSTEM PERFORMANCE AFTER PERMANENT CLOSURE

HIERARCHY DIAGRAM

RR1001

SYSTEM PERFORMANCE AFTER PERMANENT CLOSURE



SI APERTURE CARD

Also Available On Aperture Card

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HIERARCHY DIAGRAM

RR1001

SYSTEM PERFORMANCE AFTER PERMANENT CLOSURE

QUALITY ASSURANCE PROGRAM FAMILIARIZATION FOR SRA

SRA IS AN "ACTIVITY AFFECTING QUALITY" AS DEFINED BY THE CNWRA QA PROGRAM

QUALITY ASSURANCE PROGRAM FAMILIARIZATION FOR SRA

THE QA PROGRAM IDENTIFIES FACTORS INFLUENCING QUALITY, AND ESTABLISHES CONTROLS APPROPRIATE TO ASSURE QUALITY

QUALITY ASSURANCE PROGRAM
FAMILIARIZATION FOR SRA

FACTORS AND CONTROLS WHICH INFLUENCE THE QUALITY OF SRA INCLUDE

* QUALIFICATIONS OF ANALYSTS
  EDUCATION AND EXPERIENCE

  Qualification determined by NRC Management

* TRAINING
  SRA BASIC TRAINING COURSE
  SPECIFIC TRAINING FOR EACH ANALYSIS STRUCTURAL ELEMENT

  Training provided by CNWRA Staff

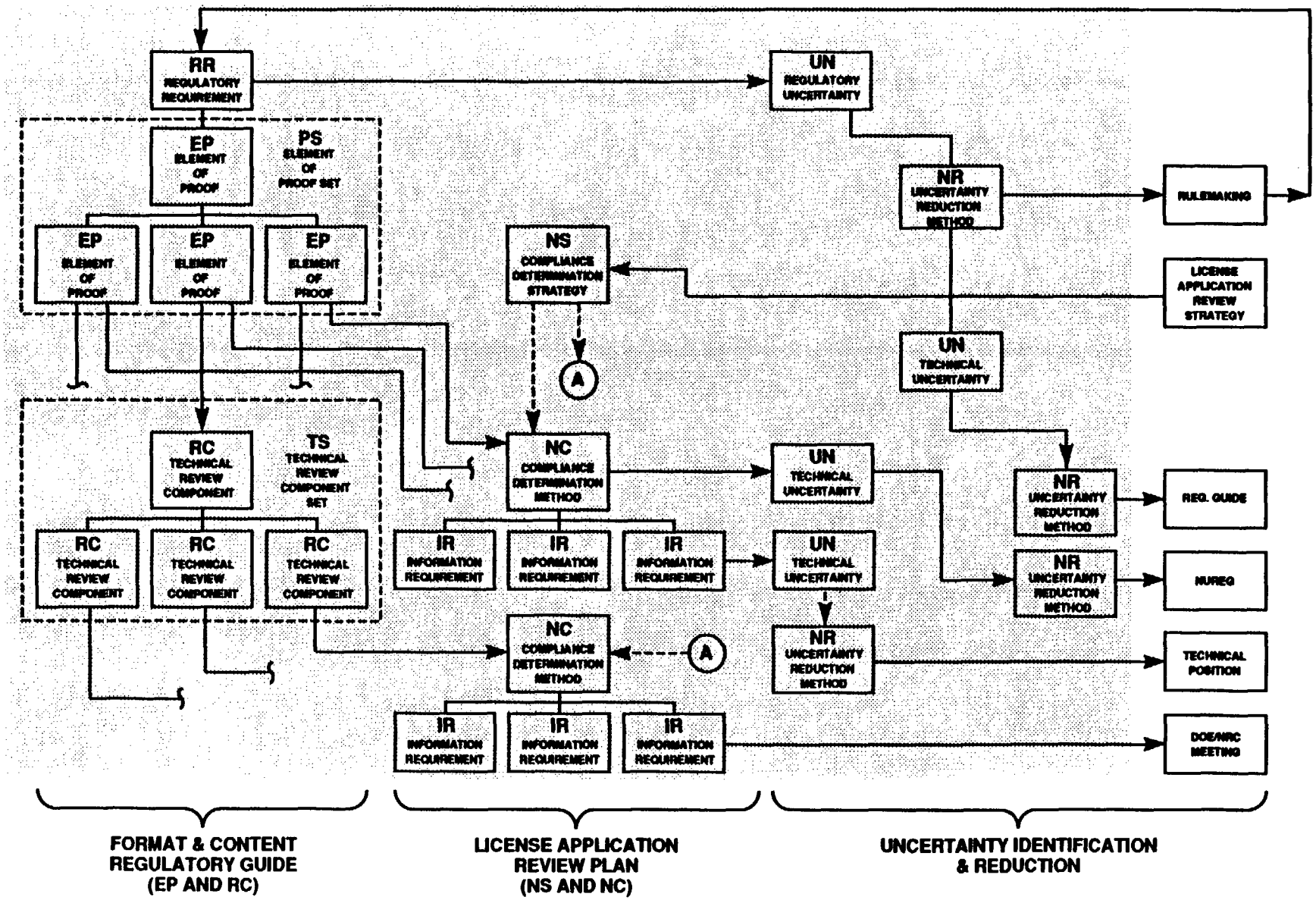
QUALITY ASSURANCE PROGRAM
FAMILIARIZATION FOR SRA

FACTORS AND CONTROLS WHICH INFLUENCE THE QUALITY OF SRA INCLUDE

* PERFORMING SRA IN ACCORDANCE WITH DOCUMENTED PROCEDURES

  TECHNICAL OPERATING PROCEDURE TOP-001 AND DAUGHTER PROCEDURES TOP-001-xx

  Procedures shall be distributed to NRC and available to NRC Staff performing SRA


RR
REGULATORY REQUIREMENT
UN
REGULATORY UNCERTAINTY
EP
ELEMENT OF PROOF
PS
ELEMENT OF PROOF SET
NR
UNCERTAINTY REDUCTION METHOD
RULEMAKING
EP
ELEMENT OF PROOF
EP
ELEMENT OF PROOF
EP
ELEMENT OF PROOF
NS
COMPLIANCE DETERMINATION STRATEGY
LICENSE APPLICATION REVIEW STRATEGY
UN
TECHNICAL UNCERTAINTY
A
RC
TECHNICAL REVIEW COMPONENT
TS
TECHNICAL REVIEW COMPONENT SET
NC
COMPLIANCE DETERMINATION METHOD
UN
TECHNICAL UNCERTAINTY
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NR
UNCERTAINTY REDUCTION METHOD
NUREG
NC
COMPLIANCE DETERMINATION METHOD
A
NR
UNCERTAINTY REDUCTION METHOD
TECHNICAL POSITION
IR
INFORMATION REQUIREMENT
IR
INFORMATION REQUIREMENT
IR
INFORMATION REQUIREMENT
DOE/NRC MEETING
FORMAT & CONTENT REGULATORY GUIDE (EP AND RC)
LICENSE APPLICATION REVIEW PLAN (NS AND NC)
UNCERTAINTY IDENTIFICATION & REDUCTION

System Engineering Management

A
Basic Course

Presented to the

Nuclear Regulatory Commission
NRC

By

Center for Nuclear Waste Regulatory Analyses
CNWRA

By: G.P. Jones, Ph.D.
P.C. Gardiner, PH.D.

February 1991

Contents

Presentations:

<u>1st Day</u>

8:30 am	Introduction:	A Systems Perspective Systems Engineering Management
9:45 am	Break & Exercise	
10:15 am	History:	Development of S.E.M. Examples
11:30 am	Lunch	
1:00 am	S.E.M. Techniques and Processes	
2:30 am	Break & Exercise	
2:45 am	S.E.M. in the Planning Phase	
4:00 am	Adjourn	

Contents
(Continued)

Presentations:

<u>2nd Day</u>

Acknowledgements

We wish to thank the Center for Nuclear Waste Regulatory Analyses, CNWRA, personnel, Mr. Robert Adler and Mr. Ted Romine in particular for their guidance in the preparation of this course.
A special note of appreciation to Mr. Michael Dumbach for the production of this document.

We also wish to thank many authors for their contributions which we have tried to acknowledge.

The errors and omissions are, however our responsibility as the authors, Dr. Jones and Dr. Gardiner. The emphasis, views and opinions expressed in this document and in the verbal presentations of this course are also ours and do not necessarily reflect the views of CNWRA, NRC or any other agency.

Biographical Sketches

Dr. George P. Jones Dr. Jones has professorial appointments in Systems Engineering and Systems Management at the University of Southern California. He was Principal Investigator on several Government-sponsored projects dealing with risk analysis in hazardous materials and product safety. Before coming to the University, Dr. Jones had a career as an engineer and manager, including positions as Project Engineer, Chief Engineer, and Director of Advanced Systems for Rockwell International Corporation. He received a National Science Foundation Fellowship for the study of nuclear power generation safety. Dr. Jones consults in the areas of engineering management and systems analysis and has published and taught extensively in these fields. His academic degrees are in engineering and management science.

Dr. Peter C. Gardiner Dr. Peter C. Gardiner is an Associate Professor of Systems Management at the University of Southern California's Institute of Safety and Systems Management. As department chair he recruited faculty who now constitute the majority of the Systems Management Department, and who now produce a large majority of the Institute's sponsored research projects. Among many other positive impacts of his leadership were major advances in curriculum and facilities development. He established laboratories for work in Decision Support Systems, Expert Systems, Systems Dynamics and Telecommunications and Information Security. He teaches, consults and is a widely published author in such areas as policy analysis, systems dynamics, logistics and systems acquisition, decision analysis, and information security.

"A System Perspective"

Session I

Objectives of Course

* Basic Knowledge of
  System Engineering Management (101)

* Preparation for
  Systematic Regulatory Analysis (SRA)
  Training Course

* Understanding of
  D.O.E. Program

* Application of Concepts

Course Objectives

NOTES

The four major objectives of the course are shown above.

1. To provide a basic understanding of what System Engineering Management is, a sort of "SEM 101" Course.

2. To prepare you for the SYSTEMATIC REGULATORY ANALYSIS course which CNWRA will present to you in the near future.

3. To provide you with an understanding of the developing DOE program and the methods that they and their contractors will be applying in the nuclear waste repository program.

4. To provide a basis for your application of the powerful and well developed System Engineering Management approach to your efforts in the nuclear waste repository program.

Outline of Course

	1st Day	2nd Day
AM	**Introduction** Systems Perspective Definitions & History	**Operations** Organization Integration
PM	**Techniques (Planning)** Mission Analysis Functional Analysis Requirements Analysis	**Issues & Summary** Control Summary Q & A

Coming!

Jones &
Gardiner

SRA Course

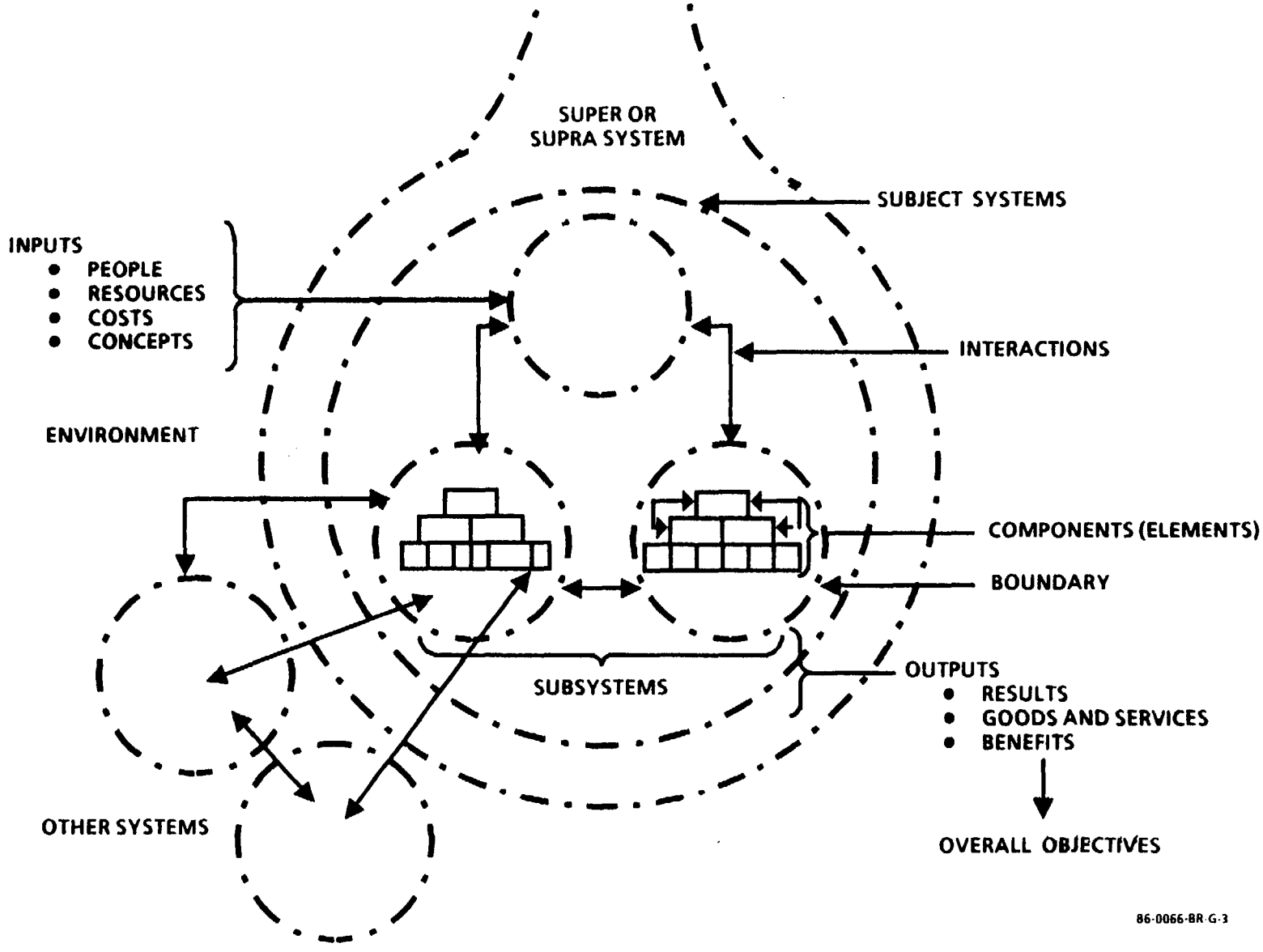
S. E. M. →

COURSE OUTLINE

A top level outline for this course is shown. Peter Gardiner and I, George Jones, will be alternating in presenting this course. A brief resume for each of us appears in the front part of this document. Center for Nuclear Waste Regulatory Analysis, CNWRA, people are also in attendance and we will all be available for your questions and comments.

NOTES

THE SYSTEMS APPROACH



THE SYSTEMS APPROACH:

Notes

To view the organization (system) that we are analyzing, designing, engineering, managing, etc. in its fullest context. This view includes the internal and external interaction of the components and subsystems of the organization with each other and with the environment outside the system and the hierarchy of systems of which the subject organization is but a subsystem. One can base decisions and actions on achieving the overall organizational objectives by this approach.

ASPECTS OF THE SYSTEMS APPROACH:

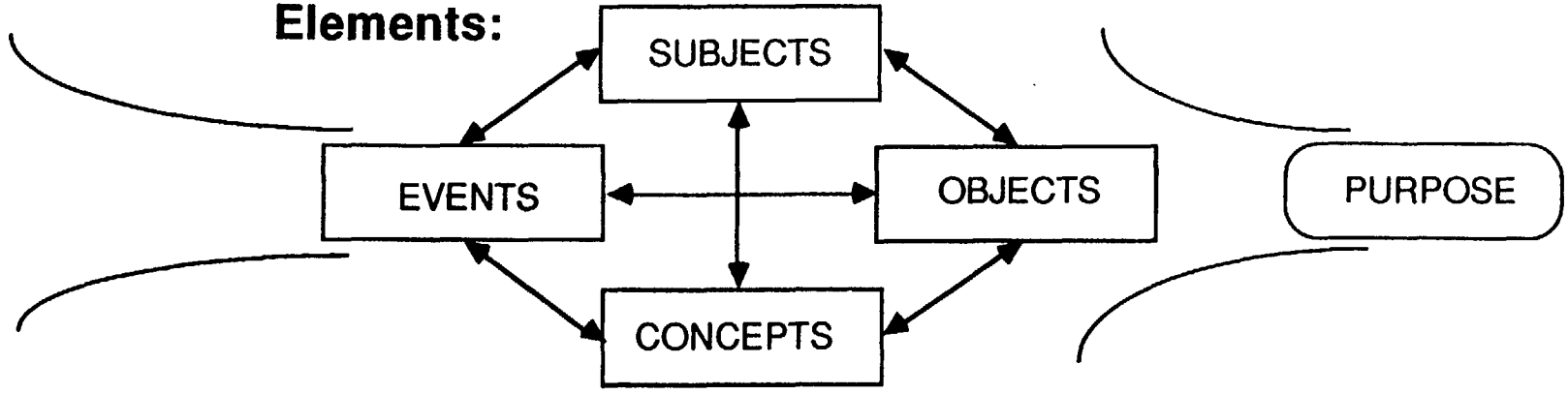
* A synthesis of management schools (classical, behavioral, scientific).
* A method related to systems analysis and decision making.
* A common conceptual scheme.
* A new kind of scientific method. (Ref. 1)
* Applied General Systems Theory.
* A half-baked idea.
* "...is not a bad idea" (Ref. 2)

RESULTS OF THE SYSTEMS APPROACH:

When the systems approach is good, things work smoothly as desired: you are unaware of the functioning. When it's bad, things are out-of-balance, frustrating, and dissatisfying; effects occur which are unplanned and unwanted.

A SYSTEM

Elements:



Purposes:

CONSTITUENTS

NORMATIVE

CONSTRAINTS

INTERACTIONS

ACTUAL

GENETIC

KNOWN

INHERENT

UNKNOWN

INFERRED

GOALS

PROGRAMMED

VALUES

A SYSTEM:

A system is a group of two or more elements which interact for a purpose. Elements can be:

* Subjects - Persons
* Objects - Things
* Concepts - Ideas, Processes, Theories
* Events - "Spatiotemporal unities" (Ref. 5)
  actual pulling together of assemblages. (Ref. 4)

INTERACTIONS AND RELATIONSHIPS:

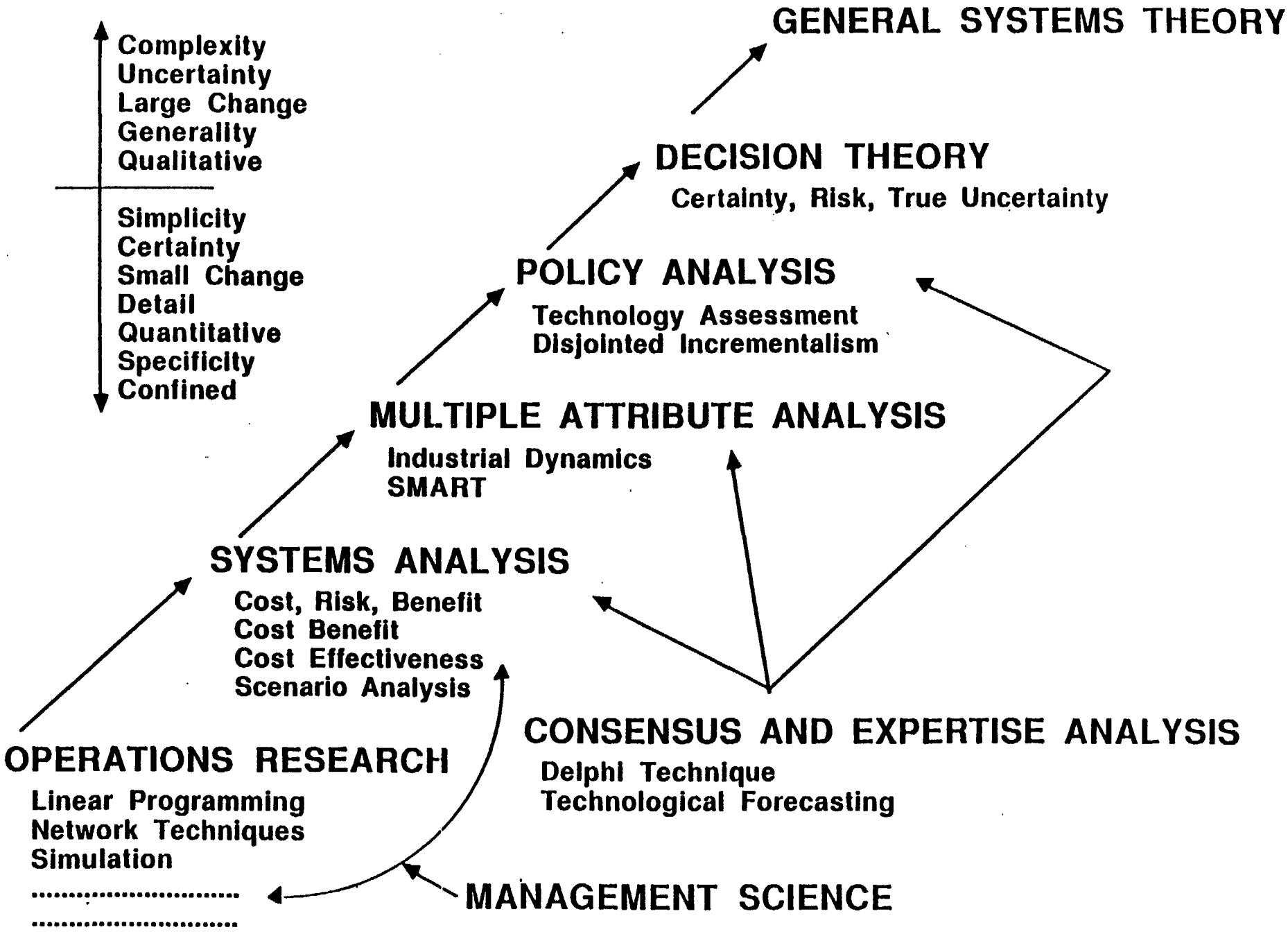
Intra and inter level transfers of matter, energy, information and/or elements between components, subsystems, systems, environment and suprasystems.

PURPOSE:

* Actual versus Normative purposes
* Genetic or programmed purpose versus controllable behavior
* Goals, purposes and values as viewed by different constituents
* Designed, inferred, unknown purposes
* Interactions as purposes
* Purposes as constraints.

NOTES

A SYSTEM PERSPECTIVE



DEVELOPMENT OF ANALYTICAL TECHNIQUES

NOTES

World War II saw the conscious development of analytical techniques to improve the effectiveness of existing systems with known, simple objectives such as air defense, naval convoys, and bombing systems. Some major tools related to this optimization process are linear programming, inventory models, and network techniques.

The more complex selection choices in limited resource situations required the development of cost-effectiveness, cost-benefit analysis, and supporting tools. These are generally classed as Systems Analysis techniques. They dealt with future system choices, different objectives and more complex situations. These techniques were, in turn, insufficient to reflect the multiple objectives of the various constituents of a system, and Multiple Attribute Analysis began to emerge.

Policy Analysis is an emerging area whose first attempts are to study, model, and explain how complex decisions are made.

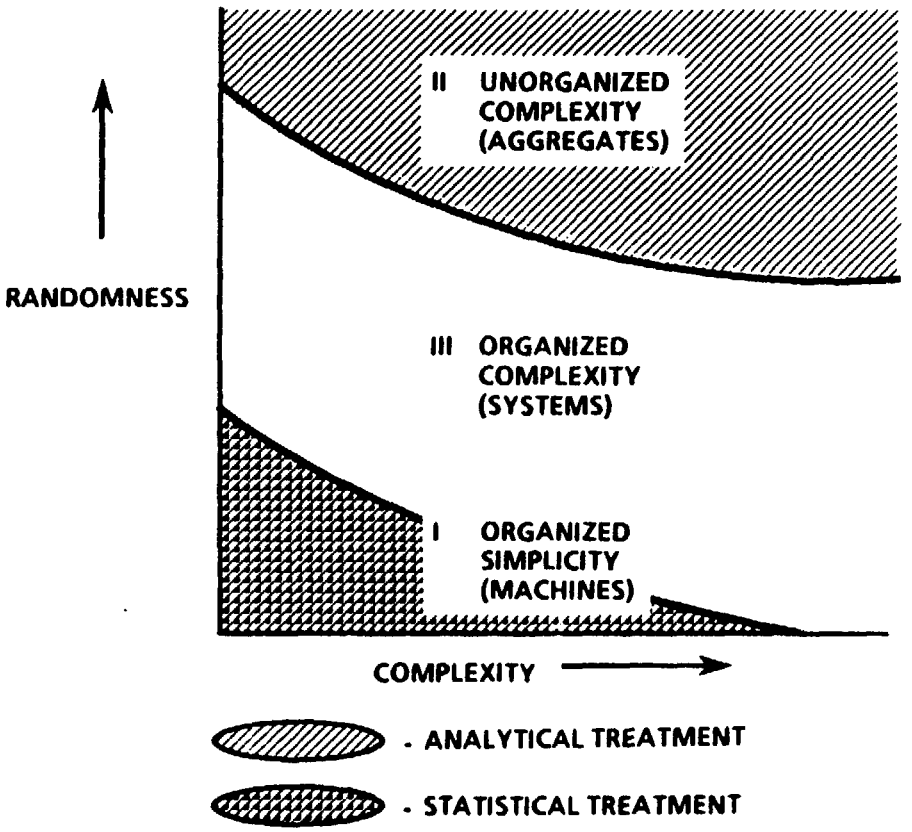
Decision Theory is a more abstract pursuit attempting to provide a decision making structure and logical procedures for choice.

Most inclusive and abstract is the "...system of systems" (Ref. 9), General Systems Theory, which is discussed next. All provide analytical tools and insights useful in the Systems Approach.

A SYSTEM PERSPECTIVE

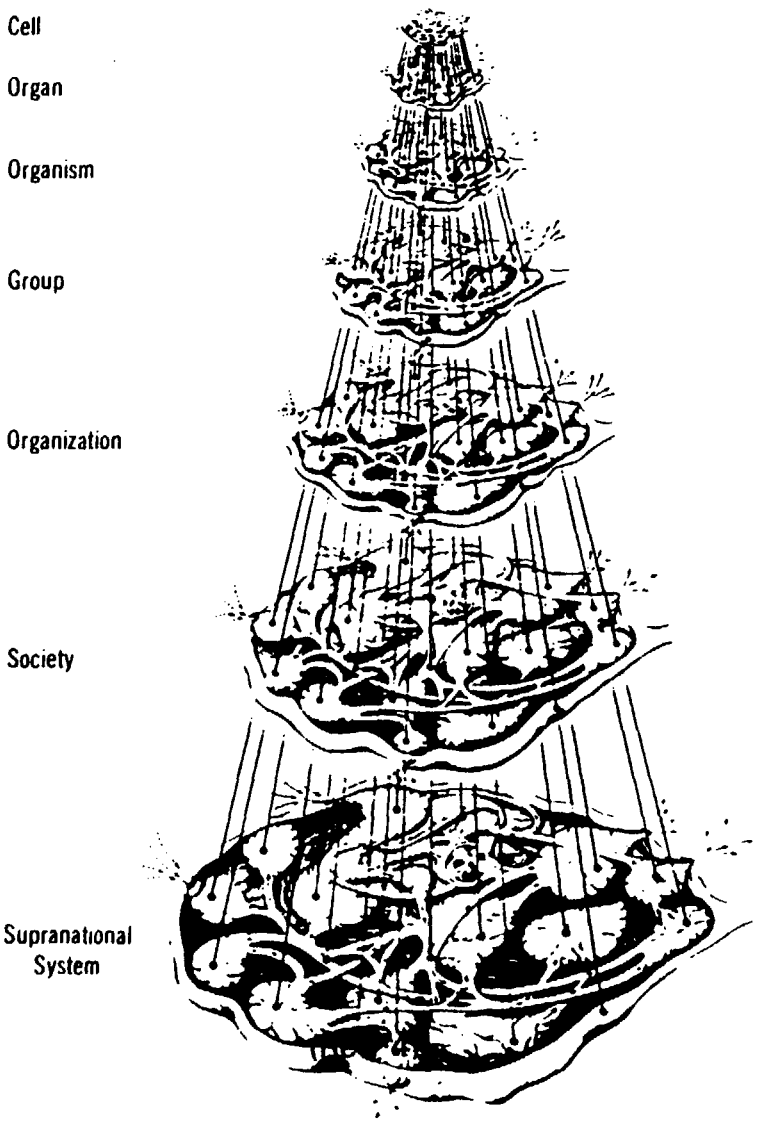
SYSTEMS

TYPES



(Ref. 7)

LEVELS



GENERAL SYSTEMS THEORY:

NOTES

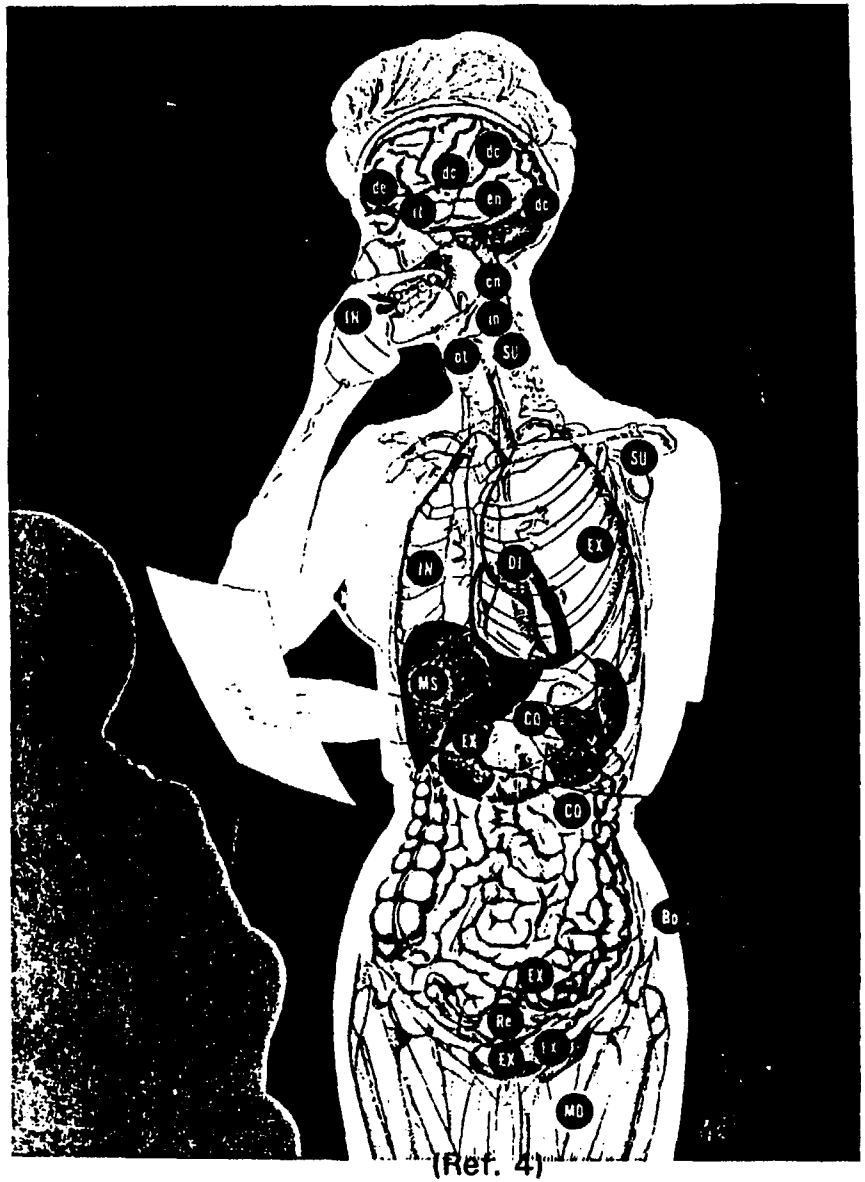
* Categorize systems, their characteristics and behaviors
* Find common nature of elements
* Define interrelationship of elements
* Formulate general principles applicable to all systems
* Develop models and laws which apply to generalized systems
* Synthesis of approaches and terms.

CATEGORIES:

Kinds - Social, Mechanical, Management
Types - Organized Simplicity versus Unorganized Complexity versus Organized Complexity (Ref. 7)
Levels - Cell to Supranational System. (Ref. 4)

A SYSTEM PERSPECTIVE

THE WOMAN SYSTEM:



(Ref. 4)

SUBSYSTEMS OF THE WOMAN:

Matter-Energy and Information Processors

1. Reproducer (Re), genitalia
2. Boundary (Bo), skin

Matter-Energy Processors

3. Ingestor (IN), mouth, lung
4. Distributor (DI), heart and vascular
5. Converter (CO), stomach, intestine
6. Producer (PR), glandular subsystem
7. Matter-Energy Storage (MS), liver
8. Extruder (EX), lungs, kidney, rectum, ureter, and anus
9. Motor (MO), muscles
10. Supporter (SU), skeleton

Information Processors

11. Input Transducer (it), eyes
12. Internal Transducer (in), synapse
13. Channel and Net (cn), nervous system
14. Decoder (dc), cortical sensory
15. Associator (ac), association area
16. Memory (me), brain
17. Decider (de), limbic areas
18. Encoder (en), temporoparietal area
19. Output Transducer (ot), larynx

SYSTEM CHARACTERISTICS AND BEHAVIORS:

NOTES

Brief discussion of terms:

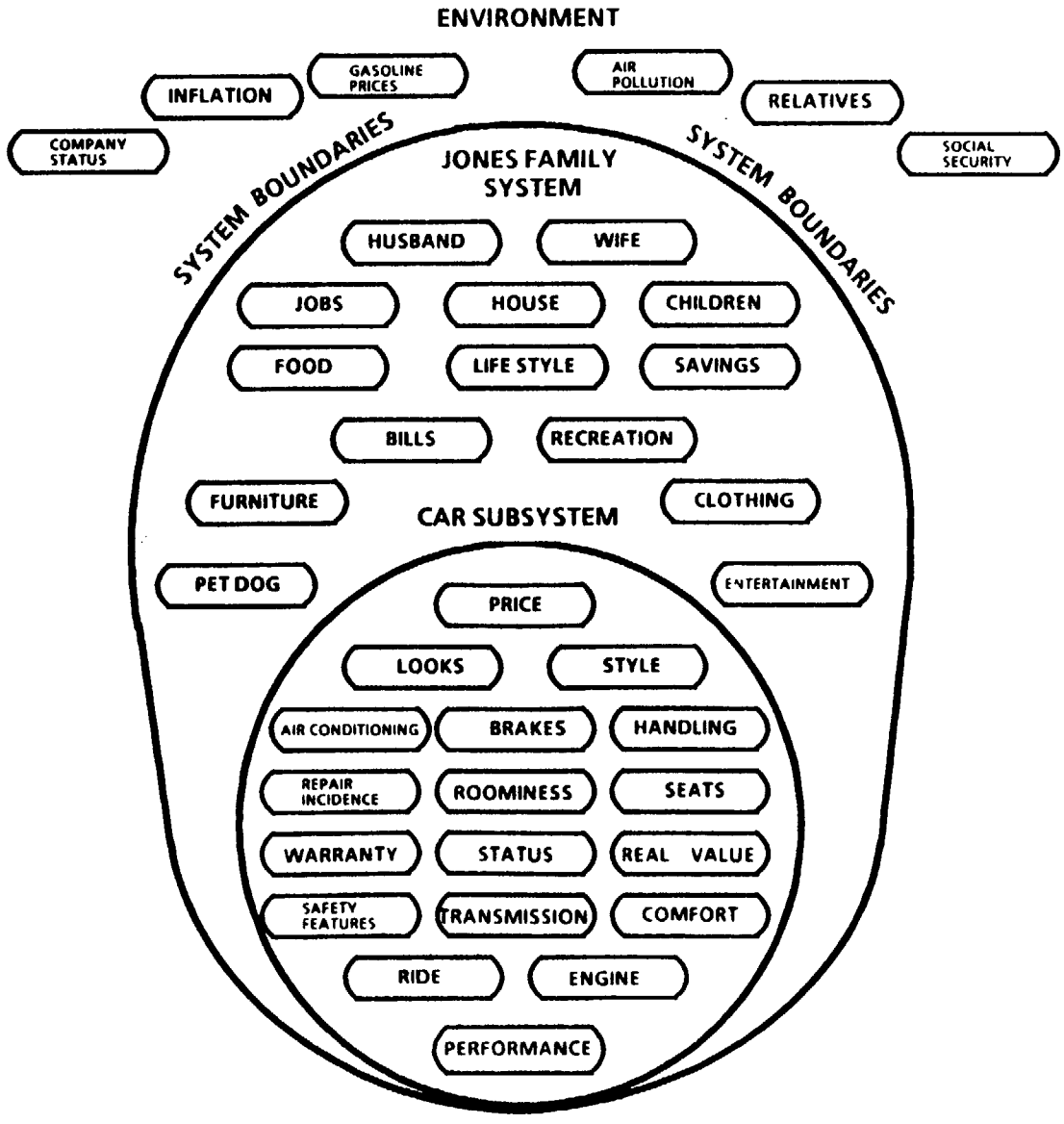
- Living versus Non-living
- Abstract versus Concrete
- Open versus Closed
- Positive versus Negative Entropy
- Purposeful Behavior
- Feedback
- Hierarchies
- Separability versus Irreducible Groups
- Wholism (aggregativeness)
- Complexity
- Boundaries
- Dynamic Equilibrium
- Homeostasis
- Internal Proliferation
- Equifinality

ELEMENTS OR SUBSYSTEMS

See diagram.

A SYSTEM CONTEXT DIAGRAM

THE JONES FAMILY CAR



EXAMPLES OF SYSTEM REPRESENTATIONS:

NOTES

A System Context Diagram - The Jones Family Car (Ref. 10), is an example of a "System Concept Diagram." It shows the subject subsystem, the car placed within the suprasystem, the family, and the environment, along with the important components, subsystems and boundaries of each domain. It provides a systems perspective and serves as an organized checklist of component parts and potential interactions. It is, however, a static representation and it does not specify the interactions between the parts of the system displayed.

A SYSTEM PERSPECTIVE

CRIMINAL JUSTICE SYSTEM DIAGRAMS

THE CRIMINAL JUSTICE SYSTEM AND MAIN FLOWS

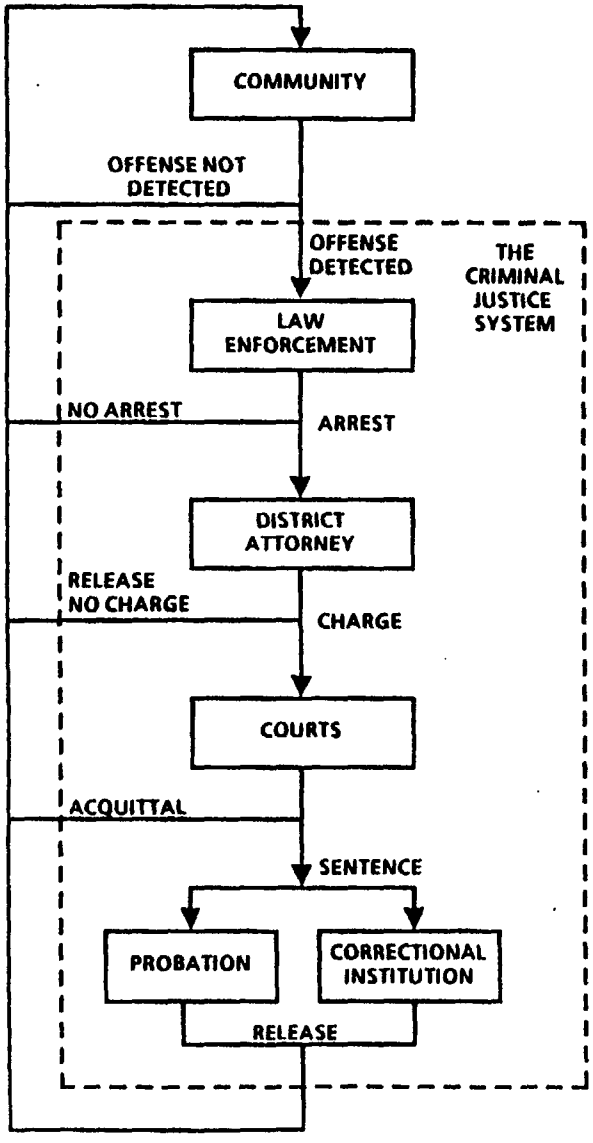


FIG. 1.2

SYSTEMS INFLUENCING THE CRIMINAL JUSTICE SYSTEM WITH SELECTED OUTPUTS

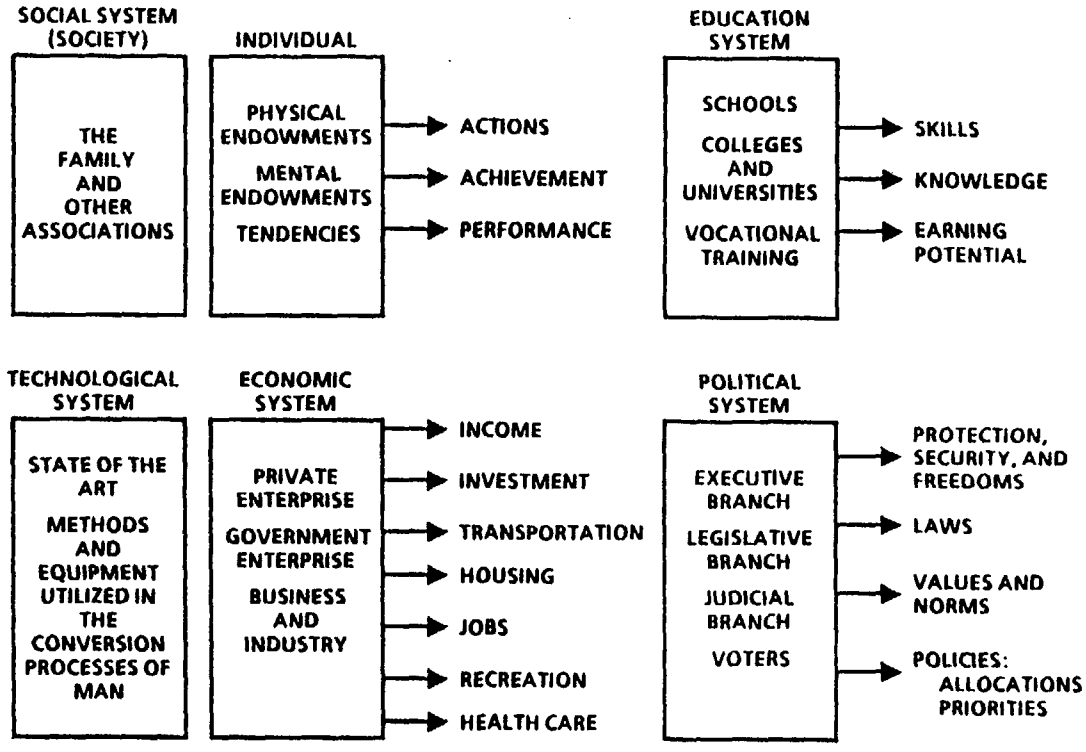


FIG. 1-3

THE LAW VIOLATOR AS AN OUTPUT OF SOCIETY AND AS AN INPUT TO THE CRIMINAL JUSTICE SYSTEM

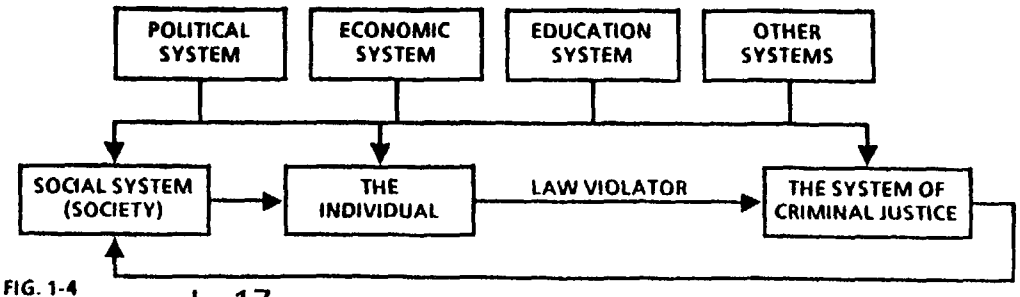


FIG. 1-4

NOTES

EXAMPLES OF SYSTEM REPRESENTATIONS:

A System Interrelationship and Flow Diagram - The Criminal Justice Systems Diagrams, (Ref. 10), show several aspects of the system. Figure 1.2 shows the various paths of a law violator through or around the criminal justice system (CJS). Obviously, many more branches are possible.

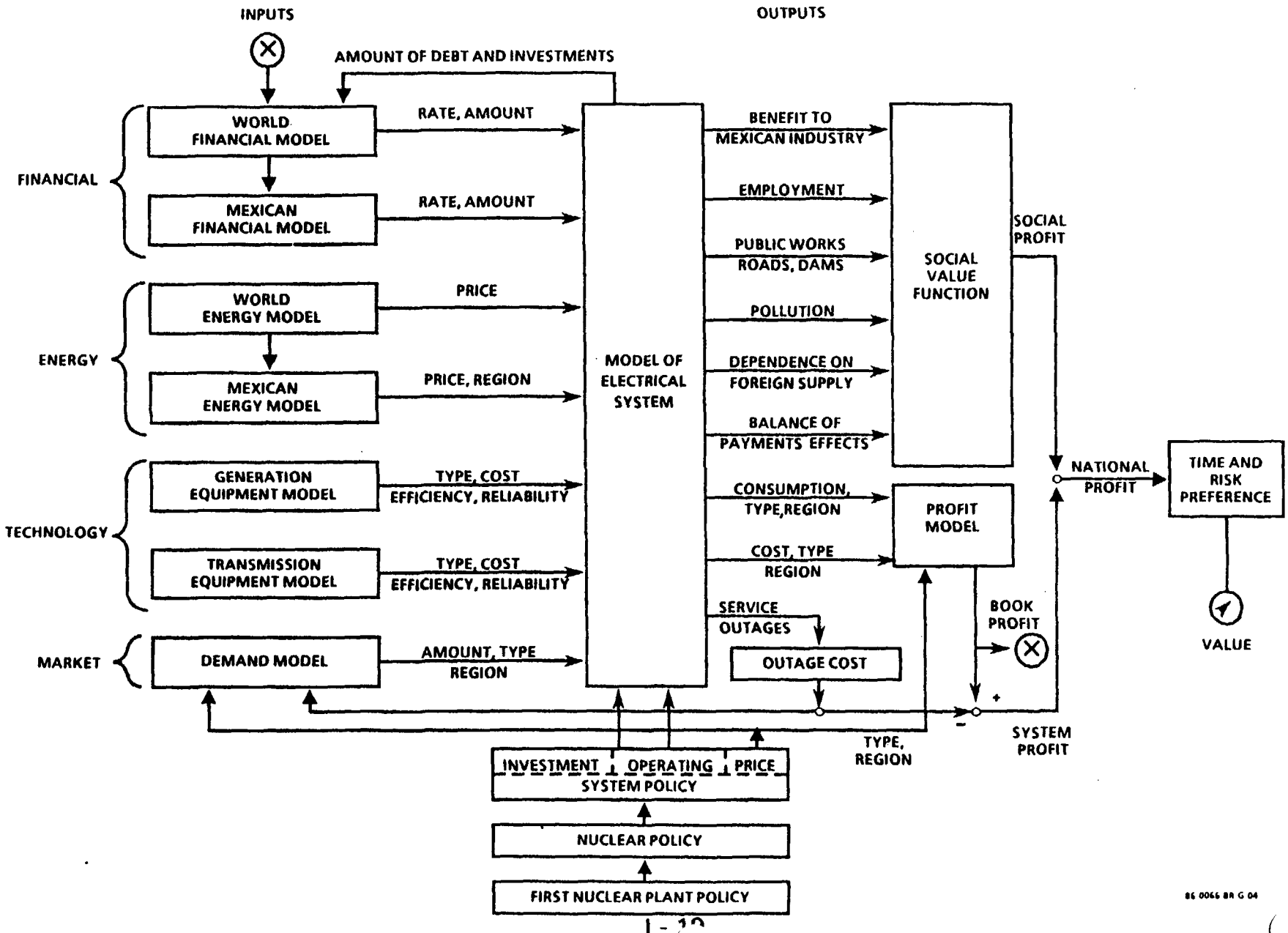
Figure 1.4 shows that a law violator is an output of society and an input to the CJS and vice versa. It shows some of the interfacing systems but, again, not the interactions.

Figure 1.3 is an attempt to show the major factors which are determined, in part, by interfacing systems that may help influence the law violator.

The flow and input-output factor diagrams are a help in making the system representations less static and more specific about the important interrelationship of systems. There is, however, still no representation of the processes by which law violators are molded or disposed of by the CJS.

A SYSTEM PERSPECTIVE

MEXICAN ELECTRICAL SYSTEM



NOTES

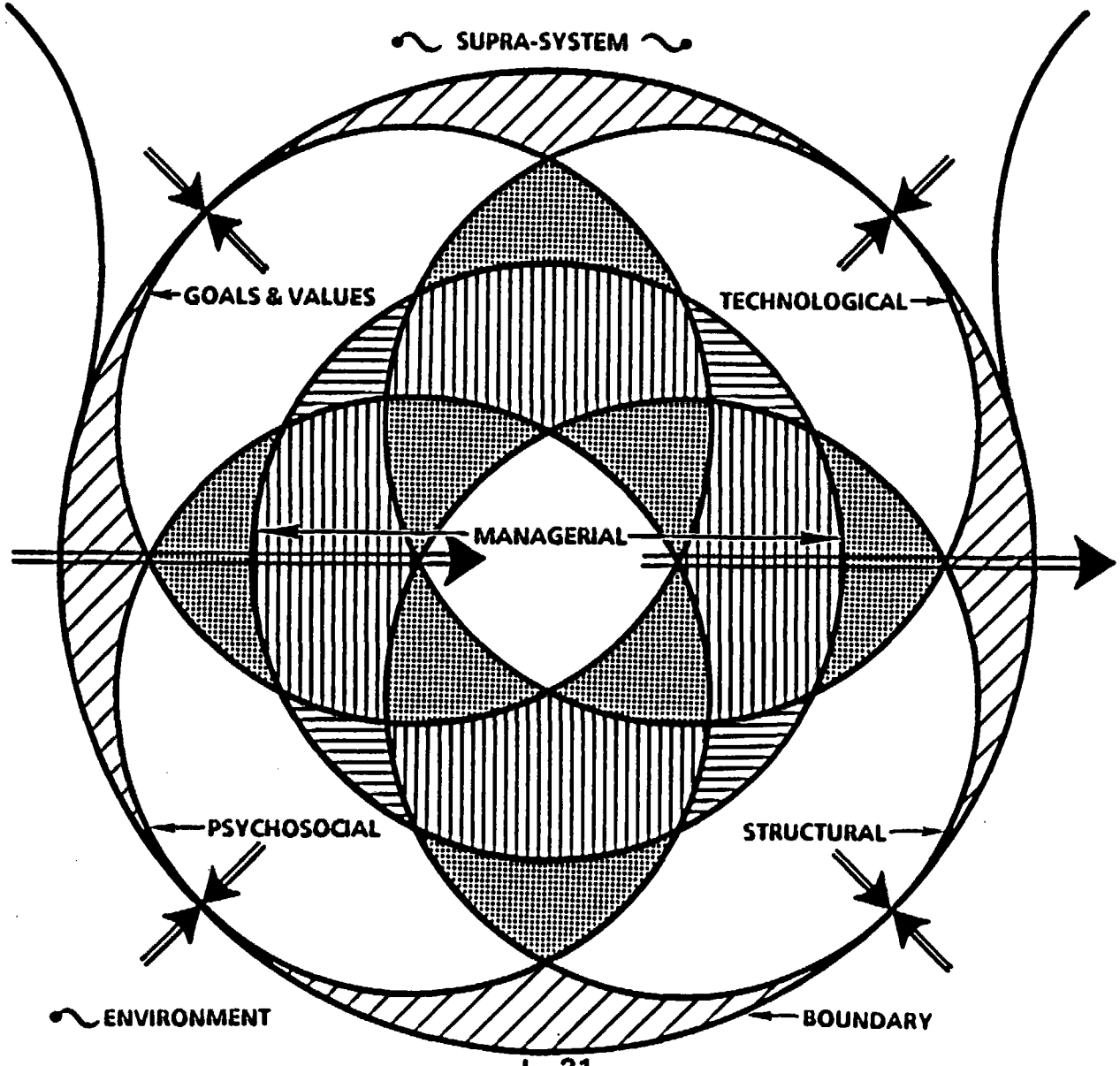
EXAMPLES OF SYSTEM REPRESENTATIONS:

A System Decision Analysis Model (Ref 16) is displayed by the Mexican electrical system representation. Both flow and factors are shown. Each block implies a method or model which combines the inputs to predict the outputs and feedbacks. The methods and models could range from rather simple forecasting and correlations to sophisticated analytical and simulation models. Such decision models, with all the detail implied, entail a large amount of effort. However, with such models the dynamics of the system can be examined, the sensitivity of system outputs to influencing factors can be determined and alternative designs, procedures, and processes can be evaluated.

The reason for relating the systems approach to systems analysis and cost effectiveness is obvious.

A SYSTEM PERSPECTIVE

ORGANIZATIONAL SYSTEM



EXAMPLES OF SYSTEM REPRESENTATIONS:

NOTES

This introductory session has the purpose of stimulating systems thinking and sorting out terms like systems engineering, engineering, management and systems engineering management. To make the transition to the terms, the Organizational System representation has been paraphrased from Ref. 11.

Five sets or subsystems are envisioned:

- Goals and Values
- Psychosocial
- Managerial
- Structural
- Technological

Each has its own function and each interacts singly and multiply with all other sets. For instance, management's function is to design and make the internal organization operate as well as to provide the main boundary bridging elements to the environment and the suprasystem. A major change in any subsystem should be preceded by consideration of effects in all areas of interaction.

SYSTEMS ENGINEERING

Engineering:

Research, Design, and Test

- Hardware
- Software and Processors
- Objects and Concepts
- Organized Simplicity, Unorganized Complexity

Systems Engineering:

Research, Design, and Test -- with Emphasis on:

- Overall Requirements and Objectives
- Specifications and Allocations of:
  - Subsystem Performance
  - Maintenance Actions
  - Failure Kinds and Rates
  - Error Kinds and Frequencies
  - Development and Operating Costs
  - Scarce Resources
- Human Elements, Factors, and Engineering
- Interfaces and Interactions
- Logistics Engineering, Production Engineering
- . . . . . .

SYSTEMS ENGINEERINGS:

Engineering - The economical utilization or conversion of natural resources, energy or information into products, services, and environments useful to individuals and societies has become more identified with the design and test of hardware, software, and processes; organized simplicity and unorganized complexity.

Systems Engineering - Seeks to optimize the overall system functions according to the weighted objectives and to achieve maximum compatibility of the system's parts.

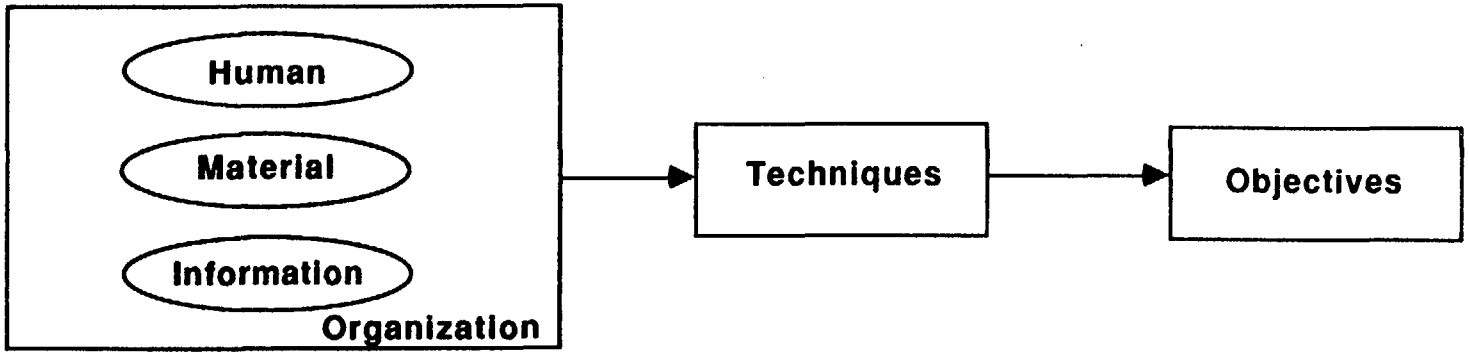
Systems Engineering generally sets the requirements and specifications of subsystems and components and it integrates reliability, maintainability, safety, human factors, etc. into the total engineering effort to optimize performance within constraints.

NOTES

A SYSTEM PERSPECTIVE

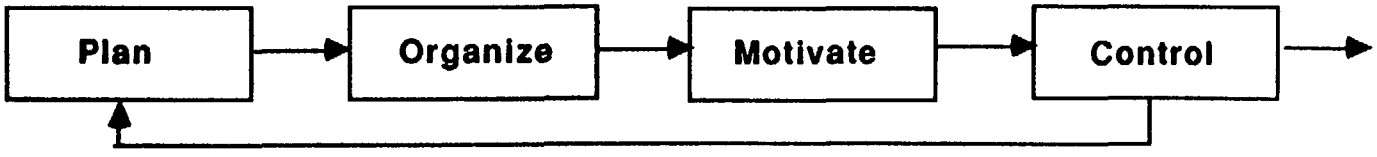
SYSTEMS MANAGEMENT

MANAGEMENT



SYSTEMS MANAGEMENT

CLASSICAL



BEHAVIORAL

Emphasizes psychological, sociological, and cultural issues

SCIENTIFIC

Emphasizes economic, technical, efficiency, measurement, and rationality

SYSTEMS MANAGEMENT

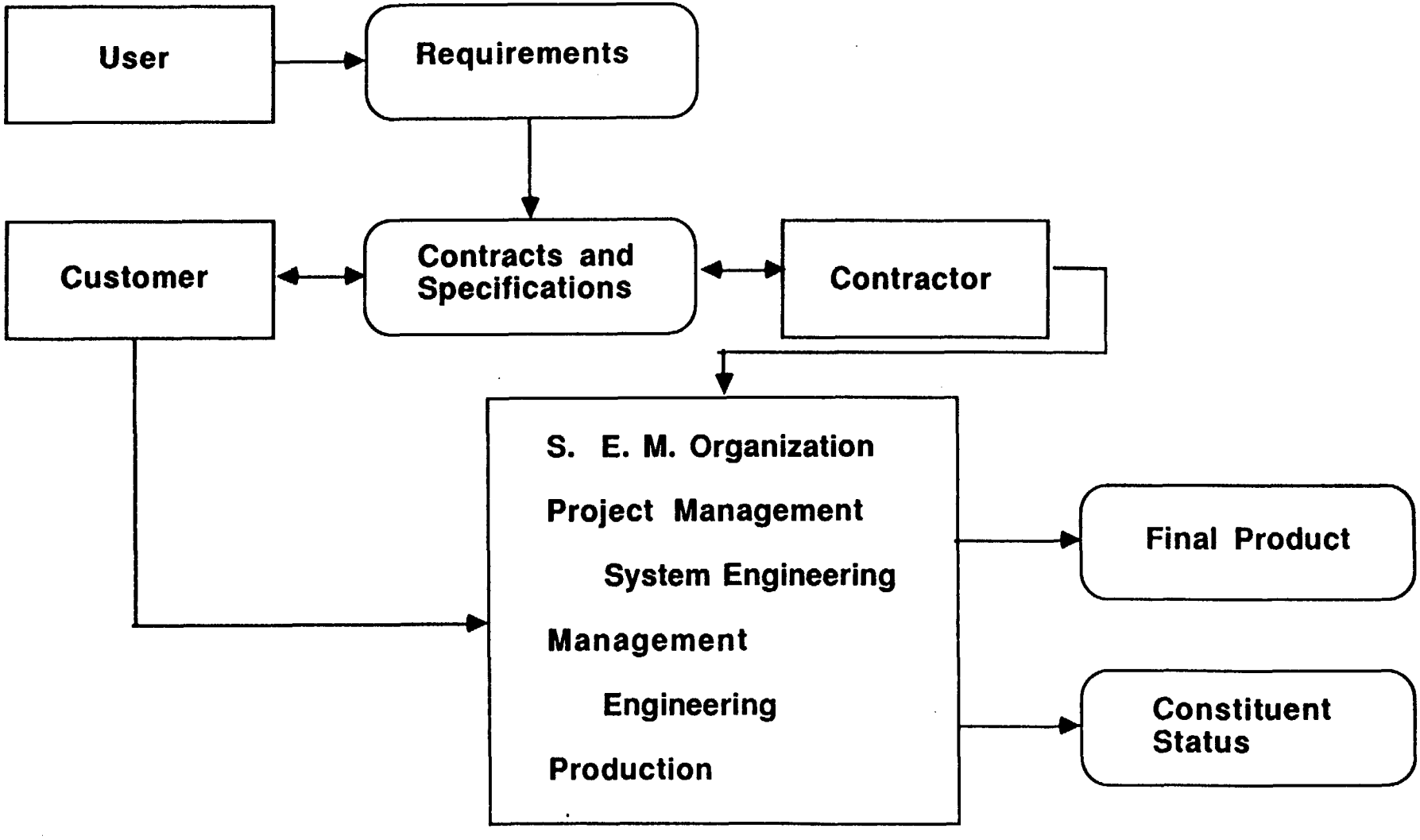
SYSTEMS MANAGEMENT:

Management - The coordination of human, informational and material resources toward the accomplishment of objectives in an organization: toward objectives - through people - via techniques - in an organization.

Are Systems Managed? - Systems Management has been offered as the synthesis of the classical, behavioral, and scientific management schools. Engineering emphasizes the design of the system; management emphasizes the operation of the system.

NOTES

SYSTEMS ENGINEERING MANAGEMENT



PROJECT MANAGEMENT

SYSTEMS ENGINEERING MANAGEMENT:

NOTES

It follows that the Systems Engineering process must be managed; that the evolving and changing desires of the system user be matched with the developing capabilities of the potential system and expectations of all other constituents, and that this be documented in specifications, schedules, contracts, reviews, etc.

The Systems Engineering Management diagram, opposite, shows a rough flow diagram of functions in the process. The two pages which follow are an incomplete list of functions which fit within the process. Each particular system will require emphasis on different aspects of the process.

Systems Engineering Management is part of Project or Program Management. The degree of control by Project Management varies as organizations vary from mainly functional organizations, through matrix organizations, to mainly projectized organizations.

SYSTEM ENGINEERING / MANAGEMENT PRACTICE

Definition of System Engineering:

System Engineering is the application of scientific and engineering effort to:

a. Transform an operational need into a description of system performance parameters and a system configuration through the use of an iterative process; e. g., definition, synthesis, analysis, design, test, evaluation, etc.

b. Integrate related technical parameters and assure compatibility of all physical, functional, and program interfaces in a manner which optimizes the total system definition and design, and

c. Integrate reliability, maintainability, safety, human, and other such factors into the total engineering effort.

(Mil-Std-881A, p. 3 & 4)

The following terms are used in describing System Engineering i: (Mil - Std - 881A, p. 384)

Integrated planning and control of:

- -- Design Engineering
- -- Logistics Engineering
- -- Specialty Engineering
- -- Production Engineering
- -- Integrated Test Planning

System Requirements

Preferred System Configuration

Logistics Engineering

It excludes actual design engineering and production engineering directly related to the products of a deliverable end item.

System Definition

Examples of System Engineering efforts are listed as:

Overall System Design

Design Integrity Analysis

System Optimization

System Cost / Effectiveness Analysis

Inter and Intra System Compatibility Analysis

NOTES

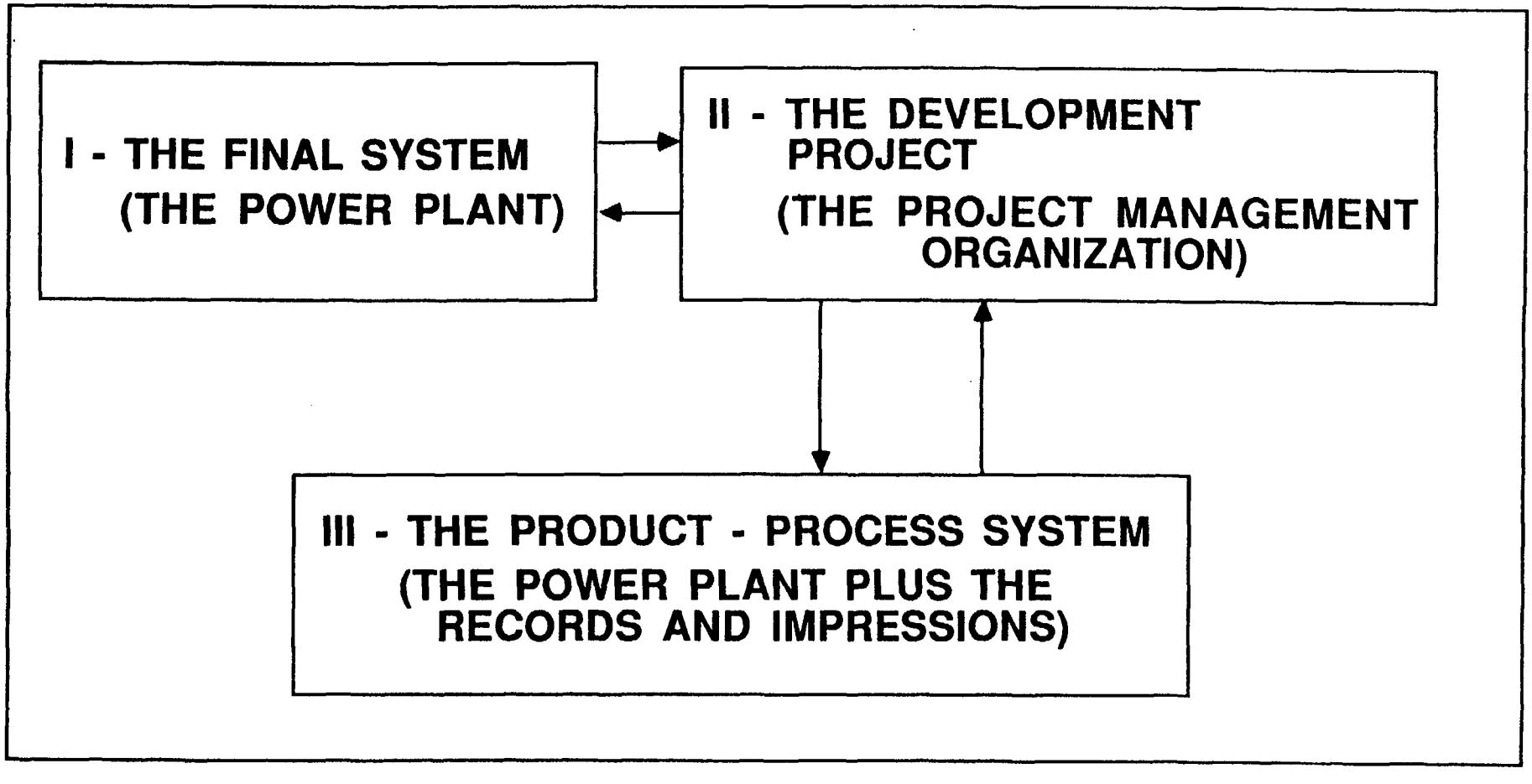
SYSTEMS ENGINEERING/MANAGEMENT PRACTICE

Examples of Systems Engineering efforts (continued)

- Integration and Balancing of Reliability, Maintainability, Producibility, Safety, Survivability, Human Factors, Personnel and Training Requirements, Security Requirements, Configuration Identification and Control, Quality Assurance, Value Engineering, Equipment and Component Performance Specs., Design of Test and Demonstration Plans.

- Support Synthesis
- Design Impact Projections
- Life Cycle Cost Factors
- Time Factors
- Trade-off Analysis
- Logistic Design Appraisal
- Use Studies
- Support Functional Requirements
- Repair Level Determination
- Task Analysis
- Standardization Review
- Logistics Support Plan
- Maintenance Plans
- Facilities Planning
- O & M Operations and Maintenance Planning
- Transportation and Handling Plan
- System Engineering Management Plan (SEMP)
- Specification Tree
- Program Risk Analysis
- System Test Planning
- Decision Control Process
- Technical Performance Measurement
- Technical Reviews
- Subcontractor/Vendor Reviews
- Work Authorizations
- Technical Document Control
- Material Review and Control
- Etc., Etc., ...

PROJECT MANAGEMENT



PROJECT MANAGEMENT:

NOTES

Project Management or Systems Engineering Management is really responsible for three systems:

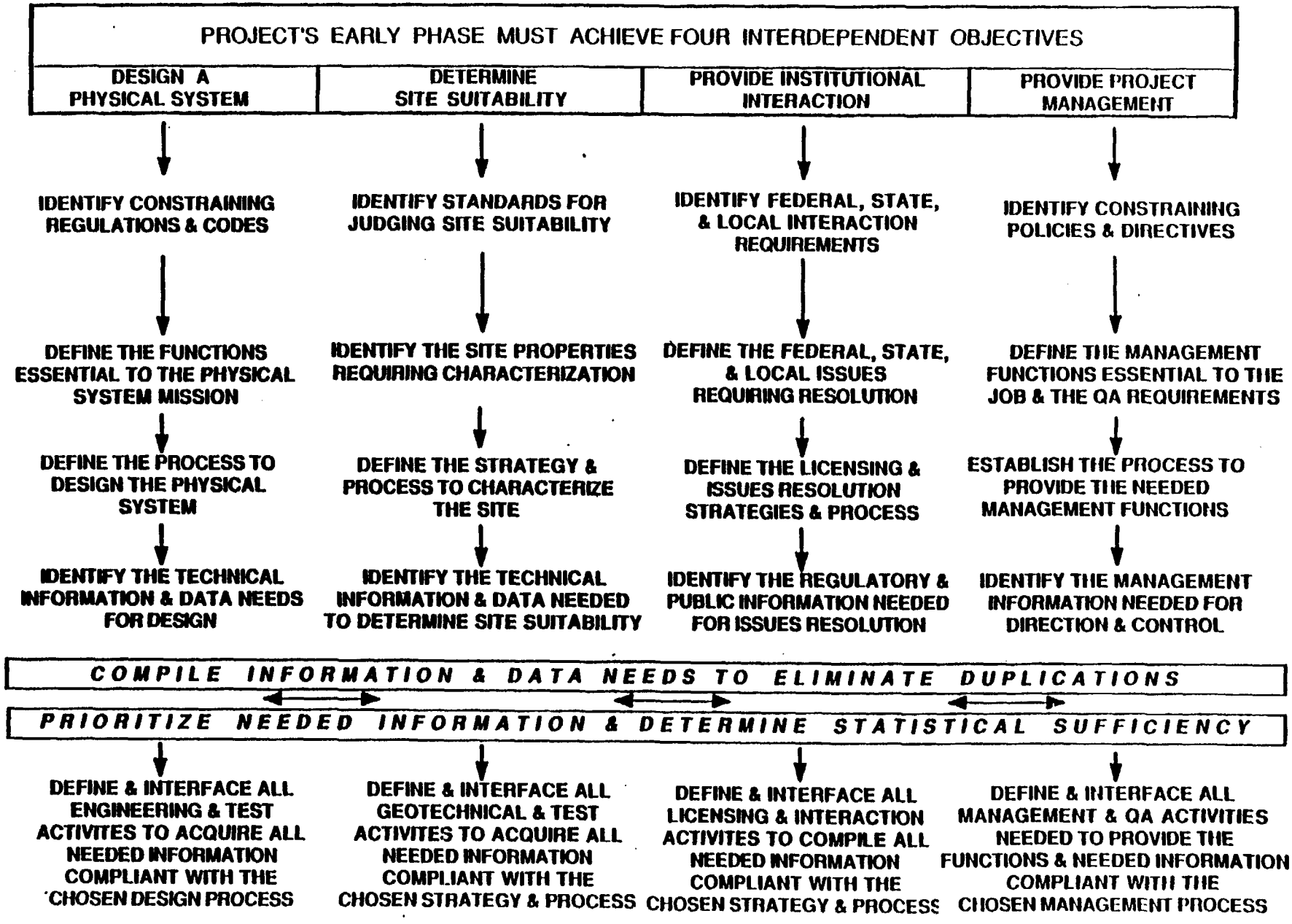
1) The system that satisfies the user's desires
2) The system that brings the former into being
3) The combination of the two above.

The first is the final product; the second is a temporary assemblage. The goals and objectives of the two systems are different as are their composition, schedules, costs, etc. Yet, the Project Manager must integrate the two systems so that the combination satisfies still another set of goals, objectives and constraints.

It is important to recognize the different systems when making decisions. Which system goals, objectives and constraints are or should be employed? What compromises in the two other systems are being made to optimize a decision for the third? It is also fortunate that there is a difference because the lessons learned and the processes developed in the first pursuit, Project Management, are more transferable between projects than are the more specific and unique details concerned with particular systems.

So with this brief introduction into systems thinking and an attempt to sort out some of the terms that will be involved, we will move on to a more detailed discussion of the Systems Engineering Process.

SYSTEMS APPROACH TO A HYPOTHETICAL NUCLEAR PROJECT



PROCESS/PRODUCT

This, and the following page, shows the generalized process and the product of the application of system engineering principles to a hypothetical nuclear project (T.Woods, Ref.19,Sect.D). The product and the process are similar, especially in the early stage of a project which is the focus here.

A "system" is created to fulfill a specific purpose, it will have an objective and several sub-objectives. Four sub-objectives are shown in order to fulfill the objective:

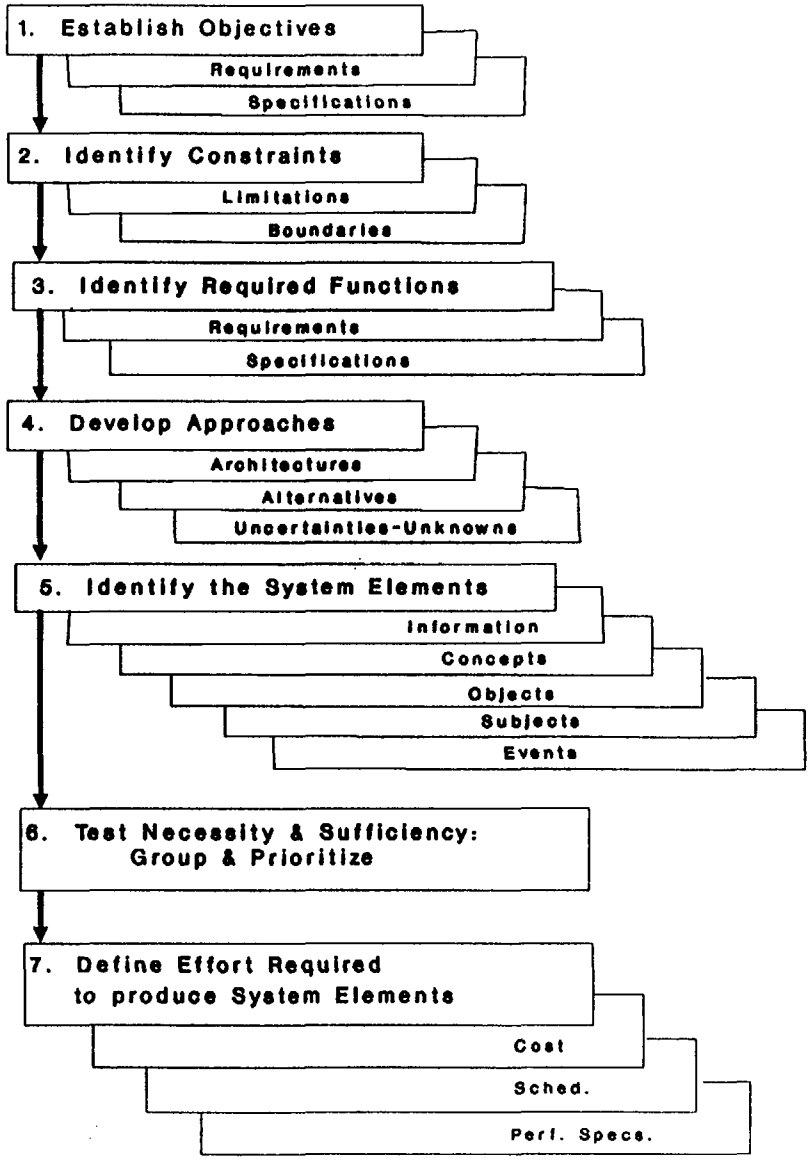
> *to achieve the mission for the permanent disposal of spent nuclear fuel and high-level waste in a manner that protects the health and safety of the public and the quality of the environment.*

The seven steps, functions or outputs of the application from the definition of the objectives to the detailed definition of all needed information (for this early project stage) are parallel to the seven steps shown for the process which develops them, on the following chart. In later project stages the detailed definitions will include cost, schedule and performance specifications for all elements of the system: objects, subjects, concepts and events.

Each product and process is directly related to its parent function, constraint, objective chain.

NOTES

Process/Product



PRODUCT / PROCESS

The seven iterative steps of the process shown here parallel the seven outputs of the product shown on the preceding page. The applicability of the process is extended beyond the early project stage to treat all system elements: hardware, software, services, people, concepts and procedures, milestones, events, etc.

The same general process can be followed to develop the product related to each of the seven steps. Each step flows from its parent function-constraint-objective set. Of course, the process will be supported by analysis, methods and organizational techniques specific to that stage. Several of these tools will be explained later.

It could be said that the process is the product or that the product is the process.

NOTES

"We are left with the sobering realization that our generation is the first whose decisions will determine whether the earth will remain habitable"

Lester R. Brown and Edward C. Wolf, State of the World, 1988

S. E. M. →

The purpose of this overhead is to remind us all that for the first time in human history we are creating systems that have the power to destroy us as well as serve us. This means that we must search for the best methods possible to research, understand, design, test, implement and manage the large, complex systems that have come to typify our age.

NOTES

Sine Factis Persona Ista Cum Opinione Solo Tu Es

S. E. M. →

This overhead is for the latin scholars amongst us.

NOTES

Without Data you are just another person with an opinion

This translation of the latin suggests that facts are critical in the design and management of large scale, complex systems. Without facts, as is suggested, one is simply adding to the collection of voices raised to express concerns but represent people who are largely uninformed.

Opinions are certainly a part of any process that involves people, but the relative weights given depend upon the point in process in which they are offered. Values and opinions are relevant in performing evaluations. Values and opinions are of little if any use in questions of fact. Values form the basis for evaluating facts and putting facts in perspective.

NOTES

There are no Facts (Data) in the Future.

S. E. M. →

There are no facts in the future. The future by its very definition has not yet occurred so no facts can occur in the future. We make efforts to project, predict, and otherwise figure out what might happen in the future but any effort to do so involves opinion no matter how well informed or educated.

We should not forget that using models and computer simulations and well established equations to make predictions does not make these predictions facts. They are still estimates and based on the opinions that have been codified by the modelers and developers of any equations used. One cannot be 100 percent certain of any "fact" until it has in fact occurred.

NOTES

Technological Systems

vs.

Sociotechnical Systems

S. E. M. →

When studying systems it is helpful to consider two major classifications of systems: technological systems and sociotechnical systems. Let's spend some time in looking further at these two classes of systems and see how they compare and in what ways there are different. As we discuss them keep in mind how the different classes might impact on our thinking as we develop regulations. Which class seems to apply in the Nuclear Regulatory setting?

NOTES

Technological Systems

- Class A: Systems Found in Physical Science
- Class B: Intellectual Technology (or products of Artificial Intelligence)
- Class C: Mix of Class A and Class B Systems

In technological systems there are three further subdivisions known as classes. There are Class A, Class B, and Class C systems. Class A systems are closest to purely "mechanical" systems and are well studied in the physical sciences. They are often called "hard" systems since the physical laws that govern them are reasonably well understood within limits.

Class B systems are systems that use intellectual technology and can be studied from the quantitative social sciences or some of the newer intellectual areas such as artificial intelligence.

Class C systems are hybrids and consist of combined Class A and Class B subsystems.

NOTES

Class A Technological Systems

Founded in Physical Science

- Radio and Television
- Laser and maser technology
- Semiconductor chips
- Electrical motors and generators
- Telephones and transmission lines
- Airplane wings and control systems

S. E. M. →

These are some examples of Class A technological systems. Notice what they all have in common. They have been well studied and developed from the physical sciences and involve physical components. There are no humans in Class A systems although humans certainly use them.

NOTES

Class B Technological Systems

"Intellectual Technology"

- Computer software
- Textbooks about computer software
- Computer languages
- That portion of the physical layout of human living and working environments that has been designed on the basis of postulated image of human behavior in that environment

S. E. M. →

These are some examples of Class B technological systems. Notice how they deal with "ideas" and ideas reduced to paper rather than physical things.

NOTES

Class C Technlogical Systems

Mix of Class A and Class B whose satisfactory performance depends on appropriate integration of these two classes into synergistic units

- Information Systems
- Management support systems
- Decision support systems
- Space missions
- Hospitals
- Nuclear power plants
- Banks

S. E. M. →

Class C technological systems are mixes of both Class A and Class B technological systems. Notice how these examples involve the combination of both "ideas" and "things" each as subsystems to form systems. Nuclear power plants are an example since such plants involve the "things" that have resulted from Nuclear Engineering and other engineering fields as well as the design as to how people and things will fit together and operate as a power plant.

NOTES

Performance of Class A Systems Can Be Described and Predicted

- (Physical scientists and engineers have primary standards as external referents)

Class B and Class C Systems Lack such referents.

- Length (made meaningfull by the existence of a primary standard of length)
- Time (made meaningful by the existence of a primary standard of time)
- Social Justice, Adequaate Safeguards to Assure Nuclear Power Safety (lack reliable and universal meaning. With no primary standards they are open to arbitrary and diverse interpretation)

In designing Class A systems engineers and scientists have well agreed upon ways to measure performance of such systems. For example, length is measured in well known ways. A measurement of length in Pakistan by a scientist should agree with a measurement of length in Alabama by a scientist. That is, two scientists measuring the same object should pretty much agree on the length of the object. What length really means and how it is measured is not the subject of great controversy.

In Class B and Class C systems, certain indicators of performance have no universally agreed upon method of measurement. For example, in order to measure the performance of a nuclear power plant or waste site with respect to meeting adequate safeguards, scientists and others would first have to agree what is meant by "adequate safeguards" and then having solved that, decide how to collect measurements given their agreed-upon definition. In Class B and C technological systems, there are often multiple and conflicting interpretations about what is meant by some indicators of performance and further conflicts about how data collection efforts should proceed even if what the term means is agreed upon. In the Quantitative social sciences we often use the term operational definition to state explicitly and clearly what is meant by an indicator of performance and how to collect measurements on it.

NOTES

Sociotechnical Systems

Mix of Technology and People

Very Difficult to Design Comprehensively

A Large Scale Extension of Class C Technological Systems Into a New Class of Systems

In sociotechnical systems all the difficulties we have in Class B and Class C systems are magnified and more difficult. This class of systems is a large scale extension of Class C systems into what has come to be recognized as a new class of systems which has not been present before.

Systems are simply growing larger, more complex, and more global. They are encompassing greater and greater numbers of people and vast amounts of things only dreamed of a few decades ago. The impacts these systems have on our lives now was the subject of science fiction only a short time ago.

These systems often exceed our capacity to understand them, design them, and manage them with the same "tried and true" methods applied to the technological systems. The results thus far have not always been good. In fact many sociotechnical systems have design flaws that produce very bad consequences.

The efforts of people to design and manage sound systems has not changed. The systems they are designing and managing have changed and many design and management tools have not adjusted to the underlying changes in the nature of sociotechnical systems.

NOTES

Systems are Growing Progressively Large in Scale

Growing from Class C Technological Systems to Sociotechnical Systems

These systems have "design flaws" which are producing:

- loss of life
- contamination of the environment due to "accidents"
- mammoth cost overruns
- criminal behavior in enterprises causing financial setbacks to many people
- transportation "accidents"
- huge loans that cannot be repaid
- erosion of confidence in organizations

S. E. M. →

As systems have grown in scale and complexity we notice increasing numbers of design flaws which produce adverse impacts on society.

NOTES

Examples of Large Scale System Failures

- Software Projects
- Nuclear Energy Projects
- Nuclear Power Plants (Cherynobl)
- Chemical Plants (Bohpal, India)
- Savings and Loan
- Eastern Airlines
- The Homeless

S. E. M. →

There are many examples of failures in sociotechnical systems and there will be many more unless changes are made in how we design and manage them.

NOTES

These Systems Are Large Scale

- numbers of people
- extent of influence of the system
- extent of the complexity of the system
- volume of information required to describe what is happening in the system
- number of interactions among system components
- the risk of disaster
- the extent of the consequences of failure of the system

There are some easy ways to spot sociotechnical systems. Although these indicators are general and no thresholds have been specified, the sheer size of some of today's systems clearly distinguish them as sociotechnical. Moreover, the situation is not one of "either/or".
Either a system is a sociotechnical system or it is not. There is a continuum and systems can be located on that continuum. In many instances one could debate whether or not a system was a Class C technological system or a sociotechnical system. It often depends on how you draw a system's boundary.

NOTES

The Nuclear Waste Repository

- Unique and Complex
- First of its kind (no Prototypes. Design, build and turn on)
- Reasonable Assurance that safe waste isolation can be provided for 10,000 years (No external primary standard)
- Unprecedented oversight and control by various affected and interested parties
- Approximately 24 pounds of waste released at Cherynobl. Estimated this will cause 17,000 to 475,000 deaths
- Repository will store 70,000 metric tons of heavy metal or equivalent (5.8 million times what was released at Cherynobl.)
- Will require stainless steel to last for 1,000 years (it's only been around for 50 years or so)

S. E. M. →

If one takes a purely "technical" viewpoint, the Nuclear Waste Repository might be classified as a Class A system. If one draws the system boundaries slightly differently one might argue that it is a Class C system. Finally, there are those who might argue that it is a sociotechnical system. Which view is "correct?"

NOTES

Large Scale Systems Have Special Needs

The Engineering (planning and design) and Management (control) are dependent upon the quality of human thought

All large scale systems involve problems and approaches that require thinking that is not aligned with "traditional", discipline oriented thought.

- Traditional Disciplines organize knowledge in "vertical slices" ("stovepipes")
- Complex problems and design tasks require knowledge to be applied "horizontally" across and beyond disciplines.

The design and management of all systems depend upon human thought. This is true of sociotechnical systems as well. There is a major and growing problem, however, that has shown up with increasing regularity in the past 50 years or so.

Over the last 50 years systems have been growing larger in size and increasingly complex. These systems have produced problems and made demands upon those who design them and manage them in ways that cut across "traditional" discipline oriented thinking and boundaries.

NOTES

Small versus Large Scale Systems

Small scale systems involve "breadboards", "pilot plants", or "prototypes"

- built and tested iteratively
- discovery of design flaws
- researched remedially
- redesigned
- retested

Large Scale systems with huge potential for disasters have no such possibility

- E.g., Nuclear power plants (and Nuclear Waste Sites) go into service after they are designed and built.
- The test arena is our life situation

One way in which the change is most obvious is that entire systems cannot be built and tested in the "back room" before they are turned loose on society. Historically, systems were engineered in the lab and tested through a process of breadboards and prototypes. Large scale systems cannot be treated in the same way. It is simply physically and financially impossible.

Many large scale systems simply exist and we are called in to "repair them". Other large scale systems are created when smaller systems join as subsystems in a much larger system. Finally, some large scale systems are designed and built from scratch. In all cases the real laboratory testing is in real life. In spite of all the modelling and well thought out equations the simple fact remains: Large scale systems are designed, built, and implemented and then tested largely "on the job."

NOTES

The Fragmentation of Engineering Disciplines

Engineering originated for fortification and roads for defense

Military engineers formed Civil Engineering to develop urban infrastructure

Mechanical Engineers split off to implement the industrial revolution

Electrical and Chemical engineers split off to provide or use energy in the industrial revolution

What about the state of engineering over the same time frame that large scale systems have been emerging? A historical review of university catalogs will show that engineering has been fragmenting over the past 50 years. New areas of emphasis emerged within existing engineering programs and simply split off once some sort of a "critical mass" was reached. The real world and universities simply recognized (not always in sync) that a demand had emerged for a new engineering talent and the knowledge exceeded the ability to cram it into an existing engineering common body of knowledge so a new branch of engineering split off with its own new and emerging common body of knowledge as its basis in education and practice.

NOTES

Current Situation

Engineering Disciplines that identify with products they create

- Aero, Bio, Computer, Mining, Nuclear, Petroleum, Paper, Software, etc.

Engineering Disciplines that identify with services they provide

- Logistics, Reliability, Safety, Test, Human Factors, Environmental, etc.

This fragmentation of engineering is best illustrated by looking at the various engineering "disciplines" that have emerged. They are typically associated with the products they create or specialize in, or with the services they provide.

NOTES

Current Situation

Each Engineering Group Creates its own:

- paradigm
- language
- journal
- society

and this leads to

- communication barriers
- paradigm barriers

Not surprisingly each engineering "discipline" as it breaks off and focuses on its specialty creates its own paradigm, language, journal, and society. This in turn makes it more and more difficult for an engineer in one specialty discipline to communicate with an engineer in another. Other than the fact that both share a method of communication and problem solving that is based on logic and rational thinking, they often have little in common.

NOTES

In a Nutshell

At the same time that systems are becoming larger and more complex

disciplines are becoming narrower and more specialized

S. E. M. →

We are now faced with a very difficult problem which can be stated quite simply: At the same time that systems have evolved and become larger and more complex, the disciplines which engineer and manage them have become narrower and more specialized.

As the elephant has grown up, the seven blind men have specialized! It's hard to find anyone in that group who can design elephant quarters and manage the elephant.

NOTES

Assessment

- 100 years ago a single engineer was responsible to conceive, design, and develop and even operate a simple engineering product

- 50 years ago it took a team of engineers to accomplish same task (but a chief engineer could still understand all the needed technologies)

- Today's situation

  - engineering product includes hardware, software, complex human and organizational interfaces

  - products can alter that global environment

  - systems are so complex that engineering teams involve many different organizations, located in different parts of the nation/world

  - a single individual cannot comprehend the whole system in any detail and it is impossible to check the work of team members without doing as much work as they have done and possessing their specialty skills

As an example consider the role of the engineer in designing solutions to societal problems. 100 years ago that meant one engineer designed an entire system because the systems involved were small and easily understood by one person.

50 years ago or so systems had grown to the point where it took a team of engineers to design one. Yet, one individual could still be placed in charge called a "chief engineer" and that person could still pretty much understand all the needed technologies involved.

Today's situation is vastly different. Systems are so large and complex and their design and construction so far flung that no one person can understand it all. Moreover, most of the work is now so specialized that in order to check the work of one of the design team members requires that this work essentially be redone in its entirety. No one person has the time or sufficient knowledge to perform such tasks.

NOTES

Engineering Failures Produce System Failures

Loss of ability for "chief engineer" from one discipline to check work of all other team members (reflecting their disciplinary perspectives) results in

- major surprises such as cost overruns, schedule slides, failure to meet performance requirements in Class C Technological Systems
- major disasters in Sociotechnical systems

The fragmentation of engineering and the growth in scale and complexity of systems has led to engineering (design) failures which in turn have led to system failures.

A review of any major newspaper on almost any given day will reveal reports of some sociotechnical system that had experienced one or more failures if not outright disasters.

A key question, of course, is whether or not the failure and/or disaster could have been anticipated and a design produced that would have prevented it. Some failures and disasters can be classified as preventable and some as unpreventable. The real failure is when a preventable failure and/or disaster occurs. Such failures can occur due to bad designs or bad actions taken in systems based on bad engineering recommendations which can make a bad situation worse.

Unpreventable failures and/or disasters result from system characteristics that could not be anticipated in advance (emergence) and from unavoidable risks (e.g., storing nuclear waste for 10,000 years). Just what is and what is not preventable is not yet well understood since sociotechnical systems are so new and not well understood either.

NOTES

Major Losses and Catastrophes

Three Year Period	# Events/Year	Avg Insurance Claim Paid
• 1971-1973	47	$18,000,000
• 1974-1976	53	$31,000,000
• 1977-1979	63	$36,000,000
• 1980-1982	63	$38,700,000
• 1983-1985	75	$56,000,000

S. E. M. →

This table illustrates the Major financial losses and losses of homes that have been identified by a large reinsurance firm. (Copyright c 1987 ASME)

NOTES

The Loss and Catastrophy Scorecard

• Total Events in Period 1970-1985	2,305
• Resulting Number of Deaths	1.5 million
• Resulting Number of Homeless	50 million People
• Total Financial Loss	$700 billion
• Amount Recovered from Insurance	$36 billion (5.1%)

S. E. M. →

This table summarizes the data presented in the previous overhead. (Copyright c 1987 ASME)

NOTES

THE SYSTEMS PROBLEM AND THE SYSTEMS SOLUTION

The Problem:

- The greatest single concern is to find a way to bring large scale systems within the purview of the human mind.

The Solution:

- Systems Engineering and Systems Engineering Management

The greatest challenge facing us in the design and management of systems is to bring sociotechnical systems within the purview of the human mind. Since individuals who have been trained, educated, or have their experience in relatively narrow disciplines are not well equipped to tackle systems that demand a purview that cuts across discipline boundaries, engineering and management generalists have emerged to perform that function.

The solution is in Systems Engineering and Systems Management were the goal is the Engineering and Management of sociotechnical systems as systems. The purview is integrating the specialty disciplines required to understand the parts of such systems into a whole sufficient to grasp the entirety of the system itself. The approach is the systems approach. In systems engineering, for example, the emphasis is on integrating the various engineering efforts not on performing them.

Tools and techniques have emerged that focus on integration. The "specialty" of the generalist is integration of the work of others who are specialists.

NOTES

"Now I believe that events in nature are controlled by a much stricter and more closely binding law than we recognize today, when we speak of one event being the cause of another. We are like a child who judges a poem by the rhyme and knows nothing of the rhythmic pattern. Or we are like a juvenile learner at the piano, just relating one note to that which immediately precedes or follows. To an extent this may be very well when one is dealing with very simple and primitive compositions; but it will not do for the interpretation of a Bach fugue."

Albert Einstein

S. E. M. →

Perhaps Albert Einstein had it right when he anticipated the emergence of large, complex systems and what had to be done to grasp them and understand them.

NOTES

SUMMARY

* Our society is witnessing the development, whether deliberate or evolutionary, of very large systems on a scale never before seen.

* Large systems with interdependent parts cannot be built repeatedly in socially isolated and non-damaging experimental forms.

* Society is experiencing an unacceptably high and growing level of social disasters from our existing large systems indicating a need for redesign of many of these systems.

* The best basis for dealing with the planning and design (and regulating) of large systems is the field of systems engineering which has developed specifically for such tasks.

* Large systems are themselves driving the need for systems engineering which can integrate the efforts of the now highly fragmented disciplines.

Summary

* Systematically translating applicable statutes and legislation (regulatory texts) into regulatory requirements.

* Systematically developing regulatory rules about what must be demonstrated by candidate systems to satisfy requirements (regulatory elements of proof).

* Systematically determining the technical evidence required to demonstrate proof (technical review components).

* Systematically defining and describing how NRC will evaluate DOE systems.

* Systematically identifying and reducing uncertainties.

Summary

* As large scale systems require systems engineering to integrate the specialty disciplines in their design, they require systems engineering to integrate the regulatory effort.

* An integrated regulatory effort means:

  A systems/systems engineering approach to designing regulations.

  A systems/systems engineering approach to evaluating systems that fall under the regulations as candidate systems for approval.

  A systems/systems engineering approach to the oversight of systems which fall under the regulations, have been approved and are in operation.

* The NRC regulatory program is itself a sociotechnical system and can therefore be best integrated and managed through the systems/systems engineering approach

AND

Integrating all this together into a unified, comprehensive system.

Systematic Regulatory Analysis!

If we are to successfully tackle sociotechnical systems and even Class C technological systems, we need both specialists and generalists. Specialists will provide the knowledge required to tackle key elements and interactions in systems. Generalists will provide the knowledge on how to integrate the contributions of the specialists. Both skills are required and essential in the design and management of today's systems.

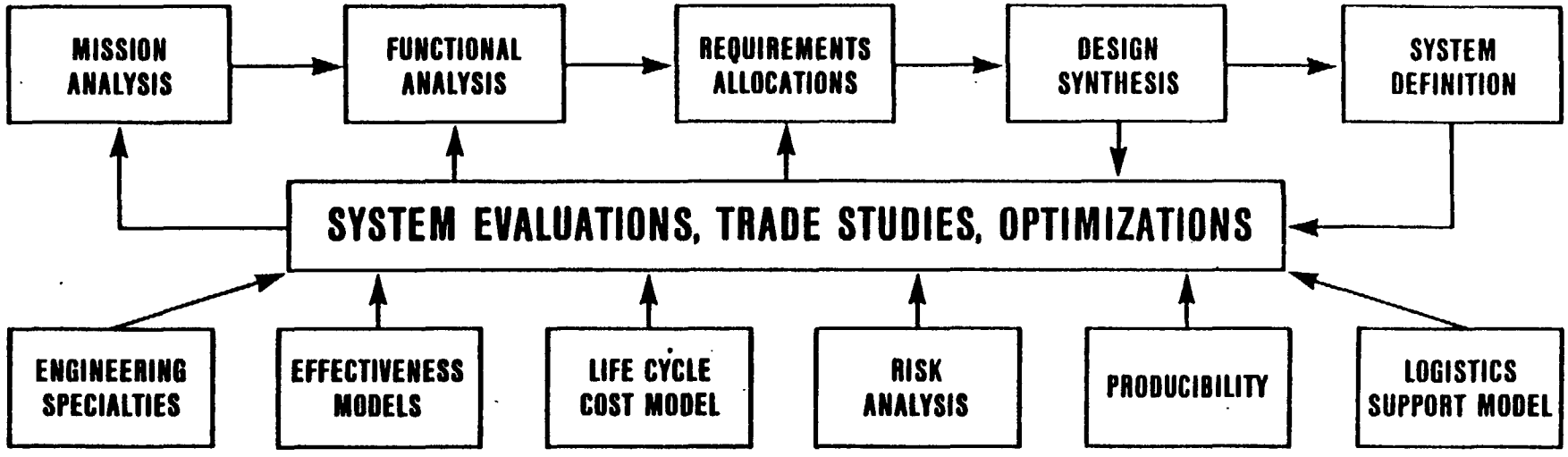
NOTES

"System Engineering Techniques"

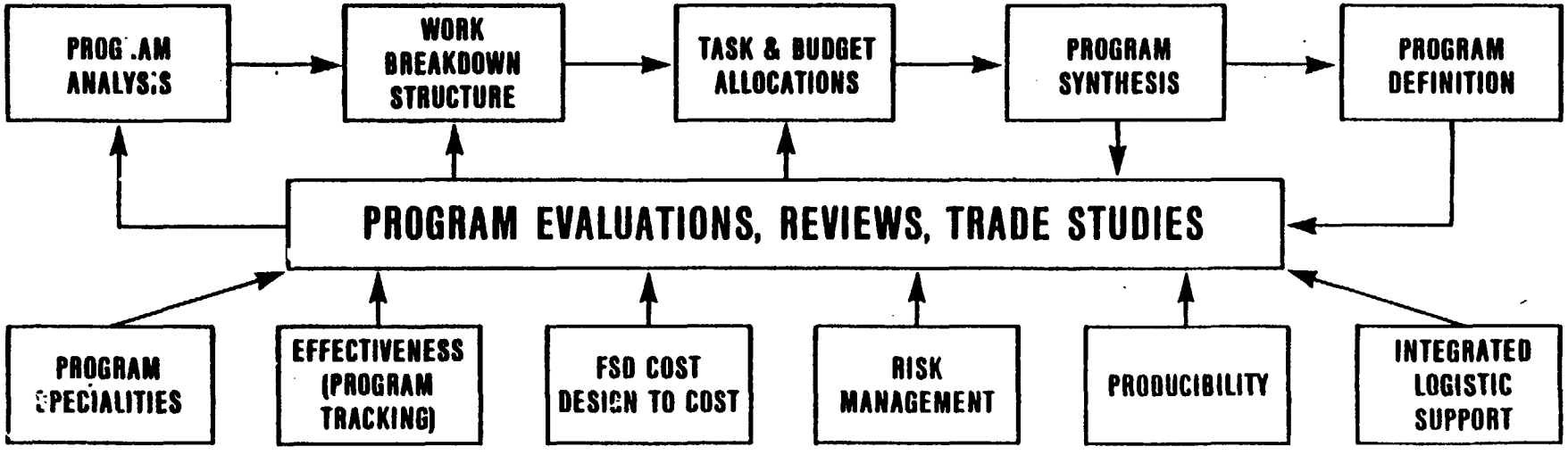
Session II

SYSTEM ENGINEERING — TWO CONCURRENT PROCESSES

SYSTEM ENGINEERING PROCESS:



ENGINEERING MANAGEMENT PROCESS:

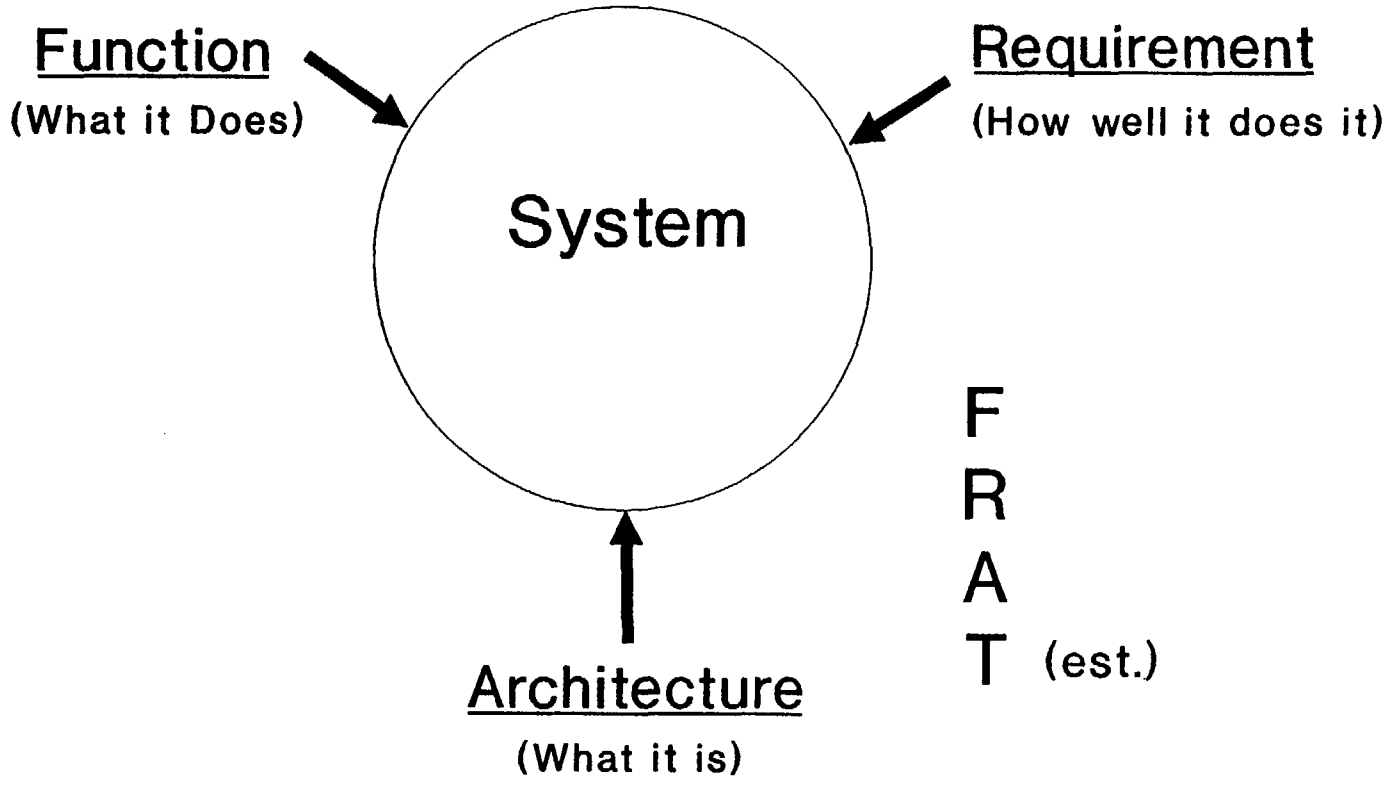


SYSTEM ENGINEERING/MANAGEMENT

NOTES

This chart shows the programmatic SEM process and the product SEM process. The parallels are obvious as is the correspondence to the generalized process discussed in the opening session. We will concentrate, in this session, on the functional analysis and requirement allocation aspects of the programmatic SEM and their counterpart, work breakdown structure and task and budget allocations of the product SEM.

The programmatic process is supported by a number of analytical procedures and the participation of a number of engineering, technical, producibility and other specialists. In the product process there is continued participation of all groups but with a different emphasis as will be discussed in the third session of this course.


Function
(What it Does)
Requirement
(How well it does it)
System
Architecture
(What it is)
F
R
A
T (est.)

AN ALTERNATIVE VIEW

NOTES

Dr. Brian Mar of the University of Washington (Ref.20) uses the model shown to explain the system(s) engineering process. He identifies five groups of people who label themselves system(s) engineers (and system(s) engineering managers we would presume).

1. F-R-A People
2. Architects
3. Product People
4. Program People
5. Analysts

Each, according to Dr. Mar, uses the F-R-A-T process explicitly or implicitly in their work.

This model incorporates the functional analysis, requirements allocation, design synthesis phases and their counterparts, discussed previously, and adds special emphasis on testing. The other phases of the process are subsumed in this top level process.

WIND ENERGY MISSION ANALYSIS

MISSION FUNCTION

- GENERATE ELECTRICITY AS AN ALTERNATE ENERGY RESOURCE

MISSION CHARACTERISTICS

- LOCATION OF RESOURCES.
- DISTRIBUTION SYSTEM.
- ENVIRONMENTAL ACCEPTABILITY.
- SAFETY.
- DURABLE EQUIPMENT.
- COMPATIBLE WITH UTILITY OPERATIONS.

PARAMETERS

- CONVERSION METHODS.
- ECONOMIC VIABILITY, FIRST COST.
- SUPPORTABILITY. LIFE CYCLE COST.
- TECHNOLOGY STATE-OF-THE-ART.

MEASURES OF PREFERENCE

- ENERGY COST RELATIVE TO OTHER COMPETING ENERGY RESOURCES.

WIND ENERGY MISSION ANALYSIS

NOTES

Complex new systems originate in a concept formulation stage. Forecasts of future needs, situations or opportunities and the obstacles associated with them are the basis for deriving the general and overall characteristics of a system to satisfy the need or mission to be accomplished.

In the case of a system to harness wind energy the major objectives and concerns might be as shown. The results of such a mission analysis would be preliminary descriptions of the desired system characteristics, estimated to be roughly within the state-of-the art, descriptions of the operating environments and constraints to be met in terms of economics, effectiveness, efficiency, societal acceptance, etc. Measures and levels to be used as objectives and constraints to be met are also developed in the mission analysis.

Depending on the system, the mission analysis will be more or less formal and results in a beginning description of what must be done, a vague idea of how it might be accomplished and a set of constraints and measures to aid in developing the system.

Mission Analysis - Waste Disposal

MISSION FUNCTION

* Safely dispose of nuclear waste materials permanently.

MISSION CHARACTERISTICS

* Safety to public and environment
* Safety to personnel
* Permanence
* Assurance of performance - no risks
* Accommodate large quantities
* Timely

MISSION DESCRIPTION

* Functional definitions
* Environmental constraints
* Societal restrictions
* Economics

MEASURE OF PREFERENCE
JUSTIFICATION OF NEED
AVAILABILITY OF TECHNOLOGY

MISSION ANALYSIS - WASTE DISPOSAL

NOTES

The kinds of considerations and results that would probably result from a mission analysis of a waste disposal system are listed. A major portion of the results would be and are the regulatory requirements, restrictions and measures which form the basis for NRC's role in the system's life cycle. These concerns along with the program to bring the system into being, the geophysical program to test and demonstrate site suitability, the product program to design, construct and operate the physical sub-system(s) and the social-political-judicial system to achieve general acceptance of such a program are the concerns of DOE.

The counterpart, Program Analysis, portion of the product SEM process provides analogous descriptions, measures and constraints to guide the work of bringing the physical system into being, operation and phase-out. The program analysis' most characteristic output is a contract or program directive defining the work to be accomplished in bringing the roughly described system into reality. Performance requirements, organizational forms, control mechanisms, legal restrictions, cost and schedule are spelled out to a level of detail consistent with the phase of development of the system. Program analysis, by its nature must follow the programmatic process counterpart steps.

Functional Analysis Forms

* Lists *XXXX *YYYY
  * Hierarchies I. II. III. I.I II.I III.I
    * Functional Flow Hierarchy and Sequence
      * Operational Flow Diagrams
        * Time Line Analysis
          * Informational Flow
            * Networks
              * Interfacing
                * Integrating

FUNCTIONAL ANALYSIS FORMS

NOTES

Higher level requirements and capabilities resulting from the mission analysis are the starting points for functional analysis which is the process of identifying and relating actions and accomplishments to meet the higher level requirements.

Functional analysis can take several forms ranging from simple lists to very detailed, hierarchical, operational sequence diagrams put on a time line basis with considerations of inputs and outputs required to allow actions to proceed. They can form the basis for analysis of interfacing activities and integration of functions. In the counterpart, product Work Breakdown Structure, the analysis forms the basis for the analysis of how lower levels of the physical systems such as elements and components are integrated into higher level subsystems and systems.

A powerful aspect of functional analysis is the traceability of the contribution of each activity (and sub-part) of the system to the top level requirements. This analysis is used to define the structure or architecture of the entire programmatic or product system of concern.

Functional analysis should be to a level of detail consistent with the stage of system development and the purpose of the analysis.

HIERARCHICAL FUNCTIONAL ANALYSIS

5. Emplace waste container/package in geologic repository

5.1 Ensure integrity of waste container/package at start of emplacement.

5.2 Verify and record identification of each waste container/package and its intended emplacement opening/location.

5.3 Transfer waste container/package to emplacement equipment (if required).

5.4 Align waste container/package with emplacement opening/location.

5.5 Place waste container/package in position in emplacement opening/location.

5.6 Emplace emplacement opening backfill (if required).

5.7 Install monitoring equipment for waste emplacement (as required).

5.8 Protect waste container/package from damage during emplacement.

5.9 Verify integrity of waste container/package and, if used, emplacement opening backfill during waste emplacement operations.

5.10 Verify and record identification of emplaced waste container/package and emplacement opening location number

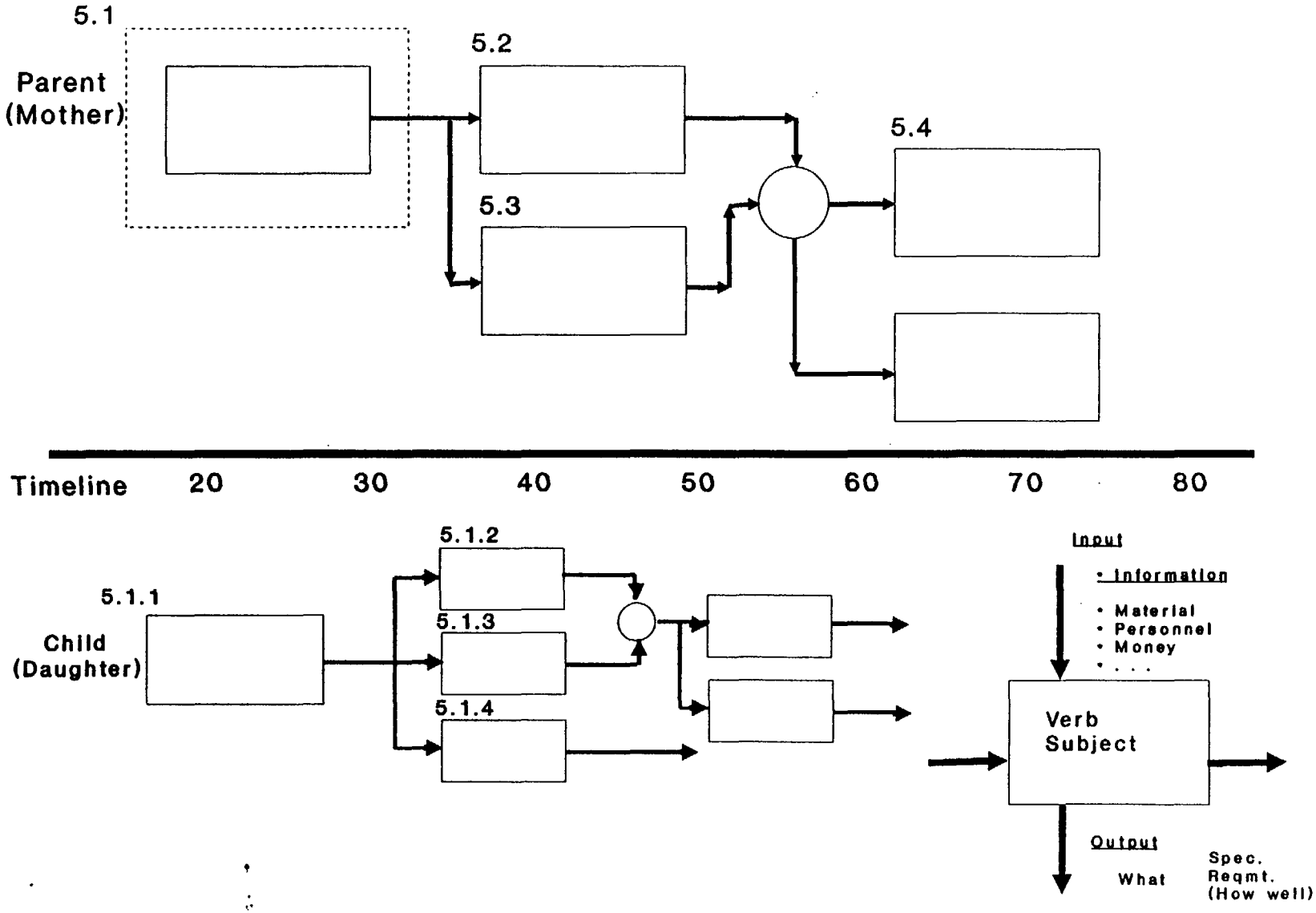
HIERARCHICAL FUNCTIONAL ANALYSIS

NOTES

Beyond unordered lists of required systems functions and consistent with the early stages of development of a system, hierarchical lists are very powerful in developing required sub-functions and in testing the completeness and necessity of higher level requirements and functions. Groupings of like functions can also lead to efficiency and simplification of the program and product system.

The example shown is taken from CNWRA's functional analysis which will be included in the follow-on course.

Functional Flow Conventions



FUNCTIONAL FLOW TECHNIQUES

NOTES

Functional flow analysis can show the parallel and sequential relationships of functions. The parent-child or mother-daughter, hierarchical relationships are generally referred to as levels. Any level can be put on a time line to study the time constraints of an operation. This is a powerful technique in studying critical, bottlenecking sequences of operations.

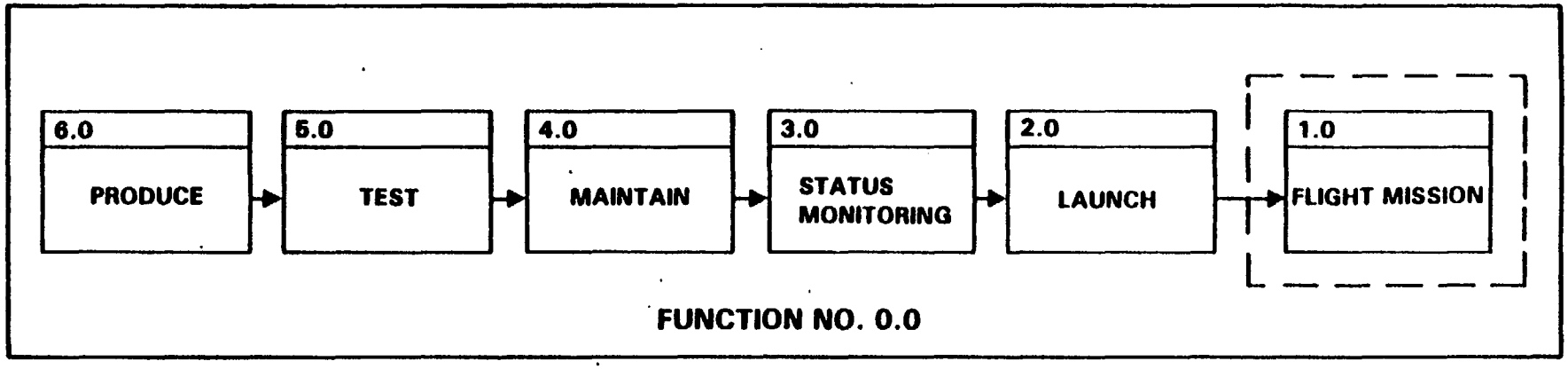
Some conventions require that each function be described by first a verb and then a subject such as was done in the previous chart e.g.

"Transfer waste container" or
"Verify integrity of waste container."

More detailed analysis can contain not only sequencing of functions but listings of the inputs required to accomplish the function in terms of any kind of resource or knowledge, outputs required of the function in whatever form or nature and the requirements or specifications that the inputs or outputs must meet to be considered satisfactory. Not only are functions incorporated in the considerations but also all basis system elements; objects, subjects, concepts and events.

Functions, requirements and architecture are related in a traceable and documentable manner to top level system requirements.

EXAMPLES OF FUNCTIONAL FLOW DIAGRAM



TOP LEVEL FLOW DIAGRAM

1.0 FLIGHT MISSION

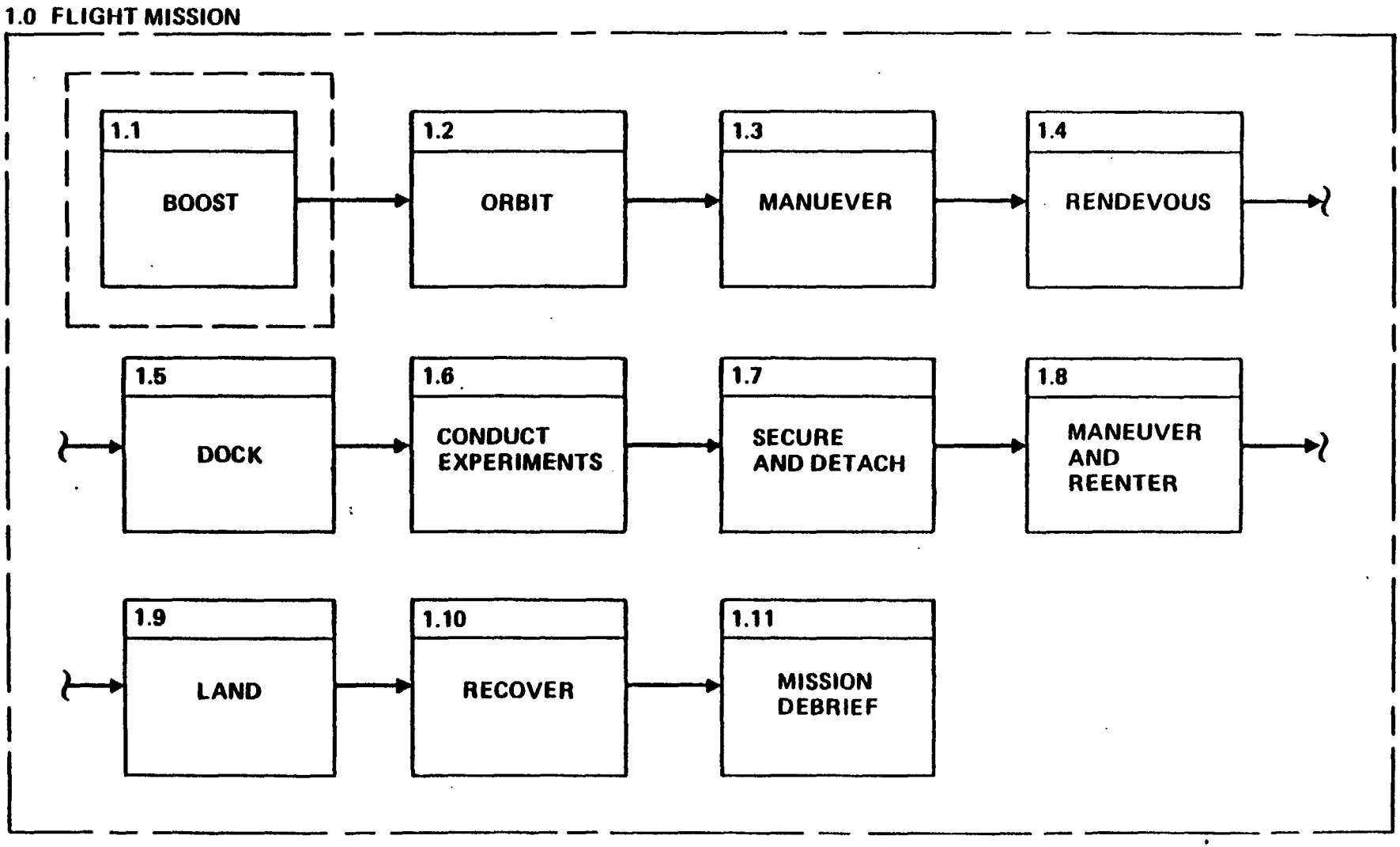
A. DELIVER PAYLOAD INTO WINDOW AT SPEED VECTOR

B. USE 1-1/2 STAGE LIQUID FUELED VEHICLE

C. STAGE 1 AND STAGE 2 TO PROVIDE THRUST SIMULTANEOUSLY UNTIL STAGE 1 SHUTDOWN

D. ASTRONAUT TO HAVE MANUAL STAGING OVERRIDE CAPABILITY

EXAMPLES OF FUNCTIONAL FLOW DIAGRAM

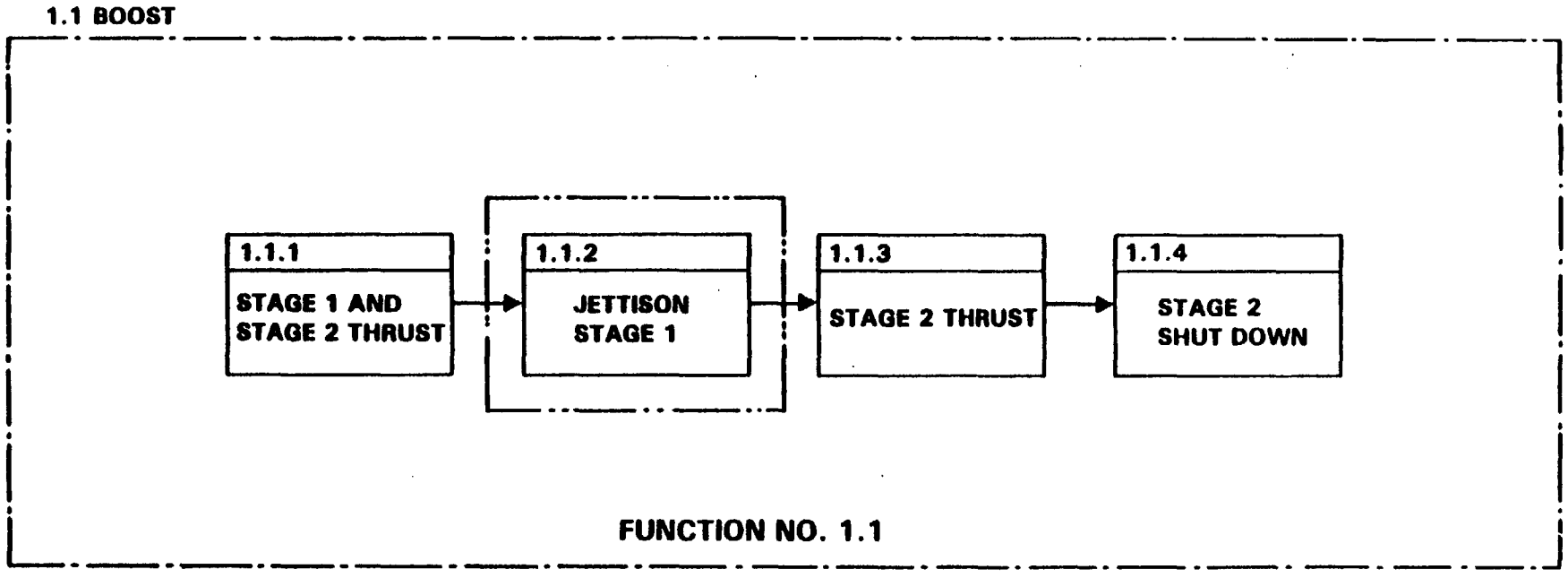


THE FIRST LEVEL

The next level flow diagram for the flight mission is shown. This is referred to as the first level in this particular system since the top level is the "Zero" level. An appropriate numbering system is used which allows tracing to the top level function. The boost phase is selected, in this example for further detailing.

NOTES

EXAMPLES OF FUNCTIONAL FLOW DIAGRAM



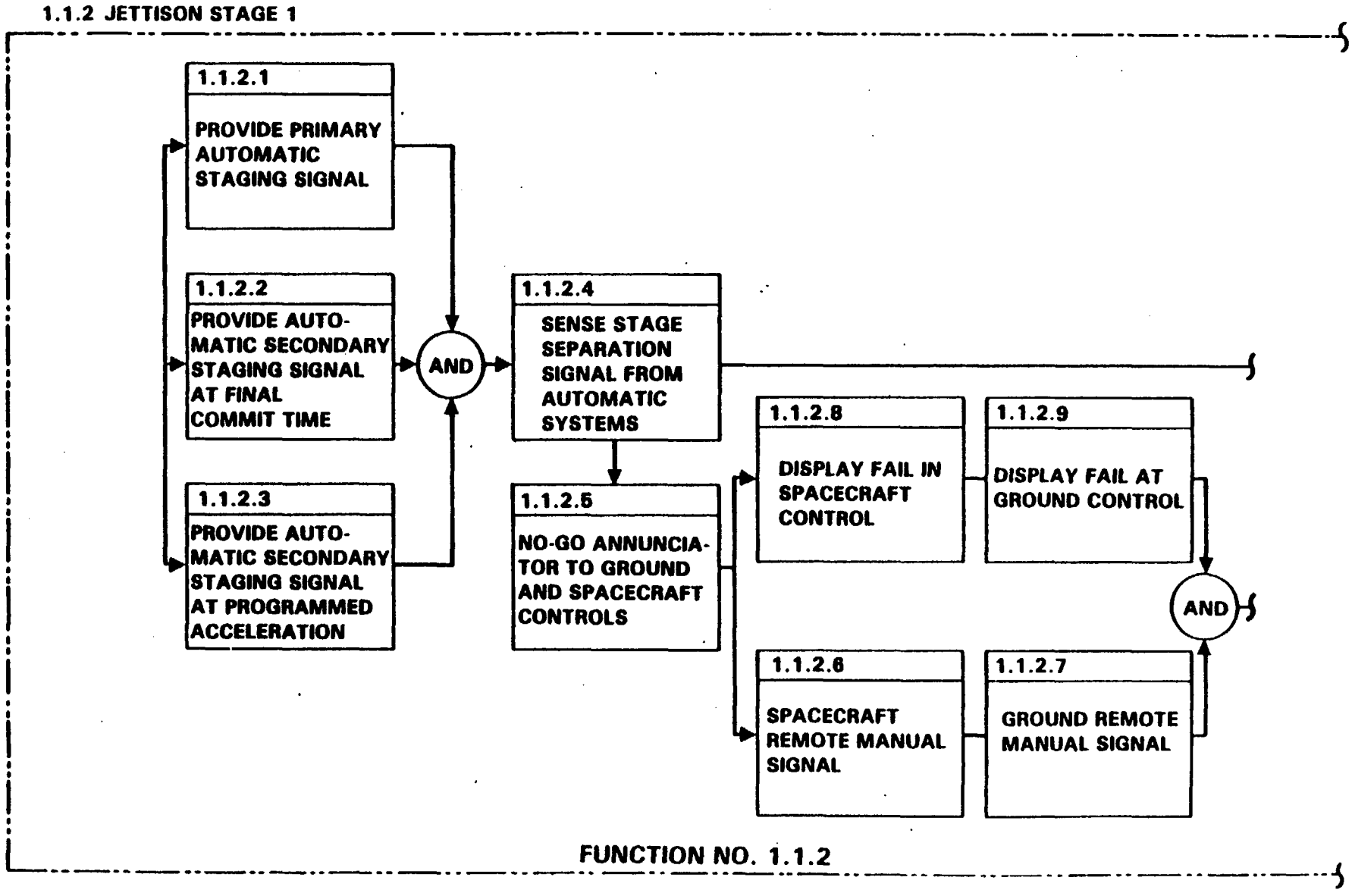
SECOND LEVEL FUNCTIONAL DIAGRAM BOOST-FUNCTION 1.1

THE SECOND LEVEL

NOTES

Out of this "Boost" function flow diagram, the "JETTISON STAGE 1" function is selected for further breakdown.

EXAMPLES OF FUNCTIONAL FLOW DIAGRAM



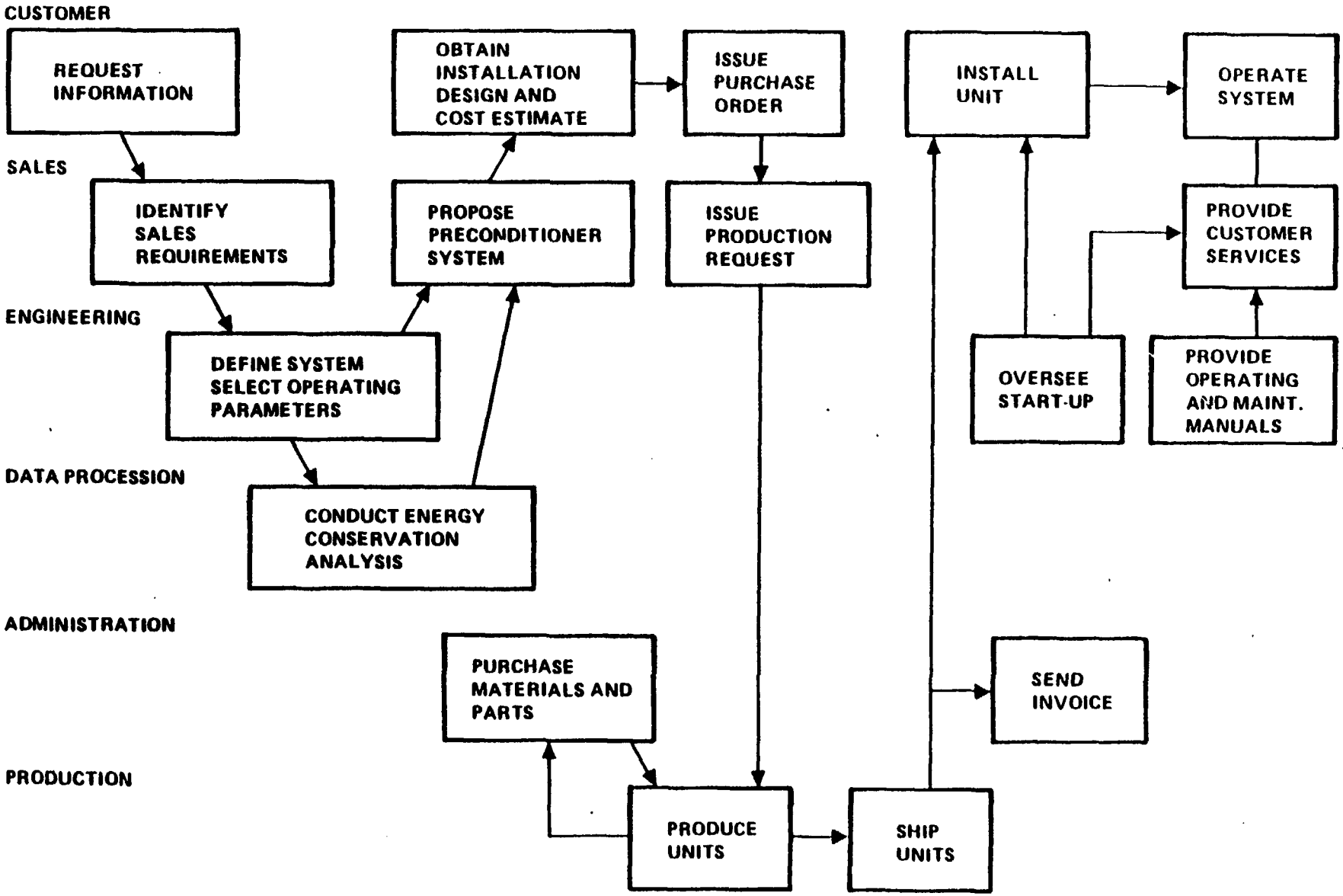
THE THIRD LEVEL

This is the first level to display parallel functions and logic nodes (and gates). It becomes obvious how lower level requirements can be related to the functional flow diagram and how interfacing and integration requirements are defined.

A normal question is "When do you stop breaking the program or system operation down to yet another level of detail?" The answer depends on the phase of the program and the purpose of the analysis. Some general guides are: Stop at the level where the function can be assigned to a specific organizational entity. This provides input to a responsibility chart to be discussed later. OR Stop when the functions are no longer specific to the program, e.g. normal engineering design functions or clerical functions. OR Stop when the amount of effort required to perform the function is within preset bounds of time or cost. This is important in work breakdown structures to define allowable work packages (not too big or too small in cost or time). OR Stop when further breakdown causes loss of meaning of the function (irreducible groups).

NOTES

FUNCTION FLOW DIAGRAM — PROCESSING AN INQUIRY



ANOTHER FUNCTIONAL FLOW DIAGRAM

NOTES

The functional analysis shown is a single level one but it does show a progression of activities and an indication of which organizational entity has operative responsibility for the function. Almost every activity involves more than one entity with some kind of responsibility or interest at some level. The contribution of functional analysis to sorting out the associated problems will be shown in the next chart.

Functional analysis is a very versatile and powerful technique. The applications and level of detail involved are limited only by the resources available and your ability and imagination. As will be seen they are not an end in themselves.

MANAGEMENT RESPONSIBILITY GUIDE

NUMBER	FUNCTION	AGENCY: SCRTD	PUC	CTA	UMTA-CONTRACTS	EQUIPMT MFGR	TEST SUB CONT						
1.0	PREPARE PROPOSAL	A B	E	E		C	C						
2.0	APPROVE PROPOSAL FOR STATE	E F	A B C G	E	E								
3.0	APPROVE PROPOSAL FOR FEDERAL	E	E F	A B C G	E								
4.0	FUND PROPOSAL FEDERAL			E	A B C G								
5.0	ISSUE CONTRACTS TO OPERATORS	A B C	D	D	E G	C G	C G						
6.0	INSTALL EQUIPMENT	A				B C	D						
7.0	TEST EQUIPMENT & WRITE REPORT	A C				D E F	B C						
8.0	APPROVE FINAL REPORT	A G	G	G		G	G						

RELATIONSHIP CODE

- **A** GENERAL RESPONSIBILITY
- **B** OPERATING RESPONSIBILITY
- **C** SPECIFIC RESPONSIBILITY
- **D** MUST BE CONSULTED
- **E** MAY BE CONSULTED
- **F** MUST BE NOTIFIED
- **G** MUST APPROVE

MANAGEMENT RESPONSIBILITY GUIDE

Using a functional analysis like that shown in the previous chart, a management responsibility guide was developed for a part of the operations in the Office of Safety and Product Qualification in the Department of Transportation.

Functions appear as rows, agencies and organizational entities comprise the columns. For each function, the particular responsibility of each agency is defined by a "Relationship Code". For example,"B" is "operating responsibility", or "G" is "must approve". From this usage of the functional analysis, integration and interaction requirements develop and signature authorities and requirement can be developed.

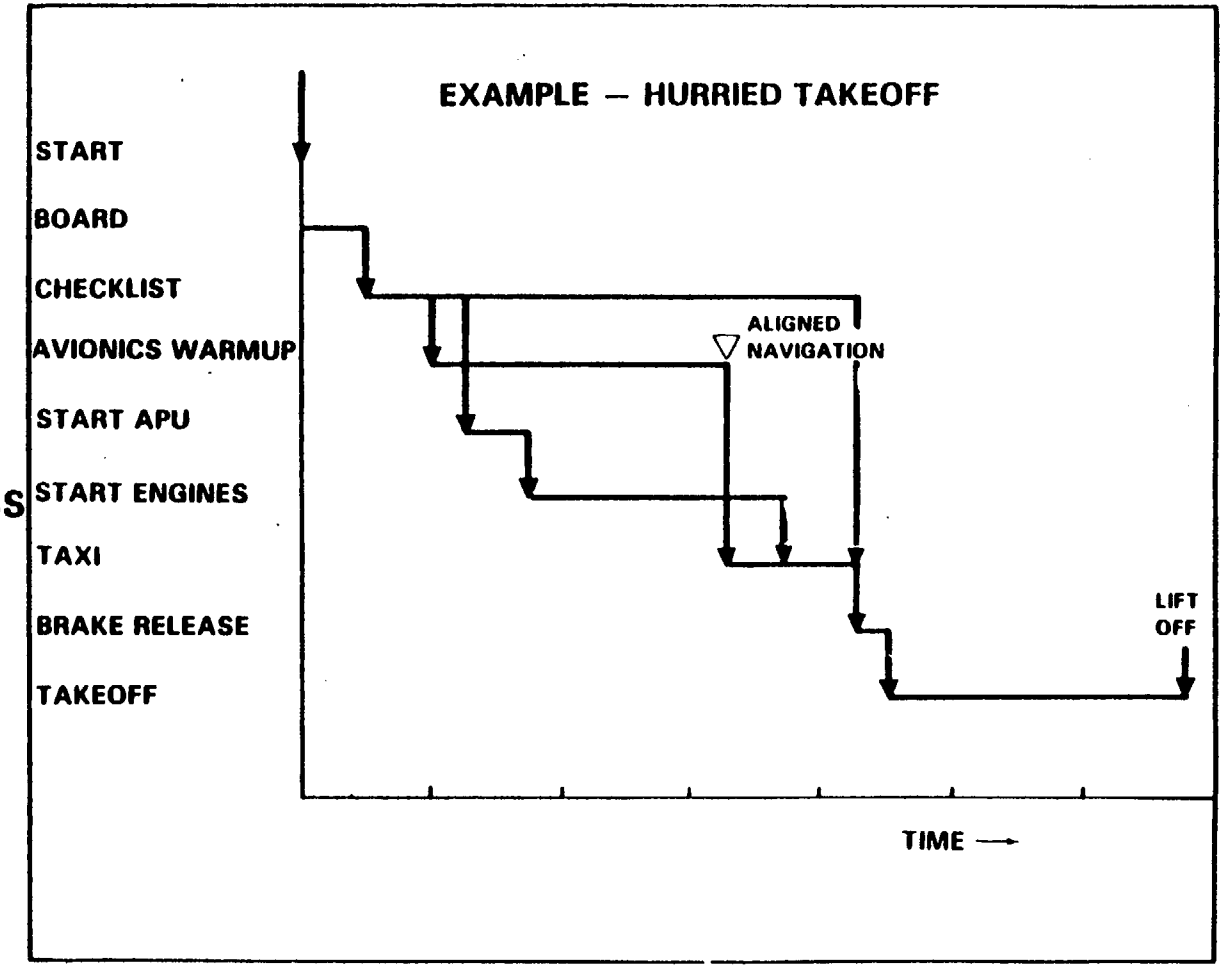
Application of the technique has been very helpful in new organizations and in situations where there is conflict about responsibility and authority. It defuses the situation by forcing a more detailed description of responsibilities and the effort required to carry them out.

NOTES

TIME LINE ANALYSIS

IDENTIFIES

- TIMING SEQUENCES
- CRITICAL PATHS
- REASONABLE WORKLOADS
- ALTERNATE STRATEGIES
- FUNCTIONAL COMPLETENESS
- PERFORMANCE PARAMETERS



TIME LINE ANALYSIS

For operations, critical in time or impact, time line analysis is another extension of functional analysis. The example shown for a hurried aircraft take-off can serve as a basis for re-engineering a cockpit, analyzing the human factors problems in the operation, prescribing mandatory limits on such take-offs or several other applications.

NOTES

WORK BREAKDOWN STRUCTURE

* TOP DOWN DEVELOPMENT
* WORK PACKAGE IS LOWEST LEVEL
* LIMITED TO ONE ORGANIZATION
* WORK PACKAGE CONTROLS:
  - TECHNICAL PERFORMANCE
  - COST
  - SCHEDULE

WORK BREAKDOWN STRUCTURE

A closely related counterpart of the functional analysis is the work breakdown structure, WBS, used primarily in the product SEM process but useable in the program SEM as well. It employs the same concept of systems levels but it addresses systems at the most aggregated levels down through major sub-systems, sub-systems, components, elements, parts and pieces. The nomenclature is particular to the agency and the application. The "work package" is the lowest level of development.

A work package must, in most systems, be limited to neither more nor less than set cost limits, take no longer than a certain lapsed time and be governed by a set of requirements or specifications that set the performance characteristics that must be met by the resulting product, service, information, design or result of the effort assigned in the work package. It is also very desirable to have work packages assignable to specific and accountable organizational entities.

NOTES

WORK BREAKDOWN STRUCTURE (WBS)

* Product Oriented Family Tree

* Composed of

  - Hardware
  - Design/Fabrication/Test
  - Services
  - Data

* Completely Displays and Defines Project/Program

* Relates Elements of Work to be Accomplished

  Summary WBS

* Upper Three Levels

WORK BREAKDOWN STRUCTURES II

NOTES

This chart lists the major characteristics of the WBS. The upper three levels of the WBS are generally called the "Summary WBS".

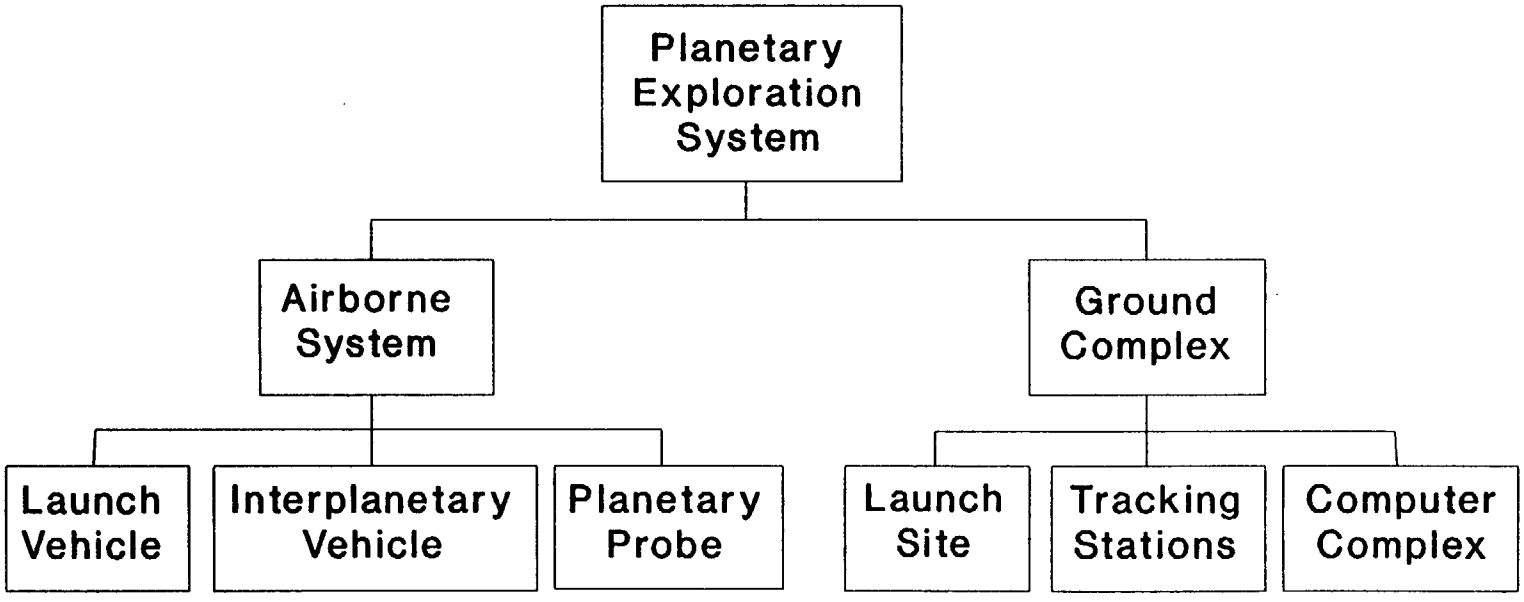
Level Identification

Level I - Entire System

Level II - Major System Elements

Level III - Subordinate to Level II

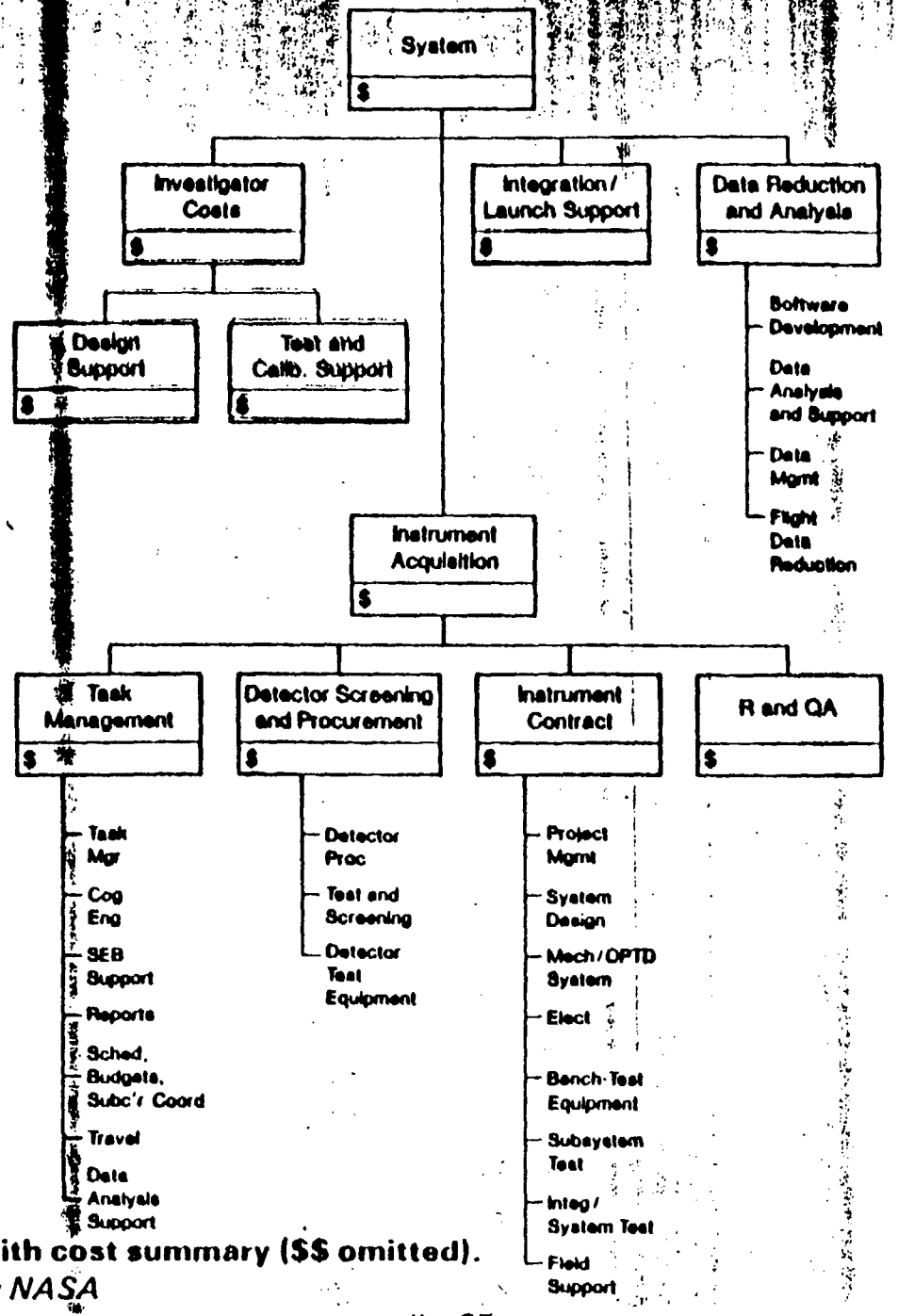
Example



SUMMARY LEVEL WBS

An example summary level work breakdown structure is shown for a planetary exploration system. The nomenclature and completeness is questionable but the concept of establishing a system architecture and a product family tree emerges.

NOTES



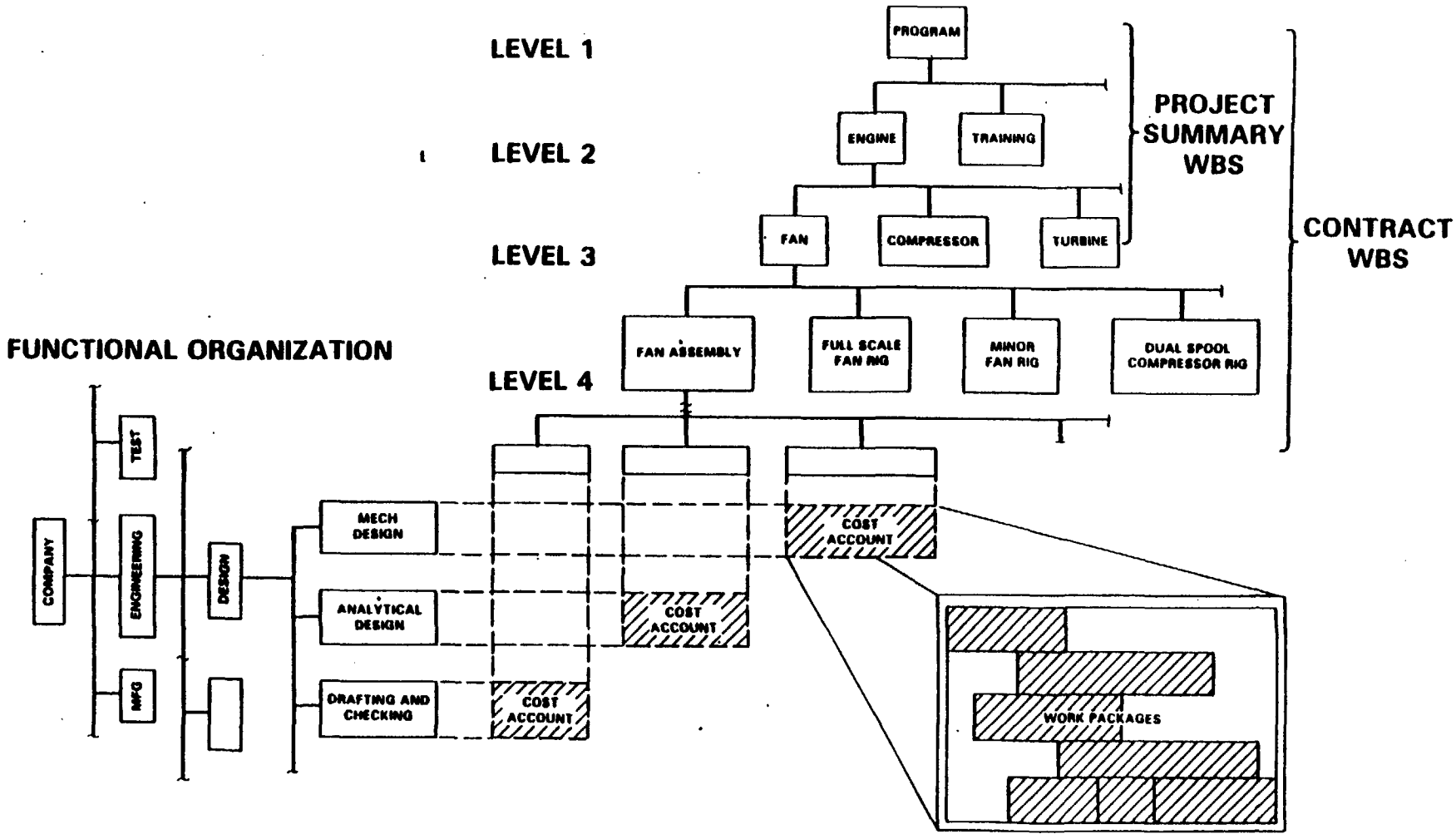
WBS with cost summary ($$ omitted).
courtesy NASA

WBS WITH COST SUMMARY

A summary, actual work breakdown structure with costs aggregated to the top three levels for a sub-system of a NASA program is displayed. A fourth level is indicated by the branches. Note that one program manager's top level may be another program manager's third level; one person's system may be another person's sub-system.

NOTES

WORK BREAKDOWN STRUCTURE



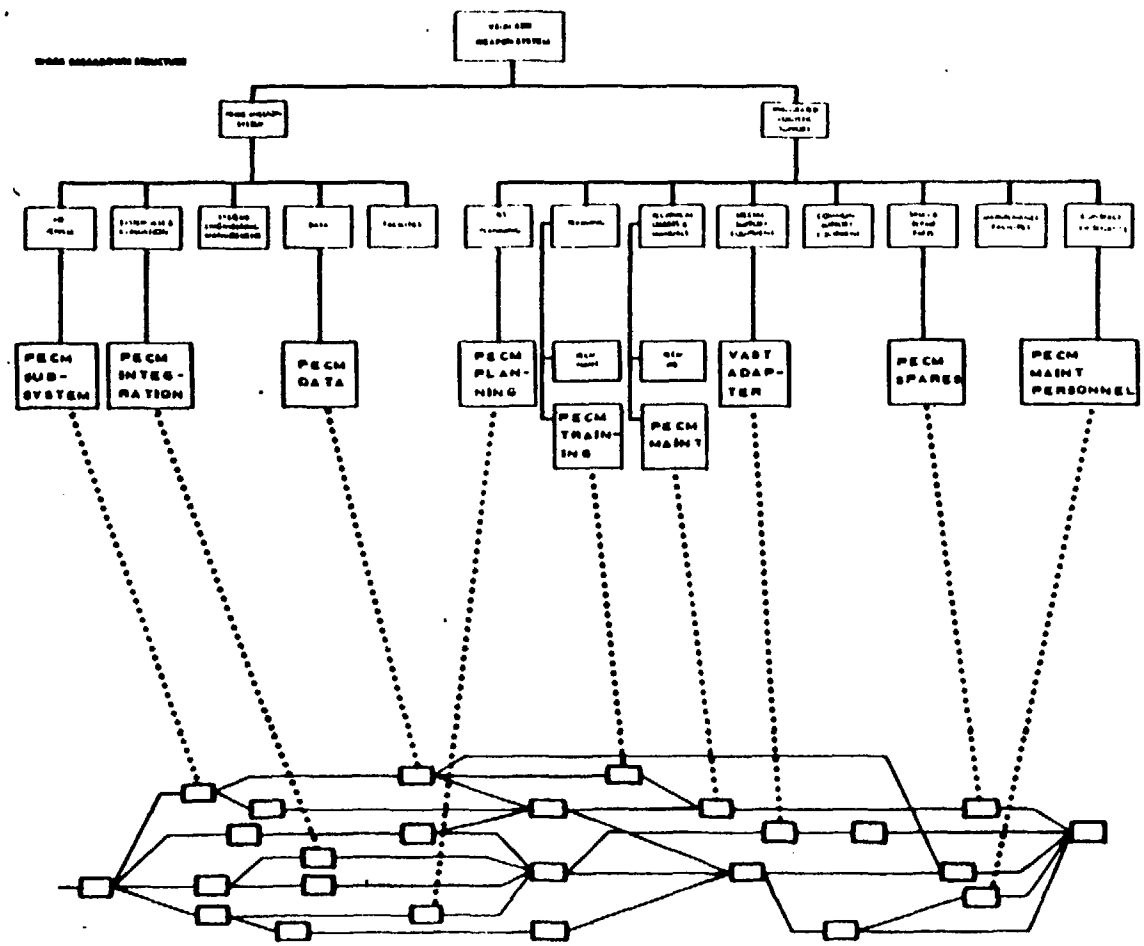
WBS AND THE ORGANIZATION

NOTES

Several aspects of work breakdown structures are displayed in this chart. There can be a contract work breakdown structure which is part of the contract and is the result of the sponsoring agency's SEM effort. The WBS employed by the contractor may or may not be similar to that structure but it will almost always be much more detailed, consisting of more downward levels. It is much more manageable when the summary WBS is the same for both parties.

The product WBS must be detailed at least to the levels to meet the requirements discussed. At that level, work packages can be assigned to the operative organizational entities. In this case a functional organization is shown. In some cases a purely projectized organization is created to exactly match the WBS elements at some level. Some sponsors dictate the form of the organization in the contract. The implications of System Engineering Management to organizational structure will be discussed in Session III. In any case it is a necessity that the reporting system be able to track cost, schedule and performance as related to the work packages assigned.

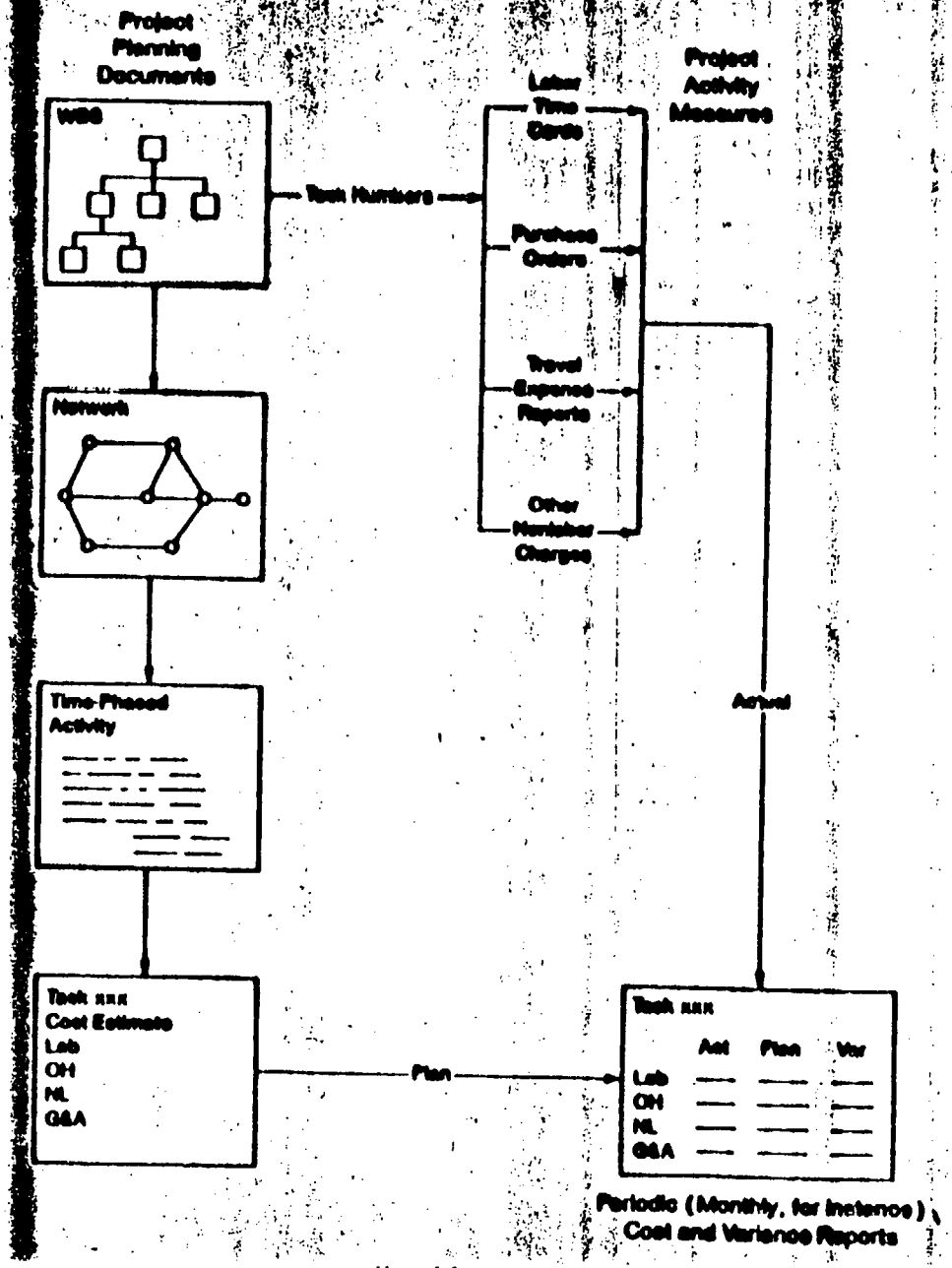
Work Breakdown Structure/Network Relationship



WBS AND SCHEDULE

The relationship of the WBS to the program schedule is indicated in this chart. A PERT, Program Evaluation and Review Technique or a CPM, Critical Path Method type network is indicated. The realization of a completed WBS element can be a node and activities can be the lines of the network. The contribution of functional analysis in helping establish sequences and necessary and sufficient informational requirements is indispensable in establishing the network. Networks can be used to incorporate cost estimates are incorporated here as well.

NOTES


Project Planning Documents
WBS
Task Numbers
Labor Time Cards
Purchase Orders
Travel Expense Reports
Other Nonlabor Charges
Project Activity Measures
Network
Time-Phased Activity
Actual
Task xxx
Cost Estimate
Lab
OH
NL
G&A
Plan
Task xxx
Act
Plan
Var
Lab
OH
NL
G&A
Periodic (Monthly, for instance) Cost and Variance Reports

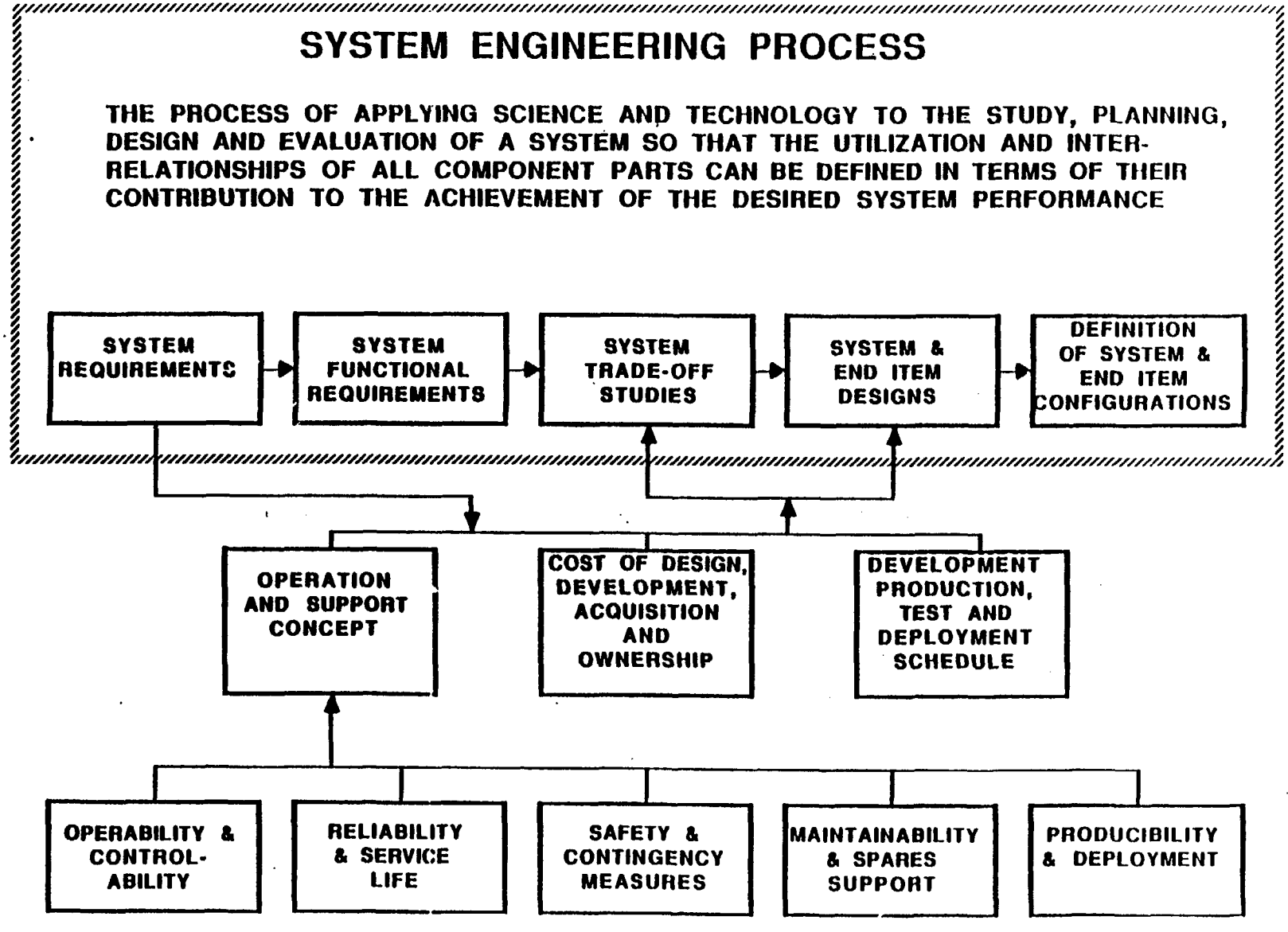
PARTIAL OVERVIEW

To this point the relationship of the functional analysis (FA) and/or the WBS to cost and schedule of activities in the programmatic or product project has been shown. The activities or work packages can be defined from either or both of the FA or the WBS.

The third part of an activity description, that of the specific requirements or specifications that define the constraints and a detailed description comes from the next activity in the process. For the programmatic SEM that is "requirement allocation" and for the product SEM that is "task and budget allocations", as we have labeled these activities.

NOTES

THE SYSTEM ENGINEERING PROCESS

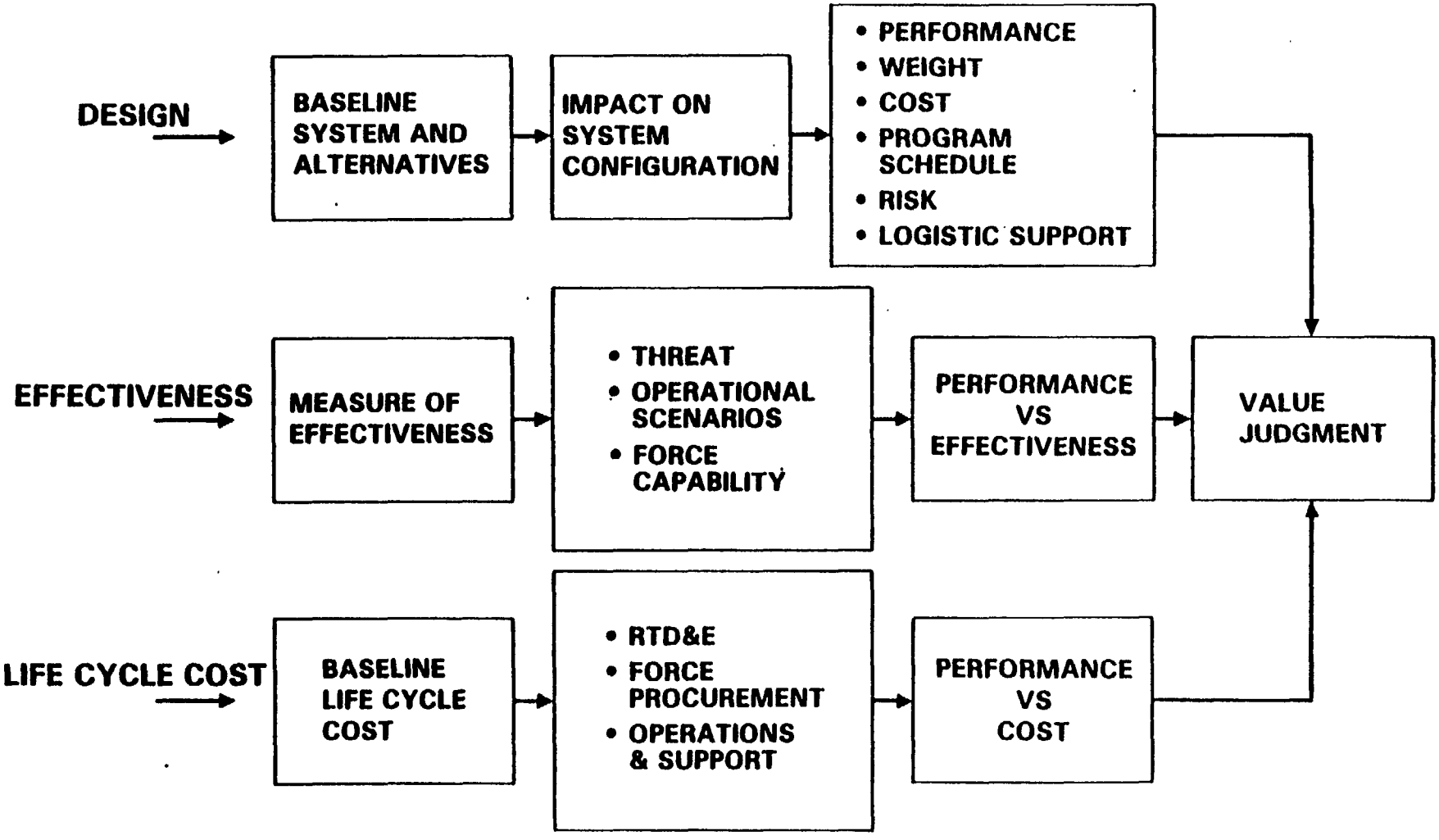


THE NEXT STEPS

This chart shows the next steps in the System Engineering Management Process according to Wilton Chase one of the first authors in the field (Refs. 15 and 19). It indicates an iterative process, particularly in what he refers to as the "System Trade-off Studies" between all the aspects of the system and possible alternative system configurations and designs with the results of this phase being the "Definition of System & End Item Configurations. The process is seen to apply to all of the program/projects involved in the entire system. the programmatic and the product systems. There is really no conflict between the nomenclature and what has been said to this point. The requirements allocation and the task and budget allocations use trade studies as the major analysis tool in their procedure.

NOTES

TRADE-OFF TECHNIQUES



TRADE STUDIES

The accompanying chart displays the interaction of designs, costs and models and methods to determine the "goodness" of an alternative system or the effectiveness determination procedures. This diagram is simplified tremendously and seems to apply more to the development of a weapon system. In other systems, political and social considerations receive more emphasis.

Note that formal effectiveness techniques are not the final determinants of the selection. In all cases there must be the exercise of value judgements. Multiple attribute and decision theory techniques are becoming more useful, as discussed in the first session of this course but the exercise of reasoned, experienced judgement will always be required

NOTES

MEASURES OF EFFECTIVENESS

* FIGHTER AIRCRAFT
  * Probability of success per encounter
  * P Availability X P Survivability X P Kill

* CARGO AND PASSENGER TRANSPORTS
  * Cost per ton mile
  * Cost per seat mile

* PATROL AIRCRAFT
  * Probability of target identification/hour on station

* TRAINING SYSTEM
  * Hours of training per student
  * Cost per student graduate

* AUTOMOBILE
  * Miles/gallon of fuel

* CORPORATION
  * Annual sales
  * Annual report

MEASURES OF EFFECTIVENESS

NOTES

A variety of possible measures of effectiveness for different systems is shown. Each particular system application may have its specific measure(s).

A Measure of Effectiveness should:

1. Apply to the system as a whole to avoid sub-optimization.
2. be quantitative
3. be statistically efficient
4. be complete
5. be simple
6. use obtainable data.

The analytical methods used in this and other phases of the SEM process are extensive and would require special background and treatment so we will return to the discussion of the overall SEM process.

REQUIREMENTS ALLOCATION

- FLOWING DOWN REQUIREMENTS
- TRADE STUDIES
- TRACEABILITY
- CHARACTERISTICS OF A REQUIREMENTS STATEMENT

REQUIREMENTS ALLOCATION

NOTES

The requirements allocation activity is a further flowing down of system requirements in terms of functions, hardware, concepts, etc., all the elements that make up a system. One element can cost more or less, perform more or less well but the aggregates must perform to a certain level so the system as a whole will meet its objectives within the constraints and in an optimal manner. This balancing of cost, schedule, weight, function, performance, etc. between all sub-systems and elements constitute the allocation process. The major mechanism to accomplish this allocation is the trade study(s).

The process again provides traceability of the assigned requirements to the top level system requirements and has a direct link to the functional analysis.

The characteristics of the resulting requirements or specification statements will be focussed in what follows.

ALLOCATING REQUIREMENTS – AN EXAMPLE

- FUNCTION
  - DISPLAY THE FALL OF A JETTISONED DEVICE AT GROUND CONTROL
    - RECEIVE A GO/NO-GO SIGNAL FROM THE SPACECRAFT
    - DECODE THE SIGNAL
    - DISPLAY THE SIGNAL
- DESIGN REQUIREMENTS
  - DISPLAY LIGHT WITH 100 FOOT CANDLE INTENSITY
  - LOCATE AT EYE LEVEL AT SITTING POSITION
  - READABLE AT 15 FEET DISTANCE
  - MAXIMUM AVAILABLE SPACE ON CONSOLE IS 2 SQ INCHES
  - RELIABILITY FACTOR 99.7%
- FACILITY REQUIREMENTS
  - 50 FOOT CANDLE ILLUMINATION IS REQUIRED AT CONSOLE SURFACE
- PERSONNEL REQUIREMENTS
- EQUIPMENT IDENTIFICATION
  - GROUND CONTROL CONSOLE

REQUIREMENTS ALLOCATING - AN EXAMPLE

NOTES

The sense of budgeting in trade studies can be seen in this example. Not only is cost allocated to the elements of the system, so are all limited resources, weight and size and power requirements and reliability, to mention a few.

Performance required is defined in operational terms, as measurable as possible. This is done not only for the element in question but also for all the support and interacting elements. Functions and activities must be included for the specific purpose of integration which is narrowly defined as the work necessary to combine n-1 level elements into n level elements, and more broadly defined as making each element blend into the system as a whole.

The requirements and specifications are developed for each product or program related task as well as for "level of effort tasks" involved in the system.

Test and quality assurance requirements to demonstrate that the requirement has been met must be included in the specification (not shown in this example).

Obviously, engineers and other technical people must interact to provide the level of knowledge required to develop meaningful specifications. This interaction where one party guides and the other implements in switching roles provides a check and balance on the activity.
The third part necessary to define a work package, the specification, has been developed.

Typical Specification Contents

* Scope
* Applicable Documents
* Requirements
  - System definition
  - Characteristics
  - Design and construction
  - Documentation
  - Logistics
  - Personnel and training
  - Verification
  - Quality assurance
  - Delivery
  - Notes

THE SPECIFICATION

The cost and schedule requirements are derived from the combination of the functional analysis and the requirements allocation activities of both the program and product SEM process. The specification contents are developed in like manner to spell out the performance side of the work package description.

The contents of the specifications provide for traceability to the overall requirements, documentation for "corporate memory" purposes, measurable definitions of results, definition of support and interfacing requirements, provisions for testing and quality assurance, review and reporting requirements, legal and organizational restrictions and whatever else is required to completely define the effort and results required and the constraints and limitations to be observed.

NOTES

PROGRAM RISK

THE LIKELIHOOD THAT AN OBJECTIVE WILL NOT BE ATTAINED BY FOLLOWING EXISTING PLANS

THE DOUBT OF ACHIEVING:

- SPECIFIED TECHNICAL PERFORMANCE
- DELIVERIES ON SCHEDULE
- COSTS WITHIN THE ALLOCATED BUDGET
- OPERATIONAL SATISFACTION

RISK ANALYSIS

An important sub-activity of the procedures already described is a risk assessment. The mechanisms for accomplishing this will not be described but the description is given above.

This kind of analysis to uncover the questionable aspects in a program or product development is very important from several aspects. In addition to those listed are the regulatory and social satisfaction questions. CNWRA addresses the former in their presentation to follow this one.

NOTES

THE SYSTEM ENGINEERING PROCESS

SYSTEM REQUIREMENTS

- MISSION DESCRIPTION
- CONCEPT OF OPERATION AND SUPPORT
- SYSTEM EFFECTIVENESS CRITERIA
- COST, SCHEDULE AND POLITICAL CONSTRAINTS
- TECHNICAL APPROACHES TO BE VALIDATED
- ALLOWABLE RISKS IN DESIGN AND DEVELOPMENT

SYSTEM ENGINEERING PROCESS

- OPERATIONAL AND SUPPORT
- FUNCTIONAL ANALYSIS
- TRADE-OFF STUDIES OF ALTERNATIVE DESIGN AND DEVELOPMENT APPROACHES CONSIDERING:
  - PROVEN VERSUS NEW TECHNOLOGY
  - RELIABILITY AND SERVICE LIFE GOALS
  - SAFETY CONSIDERATIONS
  - COMPUTER PROCESSING APPLICATIONS
  - EASE AND EFFECTIVENESS OF OPERATIONAL CONTROL AND SUPPORT
  - PRODUCIBILITY
  - COST AND SCHEDULE IMPLICATIONS
- RISK ASSESSMENT

ALLOCATIONS

- DEFINITION OF FUNCTIONAL REQUIREMENTS FOR:
  - PRIME MISSION EQUIPMENT
  - SUPPORT EQUIPMENT
  - FACILITIES
  - COMPUTER PROGRAMS
  - FABRICATION TECHNIQUES
  - ANALYSES AND TESTS FOR PERFORMANCE VERIFICATION
  - TEST FACILITIES AND SPECIAL TEST EQUIPMENT
  - OPERATION AND MAINTENANCE PROCEDURES
  - PERSONNEL SELECTION AND TRAINING
  - TRAINING EQUIPMENT

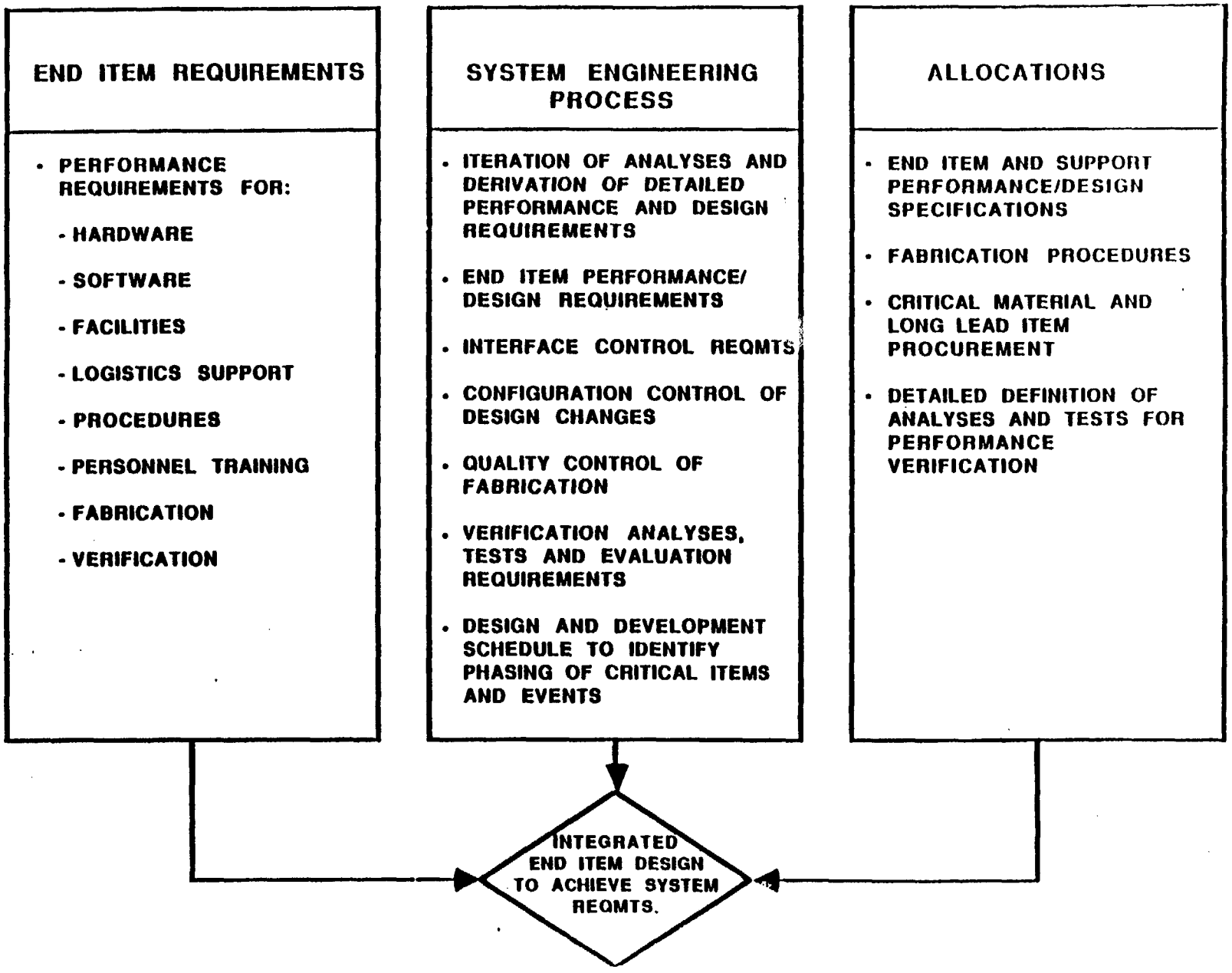
SYNTHESIS OF SYSTEM DESIGN

PROGRAMMATIC SEM FOR THE PRODUCT

NOTES

The accompanying chart, taken from the work of Wilton Chase, summarizes the processes just described. Overall System Requirements are transformed into Allocations through the application of a, now well developed and much applied, System Engineering Process to achieve a Synthesis of System Design of either the program or product system. The sub-headings used here imply a product system.

THE SYSTEM ENGINEERING PROCESS



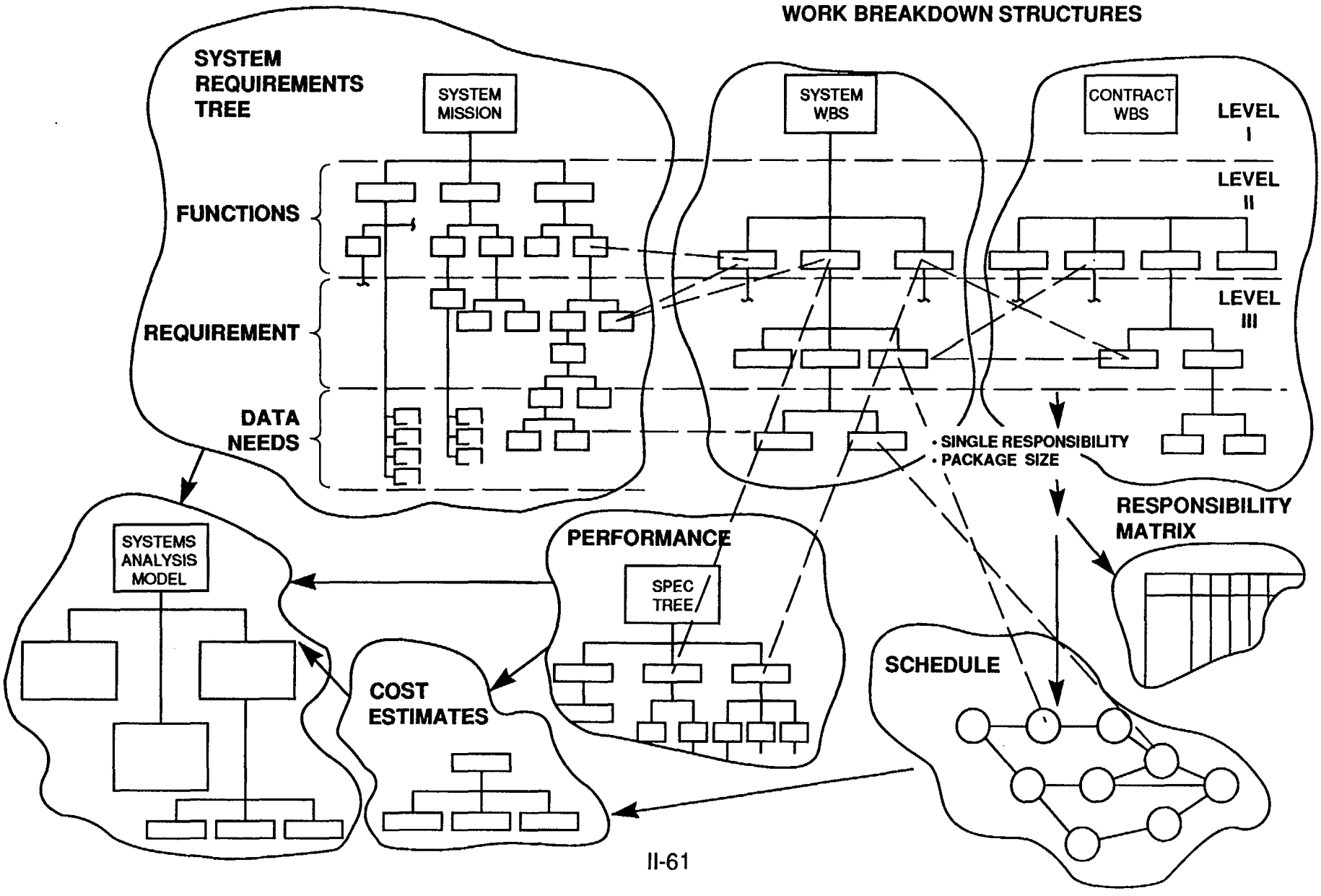
SECOND LEVEL SEM

The definition of sub-system requirements, called "End Item Requirements" in this chart, resulting from the previous chart undergo another transformation using essentially the same SEM process to more detailed allocations or specifications and procedures.

Here the result is an integrated end item design to achieve system requirements.

NOTES

PLANS INTEGRATION



NOTES

PLANS INTEGRATION

The power and complexity of the Systems Engineering Management process emerges in the simplified (?) diagrams shown. The process relates, documents, provides traceability from the desired mission capability down to the specification of end item activities and product elements. It can provide justification for and a memory structure of decisions made at all levels of the system and its development. It brings together the aspects of cost, schedule and performance in the full context of the mission of the system.

SOME ADDITIONAL SYSTEMS CONCEPTS

Emergence

Some properties of a system cannot be predicted in advance.

The property of emergence is one of the most interesting and most frustrating concepts in systems theory. Roughly speaking it points out that there are some behaviors that systems will exhibit when they are constructed (implemented, up and running, etc.) that are just impossible to anticipate in advance.

NOTES

Example of Emergence

At Kennedy Space Center

- Concern about rain falling on launch vehicles caused NASA to construct worlds largest hanger to shelter the rocket booster.
- Hanger was so large that clouds formed inside and rain fell on boosters.
- No way to predict this in advance

NOTES

15 to 20 years ago there was a newspaper report on peculiar events associated with systems. One of these reports was as reported above. This sounds rather far fetched but reportedly this was true. Regardless, it illustrates the principle of emergence nicely.

In a more tasteful example, consider when Napoleon was retreating before the Germans in one of the back and forth battles that typified that period of history. As the French were retreating, so the story goes, the cooks who were preparing a meal had a large pot full of beef cooking to feed the officers. They could not take the pot with them because it was too hot. They did not want to leave this beef for the Germans either. So they decided to pour some old red wine they had around into the pot to ruin the beef. When the Germans arrived they sampled the contents of the pot and found it delicious. It was what we now know as Beef a la Bourguignonne!

The killer bees may be a more contemporary example of emergence as well.

This property is important, of course, in the storage of high level waste in Nevada because stainless steel may be required to contain the waste for 1,000 years. Yet, this form of steel has not been around much over 30 to 40 years and certainly not in the environment that would be present in Nevada or any alternative site. How can we guarantee or even reasonably assure ourselves that emergence will not cause us some surprises?
The answer is we cannot!

OTHER SYSTEMS CONCEPTS

A System is a model, a map of a territory.

- Map cannot be as complex and detailed as the territory.
- Things get left out of the map (abstraction)
- Who decides what gets included and what gets left out?
- Inadequate "maps" put us in hot water

In many ways a system can be considered a map of some territory that we are interested in. We are all familiar with the notion that we can use a model to represent a real system. We have many ways of developing models and many ways of attempting to validate those models. The basic question of course is how well does the model mimic the real system. Our purpose is to use the model of the system for testing purposes rather than using the real system itself. It is better to make mistakes in the model of a system than in the real system itself.

The point of suggesting the map and territory metaphor is that we are familiar with how maps represent areas. Maps always leave something out. Road maps emphasize roads. Nautical maps represent shorelines and water depths. Maps that may work well for one purpose may fail or be useless for another. So it is with system models which are "maps" of real system "territories."

NOTES

SIX TOOLS FOR THINKING ABOUT SYSTEMS

- So Far As I Know
- Up to a Point
- To Me
- The What Index
- The When Index
- The Where Index

Various authors have attempted to present ways to guide our thinking about systems. Particular emphasis has been focused on how adequate our "maps" are. We have formal maps (computer simulation models) and we have mental maps (how we think about systems in our heads).

These aids to thinking range from complex mathematical proofs (which few people understand or bother to learn and use) to some hand waving philosophy about systems.

One particularly helpful set of tools has been proposed for thinking about systems. (See *How to Develop Your Thinking Ability*, by Kenneth S. Keyes, Jr. McGraw-Hill Paperbacks, 1963). In this book the author thinks out loud about thinking and comes up with six tools that improve thinking. These tools are particularly helpful in guiding our thinking about systems, models of systems, and how we construct our mental and formal "maps" of the territory we are interested in.

NOTES

What is the System?

Flying High over the Candidate Nevada waste site in the Goodyear Blimp we have

- A Member of the NRC
- The Secretary of the DOE
- The President of an Anti-Nuclear Protest Group
- An Environmentalist
- The Governor of Nevada
- A Terrorist
- A TV Anchorperson

To put the problem of developing a "map" of a territory in perspective, consider the overhead shown. Ignoring the question of how you could get such an interesting combination of players into the Goodyear Blimp in the first place, what do you suppose these people see as the system when they look out at the proposed waste site? Does anyone think the same "mental model" of the system exists in those heads? Will any observer form a mental model that agrees completely with any other observer's mental model?

If as we move away from Class A technological systems and move towards socio-technical systems (i.e., as we approach "softer" and "softer" systems) the challenge of developing a model of the system that people can agree on increases, is there anything we can do to help meet this challenge? The answer is yes.

Just as tools have been developed to assist system engineers in the understanding and design of Class A, B, and C technological systems, tools have been developed that can assist in the understanding and design of increasingly complex Class C and our large scale, complex socio-technical systems.

NOTES

Example

As they look down, what is the system?

Would the system be different if they were looking 50 years ago?

S. E. M. →

This overhead reminds us that "maps" have a useful lifetime and they should not be used past that lifetime. An old dictionary refers to uranium as a useless mineral. No one would want to drive around Washington, D. C. using a 1928 road map. Maps (both mental and formal) must be updated constantly as needed.

NOTES

SYSTEMS THINKING TOOL # 1

"As Far As I Know"

- No one person can know all about anything
- Key to openmindedness ("Life is the art of drawing sufficient conclusions from insufficient premises")
- Six Blind Men and the Elephant ("Absolute Certainty is a priviledge of uneducated minds--and fanatics.")
- A Single New Fact (Sometimes it takes only one new fact to upset our system map)
- We Tend to Believe What We First Hear

The first systems thinking tool is called "as far as I know." This points out that no one individual regardless of background, training, experience, education and the like can know everything about anything.

In viewing systems we should all have open minds and listen to others with different things to say. We can always reject what they say but if we do not encourage them to say it, we may never be exposed to other thoughts and facts that may turn out to be crucial.

When it comes to certainty in life, there isn't any. Edward Teller is reported to have said "There is only one statement I can make with absolute certainty: nothing can travel faster than the speed of light maybe."

NOTES

SYSTEMS THINKING TOOL # 2

"Up to a Point"

- Think in degrees (Avoid "It's gotta be this or that" and "either--or" thinking)
- The difference between a good idea and a bad idea is often a matter of degree
- Be Aware of the point at which a "little more" may make "more than a little" difference
- Up to What Point? Some Guidelines
  - "many" or "most" instead of "all"
  - "Usually" instead of "always"
  - "Seldom" instead of "never"
  - "Similar" instead of "same"

Systems thinking tool #2 is "up to a point." This is an attempt to get rid of "either/or" thinking. In Aristotelian thinking everything was "either this or that." In non-Aristotelian thinking we often find that "both" is a possible approach. We also find degrees rather that absolutes. Shades rather than black or white.

The guidelines shown when used express a recognition of and tolerance of other ideas and approaches that stimulate discussion rather than cut it off.

NOTES

SYSTEMS THINKING TOOL #2 Continued

Beware of Selected Examples

"Best of the Week" illustration of this pitfall

Be very careful of examples that are selected to drive a point home. Examples follow conclusions already made, they don't lead to conclusions in most settings. No example that contradicts the speaker's desired ends would ever be selected and presented.

A good example of this was the "best of the week" approach taken in certain military reporting chains during the Vietnam war. In reporting the activity for the week during end of the week briefings, everyone wanted to be upbeat. Therefore an approach was adopted which became known as "best of the week." Essentially the week's actions were reviewed and the best possible events which occurred were selected for briefing. This was not improper except that these best events were briefing as though they represented typical events that occurred during that week.

In any large system there are masses of data and events. If one is determined enough, it is almost always possible to find an event or example that can support a point of view no matter what that point of view is.

NOTES

SYSTEMS THINKING TOOL #3 Continued

- Our Personal Interests can blind us
- We tend to remember what we want to remember
- We rationalize to protect ourselves from other people's facts

"Oh wud some power the giftie gie us
to see oursels as ithers see us!"
Robert Burns

"So convenient a thing it is to be a reasonable creature, since it enables one to find or make reasons for everything one has a mind to do."
Benjamin Franklin

S. E. M. →

This overhead reminds us that it is easy to listen to and agree with people who think as we do and agree with us. The real challenge and an important thing to do from a systems approach is to listen to those who disagree with us. It is often possible to learn much from them. There is a fine balance between the two ends of the continuum where on one end we reject everyone as being crazy (even paranoids have real enemies), and on the other we listen to every one (including the crazies).

NOTES

SYSTEMS THINKING TOOL #3 Continued

- Our Personal Interests can blind us
- We tend to remember what we want to remember
- We rationalize to protect ourselves from other people's facts

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Systems thinking tool #3 is "to me" or "look who is talking." We all avoid B. O. (body odor) so why shouldn't we avoid M.O. (mental one-sidedness). We all live inside an "invisible bubble" that filters what we see and control to some extent what we see. We acquire these bubbles as we grow up in a culture, get educated in and out of school, and work on the job. Since the bubbles are invisible we can't see them and are often unaware they exist or simply conclude they don't exist for us. We can often see them in others however.

Nothing is more difficult than communicating across paradigms (invisible bubbles). Which bubble is the point of reference? I can see your bubble and you can see mine but neither of us can see our own.

One approach is to ban the use of the verb "to be". Rather than say a system is this or that, say "I see the system as this or that." Use the phrase "As I see it'' or "In my view". I can object when you say "The system is . . . " because I don't see it that way. I can't object when you say "I see the system as . . . ." because you may in fact see it that way.

Frames of reference often color how we see things. Is a 45 hour week a long work week? Suppose you are talking to someone who works 75 hours a week? Or 30 hours a week? Is 10,000 years a long time to plan a system for? Who might think that a short time?

NOTES

SYSTEMS THINKING TOOL # 4

The What Index

- **Group Words Mislead us**
  - Man $_1$ is not the same as Man $_2$ is not the same as Man $_3$
  - Funcational Analysis $_1$ is not the same as FA $_2$ is not the same as FA$_3$
- **No two individuals encompassed by a group word are the same**
- **The what index is simply a mental number (index) that reminds us that when we use a group word we are referring to a specific member of that group, not every member of that group.**
  - The what index reminds us of differences as well as similarities
  - Differences can make a real difference

S. E. M. →

Systems thinking tool #4 is the "What Index". This points out that words can mislead us. Individuals often get lumped together into groups and then every member of the group gets treated the same way. Members of groups are rarely identical. Most groups speak with many different voices and rarely are in lock step on anything.

NOTES

SYSTEMS THINKING TOOL #5

The When Index

- Our System Maps can become Obsolete
- The modes of yesterday may be the laughs of today or tomorrow
- Living people with "dead" knowledge
- The When Index attaches a date
- The date makes a difference
- A Foolish Consistence (Which " . . . is the hobgoblin of little minds, adored by little statesmen and philosophers and devines." Emerson)

S. E. M. →

Systems thinking tool #5 is the "when index". This reminds us to update our maps constantly. It also reminds us to tag a date on all our maps, mental and formal, that tell us over what time horizon these maps are good.

NOTES

SYSTEMS THINKING TOOL # 6

The Where Index

To a mouse, cheese is cheese. That is why mousetraps are effective.
(Wendell Johnson)

- Where often makes a difference
- Different situations, circumstances, or surroundings bring out different aspects of people and things
- The where index represents the whole environmental surrounding and reminds us that when parts of the environment change, there may be changes in the way our system may act/react.

S. E. M. →

Systems Thinking tool #6 "the where index". This points out the importance of putting everything in a proper context. Different situations, circumstances, or surroundings can make a big difference. A system that should last for 10,000 years has to make some big assumptions about societal conditions over that time horizon. Suppose society collapses 3,000 years from now. How would that effect a system that may have been constructed assuming an orderly social fabric? The were index would have us question assumptions about the environmental circumstances and surroundings for our system.

NOTES

I keep six honest serving-men
(they taught me all I knew);
Their names are WHAT and WHY and WHEN
And HOW and WHERE and WHO

Rudyard Kipling

In a sense there is nothing new about these systems thinking tools, but it is surprising how often they are ignored. It is also interesting to note the reactions of those who have designed and developed systems while ignoring these tools. They are often either surprised, astonished or angry when others reject their results or initiate legal challenges. In soft systems there are no rights and wrongs just different viewpoints and value systems that often effect what maps are developed and how the territory is viewed. One example of this is the U.S. war on drugs. Another is the role of nuclear power in the U.S. energy policy. These and other systems are tangled up in many viewpoints and value systems. Soft systems are messy but there is little choice other than ignoring them and hoping they go away.

NOTES

Why good system models are hard to develop

Why it was so hard to describe the system in that Goodyear Blimp

- Truth is hard to reach
- Everything changes
- Things appear differently to different people
- Things exist in varying degrees
- Things may act differently in new environments
- No two things are identical
- You can never know all about anything

S. E. M. →

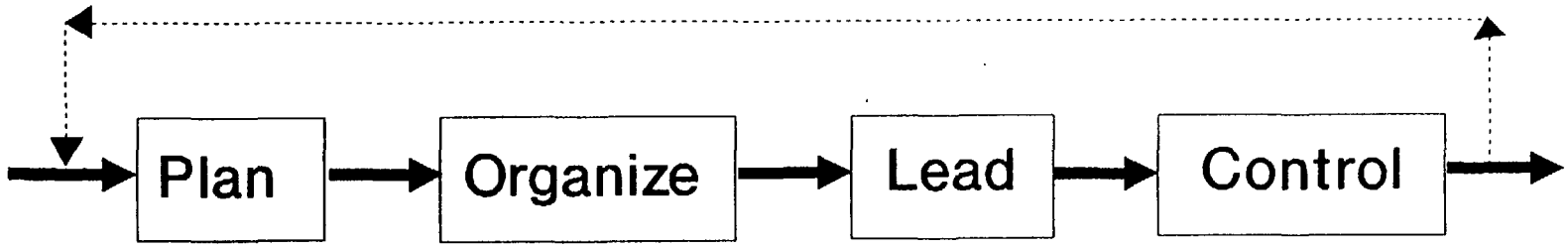
This overhead summarizes the points made in the Six Tools for thinking about systems. It also revisits the Goodyear Blimp with its unusual passenger list and suggests why it is normal that it is so difficult to describe what might to some be a simple, straight forward system.

NOTES

"The Management Process"

Session III

The Management Process



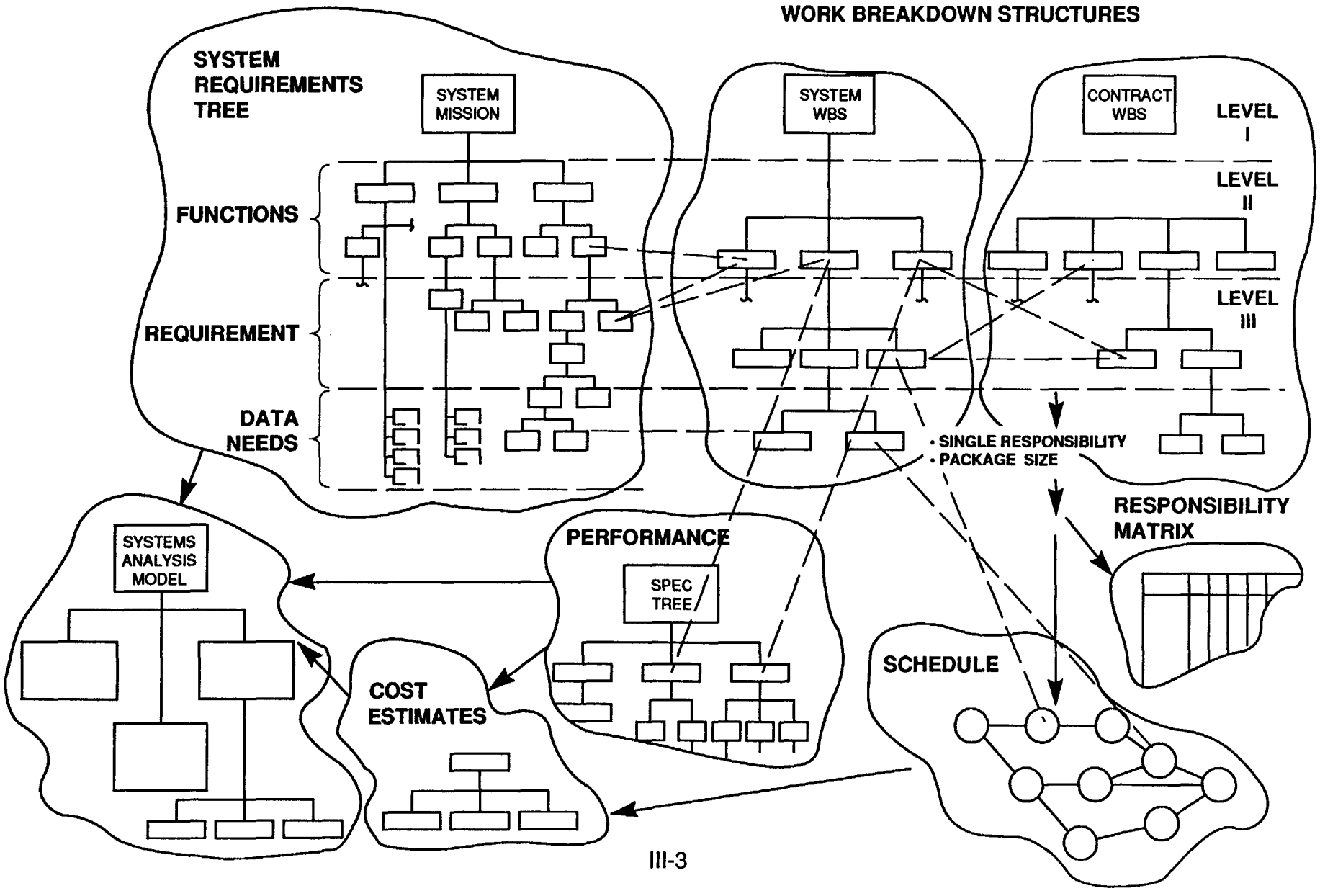
Plan	Organize	Lead	Control
* Prescribe a course of action	* Arrange & relate work for people	* Cause people to take effective action	* Measure progress & effect change
* Projections * Goals * Critical needs * Policies * Sequencing * Scheduling * Budgeting * Procedures * Specific actions	* Structure * Delegate * Operations	* Deciding * Motivating * Communicating * Staffing * Developing	* Criteria * Sampling * Analysis * Replan * Correcting

THE MANAGEMENT PROCESS

NOTES

In the classical approach, management is viewed as an iterative process with the major or top and second level activities as shown. This session will address the organizational and control aspects that have developed with the System Engineering Management approach. The "leading" or "motivating" activity will be reduced to considerations of integration and of how to get people working together which is the essence of vitalization.

PLANS INTEGRATION

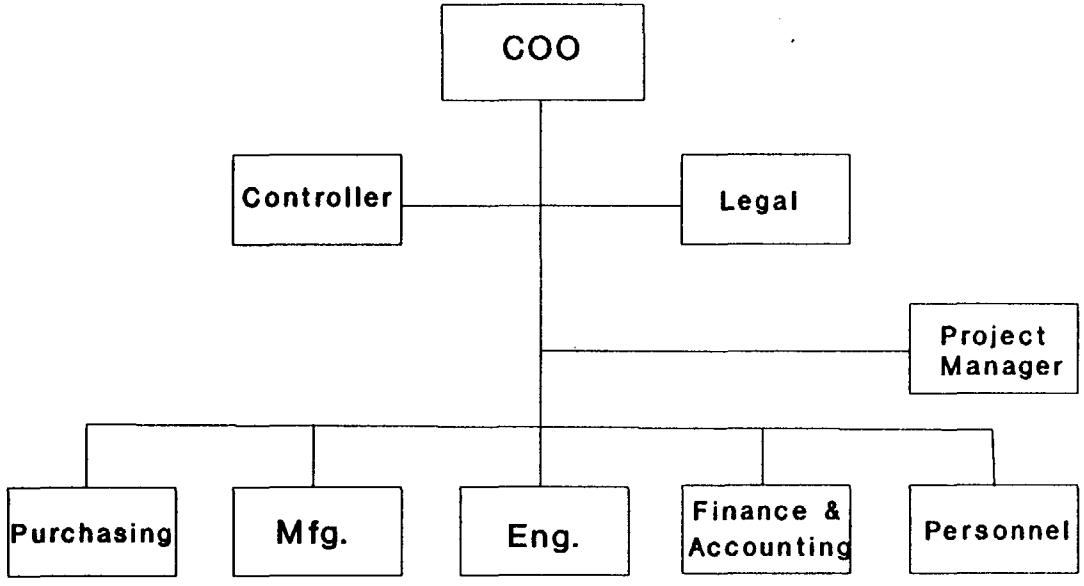


THE PLANS FUNCTION

A review of the summary part of Session #2 showing the impact of the planning phase, which is what Session #2 was about, is in order. The single organization entity requirement of the work packages can have a definite impact on the organizational structure (and vice versa). The planning function provides a structure, indicates responsibilities, allocates funds and time and all limited resources which shapes the activities which follow in the management process.

NOTES

Functional Management



Pro

* Capability building
* Quality Assurance
* Efficiency of operation
* Professional development
* Comfortable environment

Con

* Low "customer" concern
* Low program objective concern
* Lack of integration
* Poor program control & accountability

FUNCTIONAL MANAGEMENT

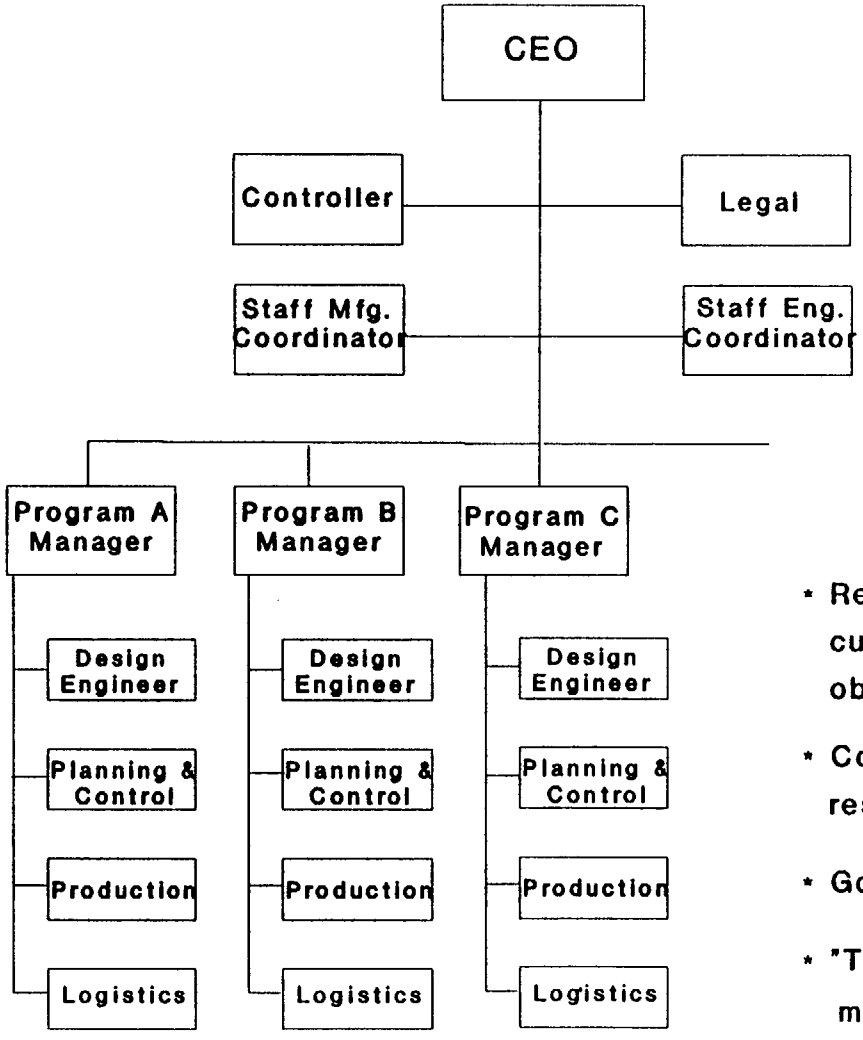
NOTES

Perhaps the oldest and most traditional organizational form is the functional form where the line management (responsible for the product) is along lines of the type of work or discipline, the profession or occupation, the segment of the overall operation that is accomplished in that organization and, for the most part, in that organization only. This type of an organization is in essence a project organization in the situation of a single product, service of even perhaps a single customer.

If a functional organization takes on multiple projects, the project management function is often tacked on in a staff like position, like legal and the controller functions (in a non-legal or non-controller firm). The project management function in this situation is often solely a planning function and derives its authority through the weight of its relationship to the Chief Operating Officer's (COO) office and the degree to which the COO backs-up the project manager.

The expected benefits and draw backs of this form of organization are listed. In a nut shell, it is expected to build strong capabilities but they may not always be directed to meeting the objectives of the system desired by the customer.

Program Management



Pro

- Responsive to customer & program objectives
- Control of resources
- Good Accountability
- "Tiger" team motivation

Con

- Misuse of people
- Duplication & overall inefficiency
- Proselizino
- Short lived

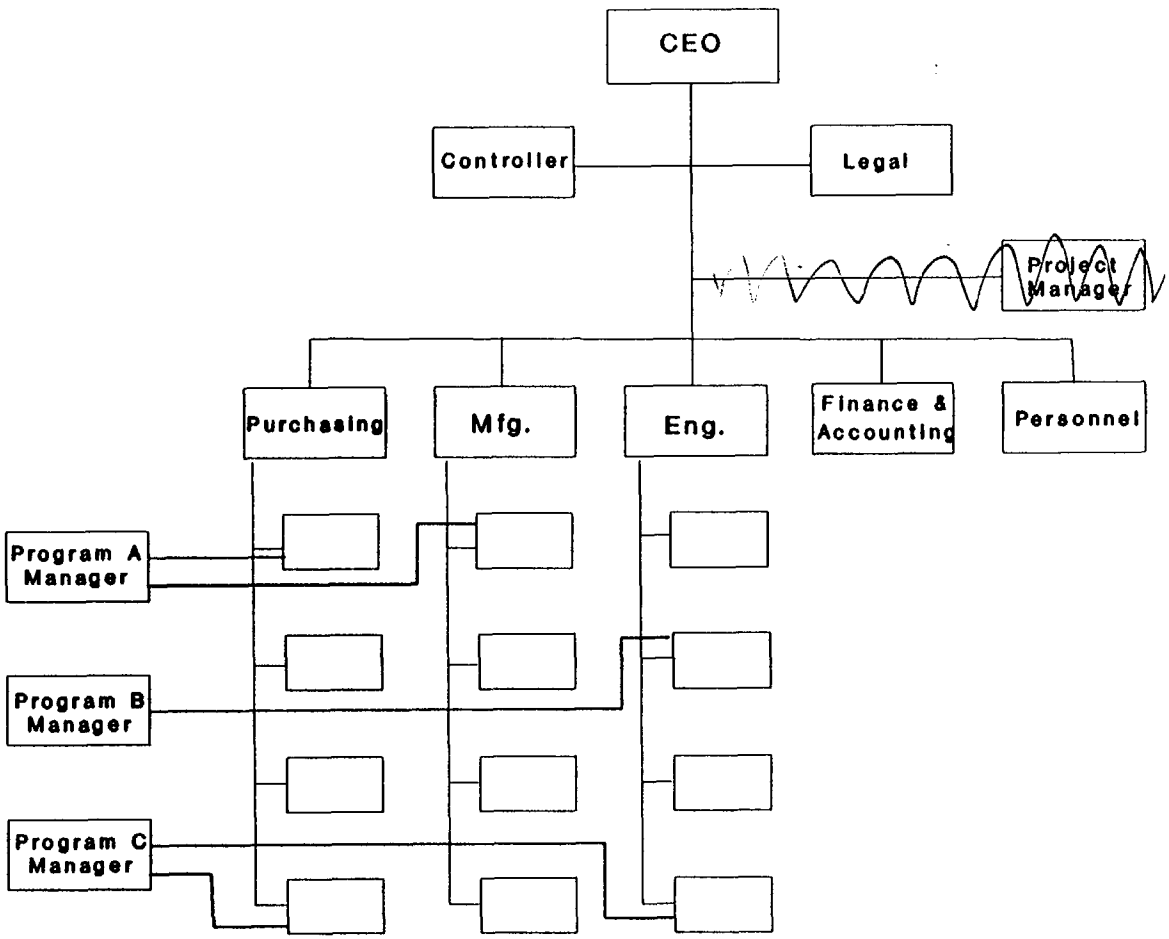
PROGRAM MANAGEMENT

NOTES

The major expected benefits of the completely projectized or program management organization are that it is dedicated to producing the required product and to customer satisfaction. On the negative side is tends to be less efficient, to misuse people and because of its planned expiration it is not concerned with long term competence. As a partial hedge against these down-side expectations, some organizations establish staff functions whose task it is to maintain the professional identity and development of the professional people in the organization and to present a desired external image.

If the organization is devoted to a single program, the COO is in essence the program manager and the organization can look just like a functional organization.

Matrix Management



The "best" of both worlds (?)

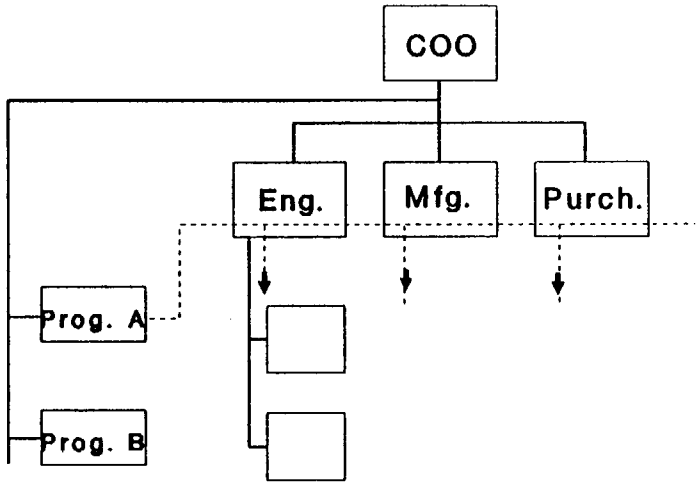
MATRIX MANAGEMENT

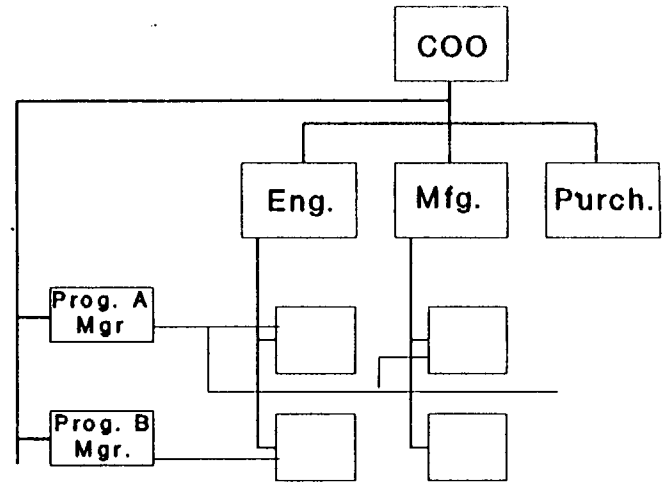
NOTES

As the situation has evolved where long term organizations must prosecute multiple large programs, the matrix management form of organization has developed. The major funding to the functional parts of the organization comes through the program offices but some funds are available to the functional groups to build competence and to develop capabilities at their own discretion. The reporting lines can still be directly tied to the functional managers and indirectly to the program managers. However, the reporting may be the different depending on the approach the COO enforces.

This is a much more complex organizational structure requiring greatly increased coordination and the active participation of the COO to maintain balance but, if properly enforced, the benefits of both the functional and the program management organizations can be realized.

Degrees of Matrix Management





* Strong Functional Org.
  * Own discretionary funds
  * Own people
  * Own program pieces
  * Kings
* Weak Project Org.
  * No control of resources
  * Doted line to people
  * Planner (maybe)
  * Beggars
* C.O.O.
  * Allows operation

* Weak Functional Org.
  * Little discretionary funds
  * Farm people out
  * Planner
  * People poolers, servants
* Strong Program Managers
  * Evaluate people
  * Direct people
  * Operative managers
  * Kings
* C.O.O.
  * Allows operation

DEGREES OF MATRIX MANAGEMENT

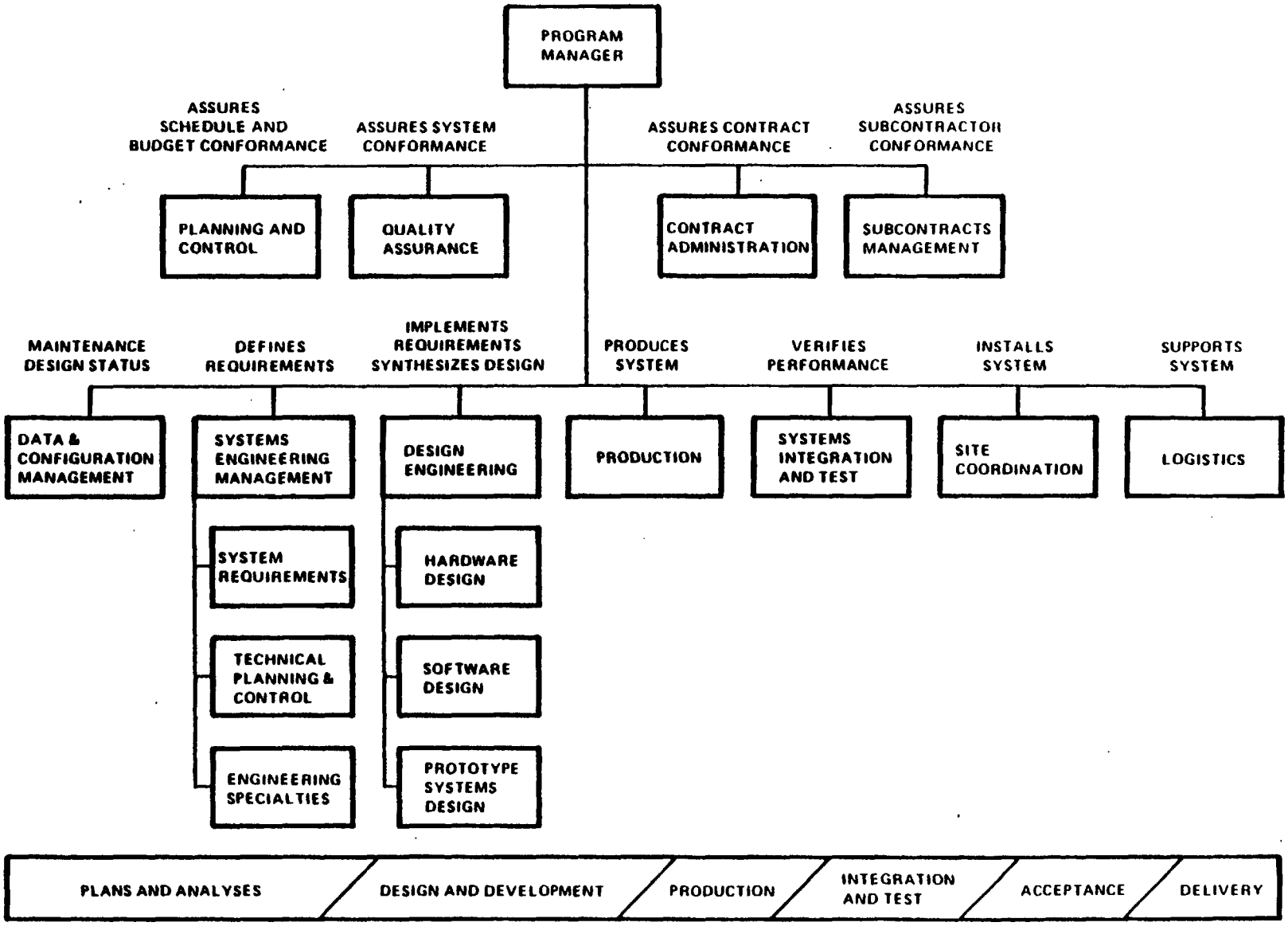
NOTES

"Proper" balance of the matrix organization is a subjective judgement and difficult to maintain. When the functional organization is relatively very dominant, the project managers become mendicants imploring with little control over the tasks or people assigned in the functional groups. Short-term and regular turn-over of project managers is symptomatic of this type of organization.

When the functional organization is weak, functional managers become little more than meat market managers, pooling people for distribution to programs. The reporting and evaluation lines become direct to the program managers and the disbenefits of the completely projectized organization begin to appear.

In either case the COO must allow the operation to happen. It is a choice between long-term organizational development and shorter-term program objectives and customer satisfaction.

PROGRAM ORGANIZATION MODEL



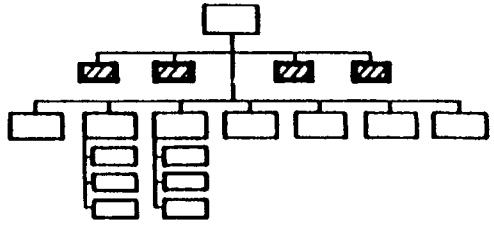
PROGRAM ORGANIZATION MODEL

Regardless of the degree of matrix management, the program office must provide for certain functions. An example of a full program management organization is used for illustration in what follows but the functions could be and often are provided by parts of a functional organization.

Program phases are indicated on the bottom of the chart. The changing role of systems engineering management, in particular, will be examined later on.

NOTES

PROGRAM ORGANIZATION FUNCTIONS



PROGRAM MANAGER

ASSURES SCHEDULE AND BUDGET CONFORMANCE

PLANNING AND CONTROL

PROGRAM PLANNING

- PROGRAM WBS
- TASK AUTHORIZATION
- ACTIVITY AND EVENT NETWORK
- PROGRAM SCHEDULES
- MANAGEMENT INFORMATION SYSTEM
- MANAGEMENT CONTROL CENTER

FINANCIAL CONTROL

- COST DATA PROCESSING
- COST DATA REPORTS
- BUDGETING
- COST/SCHEDULE CONTROL SYSTEM

ASSURES SYSTEM CONFORMANCE

QUALITY ASSURANCE

- QA ENGINEERING
- HARDWARE QUALITY ASSURANCE
- SOFTWARE QUALITY ASSURANCE

ASSURES CONTRACT CONFORMANCE

CONTRACT ADMINISTRATION

- CONTRACT ADMINISTRATION
- MONITORING FOR COMPLIANCE
- TERMS AND CONDITIONS
- FORMAL CONTRACT COMMUNICATIONS
- DATA TRANSMITTALS

ASSURES SUBCONTRACTOR CONFORMANCE

SUBCONTRACTS MANAGEMENT

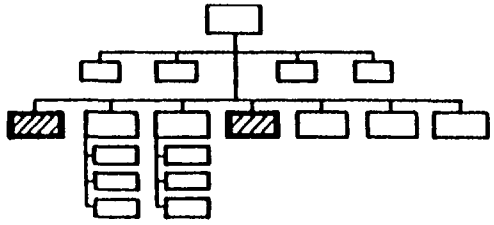
- SUBCONTRACT SOLICITATION
- SOURCE SELECTION
- SUBCONTRACT ADMINISTRATION
- MONITORING AND CONTROL
- SUBCONTRACT STATUS REPORTING
- FORMAL SUBCONTRACT COMMUNICATIONS

PROGRAM FUNCTIONS AND ORGANIZATION

NOTES

The organizational structure is repeated in the upper right with four groups identified and detailed in the remainder of the chart. The distinction of line and staff loses meaning in an organization devoted mainly to planning and control. As was stated earlier, the product is the process.

PROGRAM ORGANIZATION FUNCTIONS



MAINTAINS
DESIGN
STATUS

DATA AND CONFIGURATION MANAGEMENT

- DATA MANAGEMENT
- DATA ACCESSION LIST
- SUBCONTRACTOR/VENDOR DATA
- CONFIGURATION MANAGEMENT
- AIRCRAFT/SIMULATOR INTERFACE CONFIGURATION MANAGEMENT

PRODUCES
SYSTEM

PRODUCTION

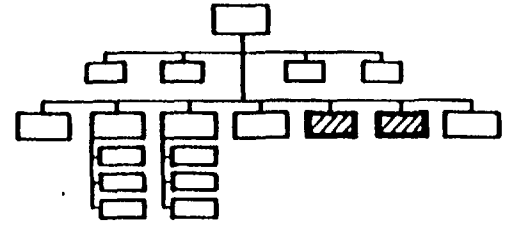
- MAKE-OR-BUY ANALYSIS
- PRODUCTION ENGINEERING AND PLANNING
- MANUFACTURING PLANNING AND CONTROL
- FACILITIES PLANNING
- MOCKUP FABRICATION
- SUBSYSTEM AND MODULE FUNCTIONAL TESTING

PROGRAM FUNCTIONS AND ORGANIZATION (continued)

NOTES

Two more organizational functions are shown in this chart. The functional claim of "Produces System" is overdone since no operative production functions are included in the more detailed functional list. The contribution of the management responsibility guide helps keep functional claims in perspective.

PROGRAM ORGANIZATION FUNCTIONS



VERIFIES
SYSTEM PERFORMANCE

SYSTEM INTEGRATION AND TEST

SYSTEM INTEGRATION

- HARDWARE/SOFTWARE INTEGRATION PLAN
- HARDWARE/SOFTWARE INTERFACE CONTROL

TEST & EVALUATION

- SYSTEM TEST AND EVALUATION PLAN
- SUBSYSTEM AND MODULE TEST COORDINATION
- SYSTEM INTEGRATION TESTS
- QUALITY ASSURANCE TEST
- ACCEPTANCE TEST

INSTALLS
SYSTEMS

SITE COORDINATION

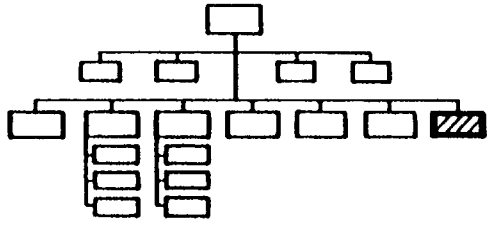
- SITE INTERFACE REQUIREMENTS
- SITE LIAISON
- TRANSPORTABILITY
- INSTALLATION AND CHECKOUT
- ACCEPTANCE TESTS
- ECP MODIFICATIONS AND MODERNIZATION KITS

PROGRAM ORGANIZATION / FUNCTIONS (continued 2)

NOTES

The "System Integration and Test" and "Site Coordination" groups are detailed here. Note again that planning, coordination and control are the responsibilities being addressed for a matrix organization, not operative responsibility.

PROGRAM ORGANIZATION FUNCTIONS



SUPPORTS SYSTEM OPERATIONS

LOGISTICS

PLANS LOGISTIC SUPPORT FOR PROGRAM LIFE

PROVIDES USER DOCUMENTS

TRAINS CUSTOMER PERSONNEL

INTEGRATED LOGISTIC SUPPORT

LOGISTIC SUPPORT ANALYSIS

- RELIABILITY ANALYSIS
- MAINTAINABILITY ANALYSIS
- LOGISTICS TRADE STUDIES
- REPAIR LEVEL ANALYSIS
- LOGISTICS DESIGN REQUIREMENTS
- SUPPORT EQUIPMENT REQUIREMENTS
- FACILITY/UTILITY INTERFACE REQUIREMENTS

LOGISTICS MANAGEMENT

- LOGISTICS MANAGEMENT PLAN
- PROVISIONS/SPARES PLAN

RELIABILITY/MAINTAINABILITY PLANNING

LIFE CYCLE COST

- LIFE CYCLE COST TRADE STUDIES

TECHNICAL PUBLICATIONS

- OPERATIONAL MANUALS
- MAINTENANCE MANUALS
- MANUAL VALIDATION
- VERIFICATION SUPPORT
- SOFTWARE MAINTENANCE
- DOCUMENT MAINTENANCE

TRAINING

- TRAINING PROGRAM PLANNING
- ORGANIC TRAINING
- TRAINING EQUIPMENT
- TRAINING PROGRAM SUPPORT

PROGRAM ORGANIZATION / FUNCTIONS (continued 3)

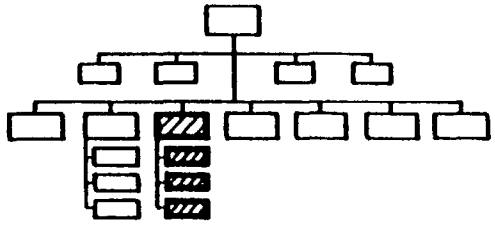
NOTES

The logistic function is detailed here. In the last few decades the pervasive influences of logistics in the life cycle of all systems has been recognized and logistics management has evolved as a definite academic and organizational entity. It is more the usual situation these days to find a functional logistics organization. The same is true of other disciplines which have evolved with the system engineering management process and which developed into recognized functional areas. In fact the normal set of functional organizations is changing to more closely match the functions developed in the systems engineering management approach (Or is it the other way around?).

PROGRAM ORGANIZATION FUNCTIONS

IMPLEMENTS REQUIREMENTS
SYNTHESIZES SYSTEM DESIGN

DESIGN ENGINEERING



HARDWARE DESIGN/DEV

DESIGN CRITERIA

- HARDWARE CRITERIA ANALYSIS
- DESIGN SPECS (PART II)
- TRADE STUDIES

HARDWARE DESIGN

- CONFIGURATION DESIGN
- SUBSYSTEM AND MODULE DESIGNS
- MOCKUP DESIGN

SOFTWARE DESIGN/DEV

- SOFTWARE CRITERIA ANALYSIS
- SOFTWARE REQUIREMENTS DEFINITION
- SOFTWARE TRADE STUDIES
- COMPUTER PROGRAM DESIGN
- DATA BASE DESIGN
- SOFTWARE CONFIGURATION DEFINITION AND CONTROL
- SOFTWARE CODING
- SOFTWARE TEST
- DOCUMENTATION
- FIRMWARE DESIGN

PROTOTYPE SYSTEMS DESIGN/DEV

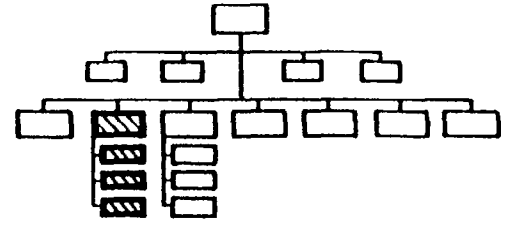
- NAVIGATION AND COMMUNICATION SUBSYSTEMS
- AIRCRAFT SYSTEMS
- TACTICAL AVIONICS

PROGRAM ORGANIZATION / FUNCTIONS (continued 4)

NOTES

The engineering function is detailed next with the realization that engineering in particular has maintained its functional status most strongly in the evolution we are discussing. But the planning, coordination and controls of the engineering functions have changed drastically. In my experience and with my bias as an engineer, I judge that most program managers have significant engineering training. The engineering group(s) work most closely with the system engineering management group (following chart), especially during the early stages of the program to provide alternative system architectures.

PROGRAM ORGANIZATION FUNCTIONS



DEFINES REQUIREMENTS

SYSTEMS ENGINEERING MANAGEMENT

DERIVES PROGRAM REQUIREMENTS
IMPLEMENTS S.E.M.P.

DERIVES TECHNICAL REQUIREMENTS

SYSTEMS ANALYSIS

- REQUIREMENTS ANALYSIS AND DEFINITIONS
- FUNCTIONAL REQUIREMENTS AND ALLOCATIONS
- EFFECTIVENESS CRITERIA DEVELOPMENT
- REQUIREMENTS TRADE STUDIES
- RISK ANALYSIS
- SPECIFICATION MANAGEMENT
- INSTRUCTIONAL SYSTEM DEVELOPMENT

TECHNICAL PLANNING & CONTROL

- TECHNICAL TASK PLANNING AND CONTROL
- DESIGN REVIEWS
- TECHNICAL PERFORMANCE MEASUREMENT
- INTERFACE MANAGEMENT
- SUBCONTRACTOR TECHNICAL MONITORING
- RISK MANAGEMENT
- SITE INTEGRATION REQUIREMENTS
- TEST AND EVALUATION REQUIREMENTS
- TRADE STUDY MANAGEMENT

INTEGRATES "ILITIES" REQUIREMENTS

ENGINEERING SPECIALTIES

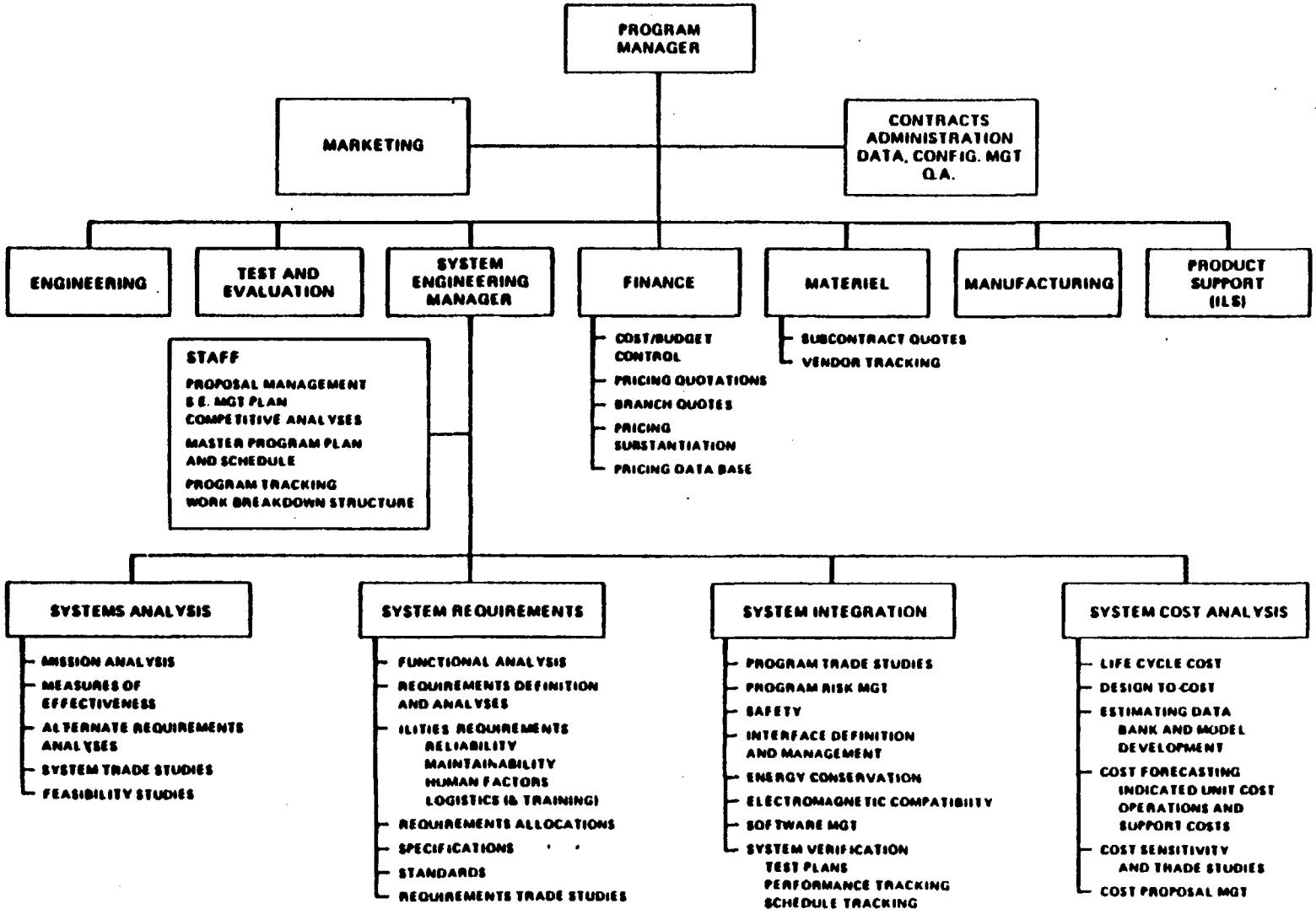
- RELIABILITY
- MAINTAINABILITY
- HUMAN FACTORS
- PRODUCIBILITY
- SAFETY
- STANDARDIZATION
- ELECTROMAGNETIC COMPATIBILITY
- LOGISTICS DESIGN INTERFACES
- LIFE CYCLE COST

S.E.M. FUNCTIONS

NOTES

Systems Engineering Management, being the focus of this course is treated in more detail now. Most of the terms are not new at this point. The types of analysis, plans and support information have been related in the explanation of the SEM process. However, in the context of the full operational application the role played by these functions takes on meaning.

SYSTEM ENGINEERING MANAGEMENT FUNCTIONS



ALTERNATIVE S.E.M. FUNCTIONS

NOTES

The accompanying chart shows an alternative arrangement of a program manager organization in general and of system engineering management functions in more detail. This one seems to emphasize integration and cost aspects more.

FUNCTIONS OF THE SYSTEMS ENGINEERING ORGANIZATION

DEFINES SYSTEM REQUIREMENTS

SYSTEM ENGINEERING MANAGER

DEFINES TECHNICAL REQUIREMENTS

REQUIREMENTS ANALYSIS

- REQUIREMENTS ANALYSIS AND DEFINITIONS
- FUNCTIONAL REQUIREMENTS
- REQUIREMENTS ALLOCATIONS
- EFFECTIVENESS ANALYSES AND TRADE STUDIES
- REQUIREMENTS TRADE STUDIES
- RISK ANALYSES
- SPECIFICATION MANAGEMENT

DERIVES PROGRAM REQUIREMENTS IMPLEMENTS SEMD

TECHNICAL PLANNING AND CONTROL

- TECHNICAL TASK PLANNING AND CONTROL
- TECHNICAL PERFORMANCE MEASUREMENT
- INTERFACE MANAGEMENT
- RISK MANAGEMENT
- CONTINGENCY PLANNING
- TEST AND EVALUATION REQUIREMENTS
- TRADE STUDY MANAGEMENT

INTEGRATES "ILITIES" REQUIREMENTS

ENGINEERING SPECIALTIES

- RELIABILITY DESIGN
- MAINTAINABILITY DESIGN
- HUMAN FACTORS DESIGN
- SAFETY
- ELECTROMAGNETIC COMPATIBILITY
- SECURITY
- STANDARDIZATION
- LOGISTIC DESIGN INTERFACE
- PRODUCIBILITY DESIGN INTERFACE

MANAGERS LIFE CYCLE COST

LIFE CYCLE COST DESIGN TO COST

NEXT PAGE

MONITORS PERFORMANCE OF NON-PRIME PARTICIPANTS

ASSOCIATE, SUBCONTRACTOR AND VENDOR SURVEILLANCE

- TECHNICAL PERFORMANCE SURVEILLANCE AND TPM
- INTERFACE MANAGEMENT

ALTERNATIVE S.E.M. FUNCTIONS 2

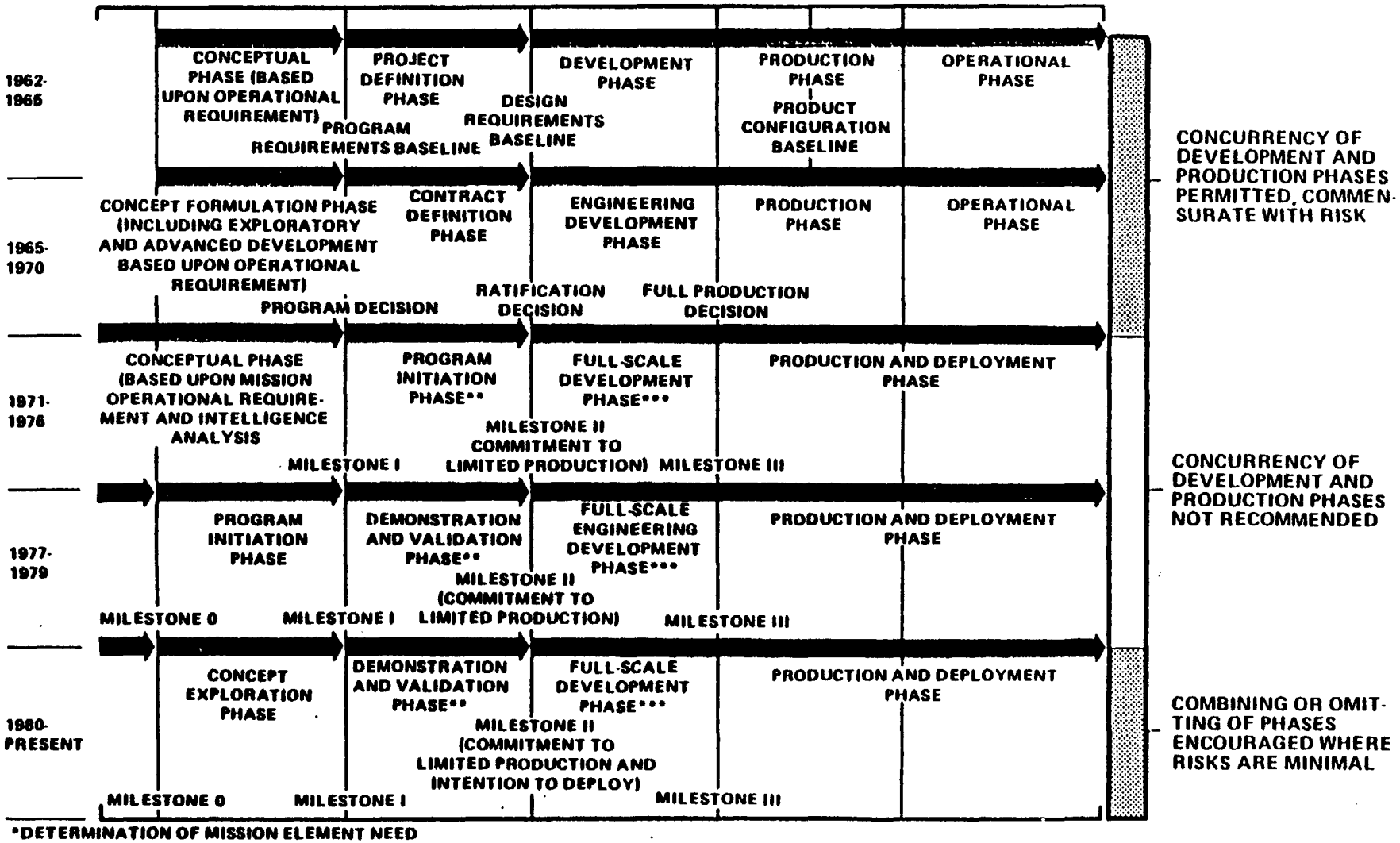
NOTES

If repetition is an aid to understanding, here is another example of a system engineering operation. This one adds a subcontractor planning and control function.

Note again that each agency in a program must decide on its own organizational structures unless specified by an agency in the supra-system or by a contract.

We have used the structures in the past few charts to provide functional groupings only.

EVOLUTION OF THE MAJOR DEFENSE SYSTEMS LIFE CYCLE



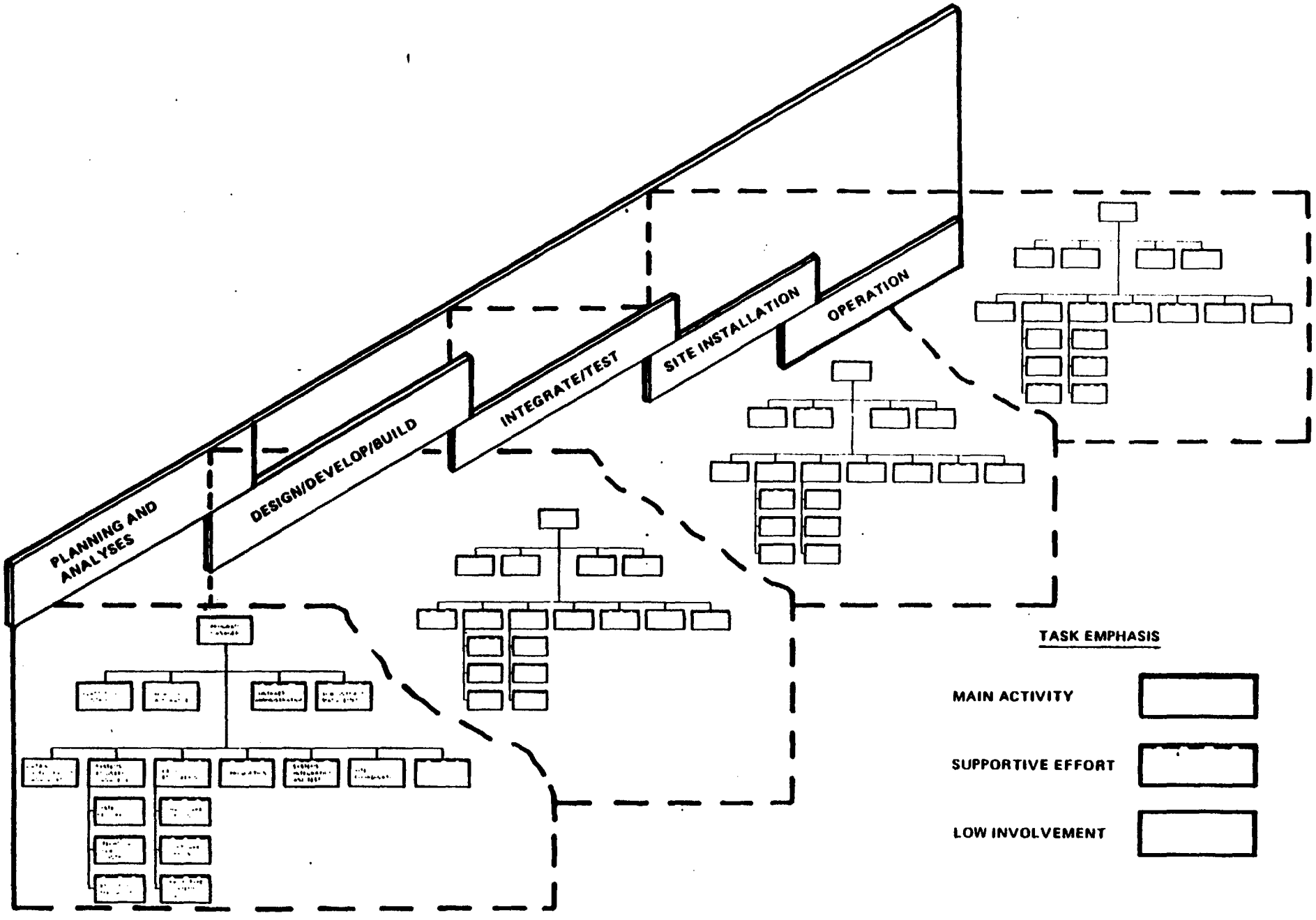
*DETERMINATION OF MISSION ELEMENT NEED
**SUCCESSFUL DEVELOPMENT TEST AND EVALUATION REQUIRED BEFORE MILESTONE II
***SUCCESSFUL OPERATIONAL TEST AND EVALUATION REQUIRED BEFORE MILESTONE III

EVOLUTION OF THE LIFE CYCLE

NOTES

The philosophy of systems development has evolved and changed over the last half century. It has changed from building on an analysis base alone to the concept of fly-before-you-buy. The vacillations occur under the pressures of inadequate systems and too lengthy and too costly systems development. For instance, the concept of concurrent development has come and gone and is emerging again.

A process of baselines, milestones and phases has evolved. The driving consideration is assurance that there is proper preparation for the following phase, which is almost always more costly, to proceed. The cancellation or phase-out stages are not shown here but must always be considered in the system birth to death life cycle.


PLANNING AND ANALYSES
DESIGN/DEVELOP/BUILD
INTEGRATE/TEST
SITE INSTALLATION
OPERATION
TASK EMPHASIS
MAIN ACTIVITY
SUPPORTIVE EFFORT
LOW INVOLVEMENT

S.E.M. CHANGES WITH PHASES

NOTES

Both the program management and the system engineering management roles change with the system life cycle. This unreadable chart indicates this changing task emphasis.

The transitions of the systems engineering management function are displayed in the following chart.

SYSTEM ENGINEERING MANAGEMENT RESPONSIBILITIES

CONCEPT EXPLORATION	DEMONSTRATION VALIDATION	FULL-SCALE ENGINEERING DEVELOPMENT	OPERATIONS AND SUPPORT
REQUIREMENTS ANALYSIS	REQUIREMENTS ANALYSIS	REQUIREMENTS ANALYSES	REQUIREMENTS ANALYSES
EFFECTIVENESS ANALYSIS	EFFECTIVENESS ANALYSIS	TECHNICAL PERFORMANCE MANAGEMENT	TECHNICAL PERFORMANCE
LIFE CYCLE COST	LIFE CYCLE COST	RISK MANAGEMENT	LIFE CYCLE COST
RISK ANALYSIS	RISK MANAGEMENT	LIFE CYCLE COST	
SYSTEM VERIFICATION	TRADE STUDIES MANAGEMENT		
INTERFACE CONTROL	SYSTEM INTEGRATION		
SOFTWARE INTEGRATION	– DESIGN		
LOGISTIC SUPPORT INTERFACE	– PROGRAM		
RELIABILITY	– TEST		
MAINTAINABILITY	– ILS		
TRADE STUDIES MGT	– SOFTWARE		
SAFETY	SYSTEM DEFINITION		
ENERGY CONSERVATION			

CHANGING SYSTEMS ENGINEERING RESPONSIBILITIES

NOTES

The involvement of the systems engineering management function is seen to change and decrease as the system matures. SEM participation is very high in the planning stages and the work done in the planning phase or concept exploration stage profoundly effects everything that comes later in the system's life cycle.

Requirement analyses and life cycle cost analysis continue throughout the system's life. As will be discussed later the control function part of the program manager's responsibility can involve much replanning. This will mean revising and rerunning the analyses and processes previously covered in detail.

INTEGRATION

* Combine n-1 level elements into n level aggregates.

INTEGRATION

From the technical standpoint much of the work necessary to accomplish integration has been done in the functional analysis and requirements allocation processes. Management's motivational job in this part of its responsibility is defined but definition is a long way from realization and we would now like to address some important issues and developments in this area.

NOTES

SYSTEMS INTEGRATION

Systems Engineering can integrate the technical aspects of systems (form, fit, function)

Systems Engineering can integrate the human side of systems

How do Systems Engineers integrate the work of those disciplinary, engineering and scientific specialists involved in planning and designing the technical and human aspects of systems?

REGULATORY REQUIREMENT SYNOPSIS

RETRIEVABILITY OF WASTE

REQUIREMENTS

Regulatory Requirement Citations

Primary Regulatory Text Citation

10CFR60 111 (b) (1) January 1, 1990

Potential Uncertainty

PASS Identification Number: RR0002/UN0001
Topic: Facilitate Versus not Prevent Waste Retrieval

10CFR60 111 (b) (3) January 1, 1990

Associated Regulatory Text Citations

10CFR60 21 (c) (12)	January 1, 1990
10CFR60 46 (a) (1)	January 1, 1990
10CFR60 131 (b) (7)	January 1, 1990
10CFR60 131 (b) (10)	January 1, 1990
10CFR60 132 (a)	January 1, 1990
10CFR60 133 (c)	January 1, 1990
10CFR60 133 (e) (1)	January 1, 1990
10CFR60 133 (i)	January 1, 1990
10CFR60 135 (b) (3)	January 1, 1990
10CFR60 135 (b) (4)	January 1, 1990

Referenced Regulatory Text Citations

10CFR60 111 (a) January 1, 1990
See Regulatory Requirement RR0004

REGULATORY REQUIREMENT TEXTS AND RATIONALES

Included Regulatory Text

Primary Regulatory Text

10CFR60 111 (b) (1) January 1, 1989

Retrievability of waste. (1) The geologic repository operations area shall be designed to preserve the option of waste retrieval throughout the period during which wastes are being emplaced and, thereafter, until the completion of a performance confirmation program and Commission review of the information obtained from such a program. To satisfy this objective, the geologic repository operations area shall be designed so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the Commission. This different time period may be established on a case-by-case basis consistent with the emplacement schedule and the planned performance confirmation program.

Rationale for Selection as Primary

This is the only text in 10CFR60 which deals solely and generally with retrieval. Other texts either deal with retrieval along with other subjects in the course of addressing another major issue, or they refer to only limited aspects of retrieval, such as the design of openings in the underground facility, or radiation standards for restricted areas. This text mentions or implies engineering design, radiation safety, performance confirmation, retrieval schedule, backfilling, and permanent closure, which are the major issues involved in retrieval.

Information in NUREG-0804 and NWPAA on retrieval deals with related, basic issues when it states that the ability to retrieve waste packages is to be incorporated into the design of the repository, but that it should not unnecessarily complicate, or dominate, the repository design. (References 10,20 of UN0001) D. S. Moulton and R. L. Wilbur, 6 Nov. 1989

Associated Regulatory Texts

10CFR60 21 (c) (12) January 1, 1989

The Safety Analysis Report shall include:

(12) A description of plans for retrieval and alternate storage of the radioactive wastes should the geologic repository prove to be unsuitable for the disposal of radioactive wastes.

REGULATORY ELEMENTS OF PROOF

WHAT MUST BE DEMONSTRATED BY DOE TO SUPPORT A CONCLUSION THAT THE RR HAS BEEN MET. EACH REGULATORY ELEMENT OF PROOF (EP) MUST BE DIRECTLY STATED IN THE REQUIREMENT ITSELF.

- PASS ID CODES: EP PASS ID NUMBER: RRxxxx/EPyyyy
- FOLLOWS FROM "DOE SHALL DEMONSTRATE THAT: "

THE GROUP OF REOP'S FOR A SINGLE REGULATORY REQUIREMENT IS CALLED A "SET"

- PASS ID CODE: PS PASS ID NUMBER: RRxxxx/PS0001
- DEVELOPED IN TEXTUAL FORMATS AND LOGIC DIAGRAM
- LOGIC DIAGRAM ACCOUNTS FOR THE INTERRELATIONSHIPS BETWEEN THE PRIMARY, ASSOCIATED, AND REFERENCED REG TEXTS
- IDENTIFIES (BUT DOES NOT DEFINE) THE RELATIONSHIPS TO BE USED IN COMPLIANCE DEMONSTRATION/DETERMINATION USING A "ROLL-UP" PROCESS

PS LOGIC IS POTENTIAL SOURCE OF REGULATORY UNCERTAINTIES

REGULATORY ELEMENTS OF PROOF ARE INTENDED FOR ENTRY IN THE FORMAT AND CONTENT REGULATORY GUIDE (F&CRG).

Regulatory Elements of Proof -- RR0002/PS0001

RETRIEVAL

DOE SHALL DEMONSTRATE THAT:

EP0100 -- Design for Waste Retrieval Option

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED TO PRESERVE THE OPTION OF WASTE RETRIEVAL THROUGHOUT THE PERIOD DURING WHICH WASTES ARE BEING EMPLACED AND, THEREAFTER, UNTIL THE COMPLETION OF A PERFORMANCE CONFIRMATION PROGRAM AND COMMISSION REVIEW OF THE INFORMATION OBTAINED FROM SUCH A PROGRAM. TO SATISFY THIS OBJECTIVE, THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT ANY OR ALL OF THE EMPLACED WASTE COULD BE RETRIEVED ON A REASONABLE SCHEDULE STARTING AT ANY TIME UP TO 50 YEARS AFTER WASTE EMPLACEMENT OPERATIONS ARE INITIATED, UNLESS A DIFFERENT TIME PERIOD IS APPROVED OR SPECIFIED BY THE COMMISSION. THIS DIFFERENT TIME PERIOD MAY BE ESTABLISHED ON A CASE-BY-CASE BASIS CONSISTENT WITH THE EMPLACEMENT SCHEDULE AND THE PLANNED PERFORMANCE CONFIRMATION PROGRAM. FOR PURPOSES OF THIS PARAGRAPH, A REASONABLE SCHEDULE FOR RETRIEVAL IS ONE THAT WOULD PERMIT RETRIEVAL IN ABOUT THE SAME TIME AS THAT DEVOTED TO CONSTRUCTION OF THE GEOLOGIC REPOSITORY OPERATIONS AREA AND THE EMPLACEMENT OF WASTES. (10 CFR 60.111(b)(1) & 10 CFR 60.111(b)(3))

EP0200 -- Design for Retrieval - Reasonable Schedule

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT ANY OR ALL OF THE EMPLACED WASTE CAN BE RETRIEVED ON A REASONABLE SCHEDULE STARTING AT ANY TIME UP TO 50 YEARS AFTER WASTE EMPLACEMENT OPERATIONS ARE INITIATED. (A Portion of 10 CFR 60.111(b)(1))

EP0300 -- Design for Waste Retrieval - Other Retrievability Period

THE GEOLOGIC REPOSITORY OPERATIONS AREA IS DESIGNED SO THAT ANY OR ALL OF THE EMPLACED WASTE CAN BE RETRIEVED IN A DIFFERENT TIME PERIOD IF APPROVED OR SPECIFIED BY THE COMMISSION. (A Portion of 10 CFR 60.111(b)(1))

THE IMPORTANCE OF THE LOGIC DIAGRAMS

- LOGIC DIAGRAMS ARE THE BASIC INTEGRATION MECHANISM FOR A REGULATORY REQUIREMENT
  - NOT ENOUGH TO PROVE THAT EACH PART PERFORMS
  - MUST HAVE ASSURANCE THAT PARTS PERFORM TOGETHER

- INHERENT LOGICAL INTERRELATIONSHIPS BETWEEN INDIVIDUAL:
  - REGULATORY ELEMENTS OF PROOF
  - TECHNICAL REVIEW COMPONENTS
  - COMPLIANCE DETERMINATION METHODS

THE IMPORTANCE OF THE LOGIC DIAGRAMS
(CONT'D)

- INTERRELATIONSHIPS MUST BE ACCOUNTED FOR IN:
  - THE STRUCTURE AND ANALYSIS OF THESE ITEMS
  - COMPLIANCE DEMONSTRATION
  - COMPLIANCE DETERMINATION

- EARLY PREPARATION OF LOGIC DIAGRAMS AND TEXTUAL HIERARCHIES PROVIDES:
  - VISIBILITY OF COMPLETE SET(S)
  - VEHICLE FOR REVIEW PRIOR TO REGULATORY REQUIREMENT APPROVAL

STANDARD NUMBERING SCHEME FOR LOGIC ELEMENTS

Regulatory Elements of Proof	Technical Review Components	Compliance Determination Methods
0100		0100
0200	0210, 0220, etc.	0200, 0210, 0220, etc.
0300		0300
0400	0410, 0420, etc.	0400, 0410, 0420, etc.
0500	0505, 0510, 0515 etc.	0500, 0505, 0510, etc.
0600	0610, 0620, etc.	0600, 0610, 0611, 0620, etc*
0700	0705, 0710, 0715, etc.	0700, 0705, 0710, 0715, etc*
0800		

* 611 is an alternative to 610.

EXAMPLE OF PS LOGIC DIAGRAM

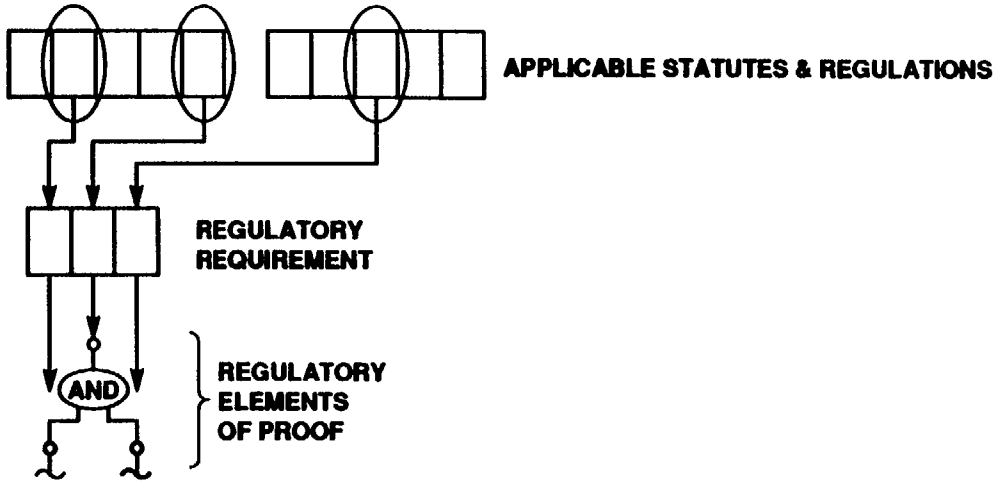
PRODUCTS OF REGULATORY ELEMENTS OF PROOF ANALYSIS
(PAPD STEP 3a)

5.1. Regulatory Elements of Proof Set PASS ID Number
5.2. Parent Regulatory Requirement
5.3. Topic of the Regulatory Elements of Proof Set
5.4. Regulatory Elements of Proof Set Keywords
5.5. Cognizant Element
5.6. When Action Required
5.7. Rationale for When Action Required
5.8. References for When Action Required Rationale
5.9. Regulatory Elements of Proof Hierarchy
5.10. Rationale for Logical Relationships
5.11. References for Logical Relationships Rationale
5.12. Candidate Regulatory Uncertainty Identifiers
5.13. Overall Comments/Observations
5.14. References for Comments/Observations
5.15. Individual Regulatory Elements of Proof
   a. Individual Regulatory Element of Proof PASS ID Number
   b. Parent PASS ID [Set (PS) or Element of Proof (EP)]
   c. Topic of the Individual Regulatory Element of Proof
   d. Individual Regulatory Element of Proof Keywords
   e. Individual Regulatory Element of Proof Citations and Revision Dates
   f. Individual Regulatory Element of Proof Text
   g. Comments/Observations
   h. References for Comments/Observations

PADB Ver. 2

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

REQUIREMENTS



INSTITUTIONAL AND REGULATORY UNCERTAINTIES

PASS ID CODE: UN

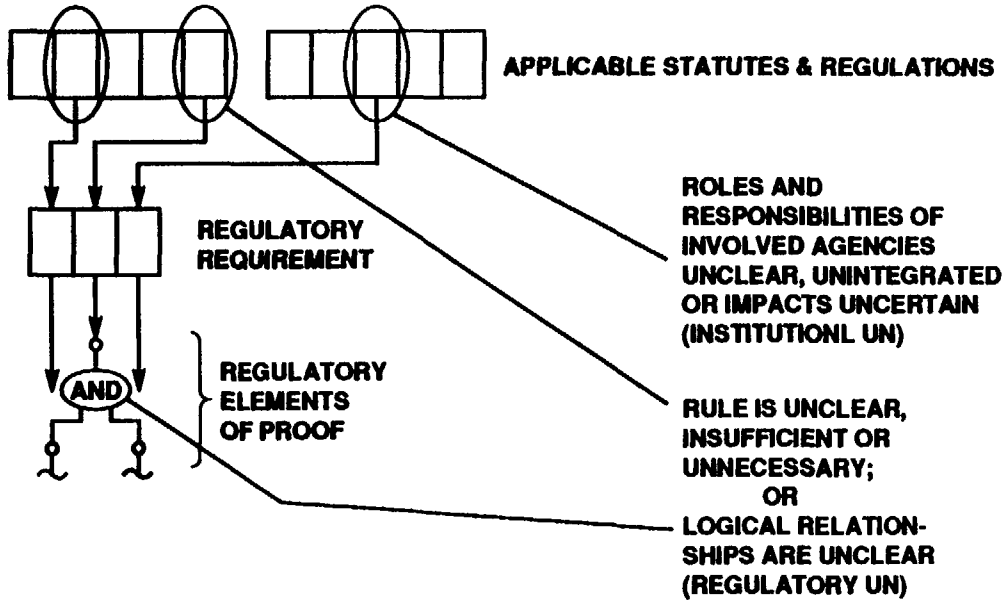
PASS ID NUMBER: RRxxxx/UNyyyy

GENERALLY, A PERCEIVED INSUFFICIENCY IN A REGULATION.

- INSTITUTIONAL – LACK OF CERTITUDE REGARDING:
  - THE ROLES, MISSIONS, ACTIONS, AND SCHEDULES OF AGENCIES WITH REQUIREMENTS THAT AFFECT HLW REGULATORY PROGRAM
  - THE IMPACTS OF THOSE REQUIREMENTS, OR
  - THEIR INTEGRATION WITH THE NRC REGULATORY PROGRAM
- REGULATORY – LACK OF CERTITUDE AS TO:
  - WHAT IS MEANT BY A RULE
  - A LOGICAL RELATIONSHIP IN THE REGULATORY ELEMENT OF PROOF SET (PS)
  - THE ADEQUACY, COMPLETENESS, AND/OR NECESSITY OF THE REQUIREMENT ITSELF

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

UNCERTAINTIES



UNCERTAINTIES
(CONT'D)

- FIRST, DEFINE THE PROBLEM!!!

  FOCUS ON THE ANALYSIS OF THE UN AND DEVELOPMENT OF THE TEXT

  — A POSITIVE STATEMENT —- SHORT, SIMPLE, SPECIFIC

  — IDENTIFIES WHAT IS UNCERTAIN
  (E.G., "THE REGULATORY INTENT . . ")

  — DEFINES IN GENERAL WHAT IS NEEDED TO CORRECT THE UN
  (E.G., ". . NEEDS TO BE CLARIFIED . . ")

  — IDENTIFIES WHY THE UN NEEDS TO BE CORRECTED
  (E.G., ". . TO PROVIDE A PRECISE BASIS FOR COMPLIANCE DETERMINATION.")

  — AVOID THE INCLUSION OF ANALYSIS, RATIONALE, OR UN REDUCTION METHOD ("HOW")

- THE FACT THAT SOME WORK REMAINS TO BE COMPLETED DOES NOT CAUSE THE RESULTS OF THAT WORK TO BE AN UNCERTAINTY

- ANALYSIS OF THE UN AND THE REASON FOR ITS INCLUSION ARE INCLUDED IN THE "RATIONALE"

REGULATORY REQUIREMENT RR0080: IMPORTANT TO SAFETY - MINING REGULATIONS

Primary Regulatory Text Citation

10CFR60 131 (b) (9)	January 1, 1989

Associated Regulatory Text Citations

10CFR60 21 (c) (1) (ii) (E)	January 1, 1989
10CFR60 130	January 1, 1989

Referenced Regulatory Text Citations

30CFR, Chapter I, Subchapter D (Reserved)	July 1, 1989
30CFR, Chapter I, Subchapter E (Reserved)	July 1, 1989
30CFR, Chapter I, Subchapter N (Includes 30CFR56 and 30CFR57)	July 1, 1989

POTENTIAL UNCERTAINTIES

Included Potential Uncertainty

UN0001 -- Secondary Effects from Nonradiological Accidents

Parent Record: 10 CFR 60.131(b)(9)

Text of the Potential Uncertainty

It is uncertain how the NRC is going to determine compliance with mining regulations as they relate to nonradiological accidents whose secondary effects are radiological accidents.

The uncertainty needs to be addressed to ensure adequate oversight of all potential sources of radiological accidents as well as worker health and safety in the geologic repository operations area.

Rationale for Inclusion

Since DOE is not subject to MSHA regulatory jurisdiction by law, and worker protection provisions of 30 CFR Part 57 must be applied by reference in 10 CFR 60.131(b)(9), clarification of NRC's compliance determination strategy is needed to ensure worker protection (Reference 10).

The NRC OGC position (Memorandum to Robert M. Bernero from William C. Parler, General Counsel, 16 November 1989) is clear: 1) The HLW repository is not a mine, 2) 30 CFR Part 57 does not apply as a mining regulation, and 3) MSHA has no jurisdiction over the HLW repository.

2. POTENTIAL UNCERTAINTIES

Included Potential Uncertainties

UN0001 -- Facilitate Versus not Prevent Waste Retrieval

Parent Record: 10 CFR 60.111(b)(1)

Text of the Potential Uncertainty

The NRC intent needs to be clarified as to whether the geologic repository is to be designed to facilitate waste retrieval, or only that the design must not preclude waste retrieval (i.e., not make retrieval impossible). DOE needs guidance regarding what design action, if any, is intended by the regulation, particularly with respect to the waste package and its handling equipment, in order to respond with an acceptable design and to permit NRC to evaluate the DOE compliance demonstration effectively.

Rationale for Inclusion

Several phrases are used in 10 CFR Part 60 to describe retrievability. These include "...designed to preserve the option of waste retrieval..." and "...designed so that...waste could be retrieved..." (60.111(b)(1)), and "...designed to permit retrieval..." (60.133(c)). Although these phrases seem to be consistent, a question arises regarding whether the design process and the resulting facility and equipment designs should (1) make provisions for and, to some degree, facilitate retrieval, or (2) simply not do anything to prevent retrieval.

The intent of the waste retrieval regulatory requirement as discussed in NUREG-0804 (Reference 10) supports the "not precluded" interpretation. In Reference 10, NRC adheres to the position that retrievability is an important design consideration, but rephrases the requirement in functional terms. NRC recognizes that any actual retrieval would be an unusual event and may be expensive. The expressed intent is that it should not be made impossible or impractical to retrieve the waste if such retrieval turns out to be necessary to protect the public health and safety.

The language of the NWPAA (Reference 20), 10 CFR 60.111(b)(1), and the requirement on underground openings (10 CFR 60.133(e)(1)) do not seem to support this interpretation. The NWPAA reads "...any repository constructed on a site approved under this part shall be designed and constructed to permit the retrieval of any spent nuclear fuel placed in such repository, during an appropriate period of operation of the facility, for any reason pertaining to the public health and safety, or the environment, or for the purpose of permitting the recovery of the economically valuable contents of such spent fuel." 10 CFR 60.111(b)(1) requires that the repository "...be designed to preserve the

REPOSITORY FUNCTIONAL ANALYSIS PURPOSES

- PROVIDE DATUM FOR TEST FOR ADDITIONAL REGULATORY UNCERTAINTIES
  - BASIS FOR PART 60 "SUFFICIENCY TEST" TO COMPLETE IDENTIFICATION OF REGULATORY UNCERTAINTIES (AUGMENTS CNWRA 90-003)
  - LEADS TO ADDITIONAL UNCERTAINTY REDUCTION NEEDS
  - AID COMPLETION OF NRC REGULATORY STRATEGY
- ESTABLISH FUNCTIONAL FOUNDATION FOR NEW RULES OR MAJOR REVISIONS, OR FOR INTERPRETATION OF CURRENT RULE; E.G.,
  - ROC
  - MINING REG ANALYSIS
- ESTABLISH FUNCTIONAL LINKAGE BETWEEN REGULATORY REQUIREMENTS AND REPOSITORY SYSTEM MISSION
- ENHANCE PUBLIC CONFIDENCE
  - SYSTEMATIC ANALYSIS
  - COMPREHENSIVE EXAMINATION OF REPOSITORY NEEDS

PRODUCTS OF UNCERTAINTIES ANALYSIS
(PAPD STEP 4 AND PART OF STEPS 11 AND 12)

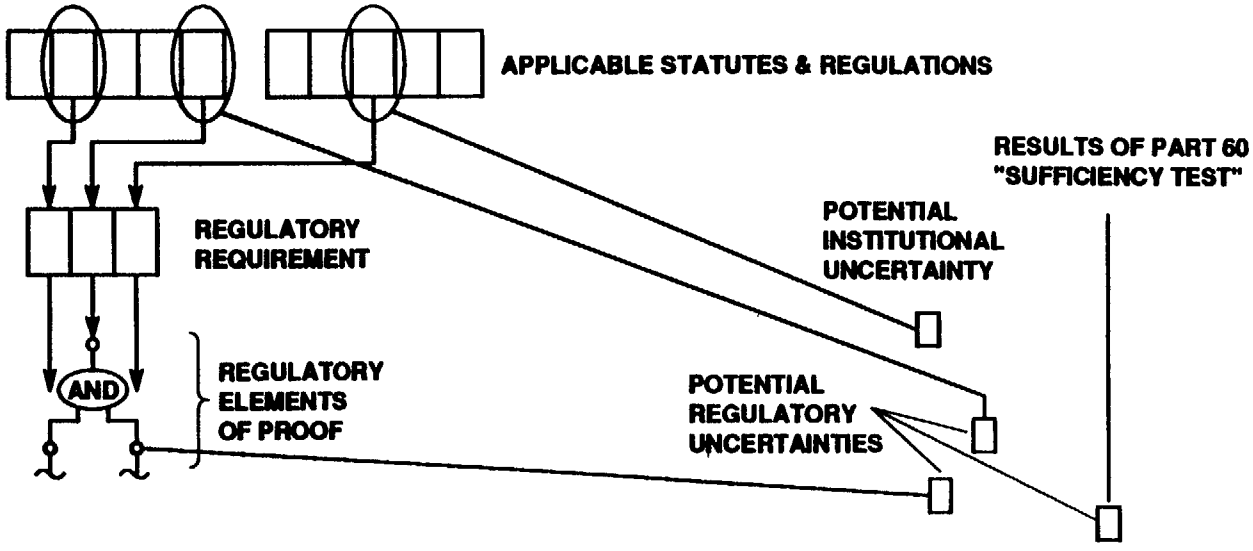
Section 14

a. Uncertainty PASS ID Number
b. Parent Record PASS ID Number
c. Topic of the Uncertainty
d. Uncertainty Keywords
e. Uncertainty Type
f. Uncertainty Source
g. Correlation Status
h. Uncertainty Action Agency
i. Site Dependency
j. Inclusion/Exclusion Status
k. Uncertainty Text
l. Rationale for Uncertainty Inclusion or Exclusion
m. References for Inclusion or Exclusion Rationale
n. Comments/Observations
o. References for Comments/Observations
p. Uncertainty Correlation
q. Rationale for Correlation
r. References for Correlation Rationale

PADB Ver. 2

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

REQUIREMENTS AND ASSOCIATED UNCERTAINTIES



REGULATORY INTEGRATION

THE FOLLOWING LINKAGES ARE TO BE RECORDED IN THE PADB:

- PART 60 CITATIONS TO INDIVIDUAL FUNCTIONS, CONSTRAINTS, AND CAPABILITIES OF THE FUNCTIONAL ANALYSIS

- REGULATORY TEXT, TECHNICAL REVIEW COMPONENTS, UNCERTAINTIES, COMPLIANCE DETERMINATION METHODS COMMON TO TWO OR MORE RR

- UNCERTAINTY-TO-UNCERTAINTY AND IR-TO-IR INTEGRATION IS PART OF CONSOLIDATION ACTION

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION

1. SELECTION CRITERIA FOR LICENSE APPLICATION (LA) REGULATORY REQUIREMENT

- DOE MUST DEMONSTRATE COMPLIANCE, OR
- RR AFFECTS CONTENT OR DOCKETING SUBMITTAL OF LA.

- RR TO BE ADDRESSED IN COMPLIANCE REVIEW AND
- FINDINGS WILL BE MADE IN THE SER.

TYPE OF CDS

PERFORM ACCEPTANCE REVIEW ONLY

- REVIEW LA RESPONSE TO RR FOR ACCEPTABILITY FOR DOCKETING; I.E., FOR --
  - COMPLETENESS AS PRESCRIBED BY F&CRG
  - CONSISTENCY WITH BASIC REQUIREMENTS OF PART 60 AND NWPAA
- DO NOT REVIEW LA RESPONSE FOR ADEQUACY

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION
(CONT'D)

2. SELECTION CRITERIA FOR LA PROCEDURAL REGULATORY REQUIREMENT

- RELATED TO LA
- ONLY PROCEDURAL IN NATURE
- NOT RELATED TO RADIOLOGICAL SAFETY OR WASTE ISOLATION

TYPE OF CDS

PERFORM PROCEDURAL REVIEW ONLY

- REVIEW LA RESPONSE TO REGULATORY REQUIREMENT FOR COMPLIANCE WITH PROCEDURAL REQUIREMENT

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION
(CONT'D)

3. SELECTION CRITERIA FOR REGULATORY REQUIREMENT RELATED TO SAFETY/ISOLATION

- COMPLIANCE IS NECESSARY TO MAKE SAFETY DETERMINATION
- APPLIES TO RRs THAT EMBODY SUBPARTS E, G, H, AND I

TYPES OF CDS

PERFORM -

- ACCEPTANCE REVIEW OF LA RESPONSE TO COMPLETE RR

  AND

- SAFETY REVIEW AS DEFINED IN 10 CFR 60.31

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION (CONT'D)

4. SELECTION CRITERIA FOR RR THAT PRESENTS HIGH POTENTIAL RISK OF NON-COMPLIANCE

- HIGH POTENTIAL RISK OF NON-COMPLIANCE WITH RR,

  AND

- POTENTIAL FOR NON-COMPLIANCE WITH ONE OR MORE PERFORMANCE OBJECTIVES
- RISK CAUSED BY ONE OR MORE "KEY ADVERSE EFFECTS" OR "KEY TECHNICAL UNCERTAINTIES"

TYPES OF CDS

PERFORM -

- ACCEPTANCE REVIEW OF LA RESPONSE TO COMPLETE RR

  AND

- AS APPLICABLE TO INDIVIDUAL EP, SAFETY REVIEW

  AND

- AT LEAST ONE REOP WILL HAVE A DETAILED SAFETY REVIEW AND COMPARISON TO CONFIRMATORY ANALYSES
  - EXPANSION OR EXTENSION OF SAFETY REVIEW PER 60.31
  - FOCUS ON ASSESSMENT OF EACH KEY ADVERSE EFFECT AND KEY TECHNICAL UNCERTAINTY AND HOW IT IS REDUCED, COMPENSATED FOR, OR REMEDIED
  - USE METHODS DEVELOPED BY DOE OR OTHER (NON-NRC) PARTIES

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION (CONT'D)

5. SELECTION CRITERIA FOR RR THAT PRESENTS HIGHEST POTENTIAL RISK OF NON-COMPLIANCE

- RISK IS MOST DIFFICULT TO REDUCE, COMPENSATE FOR, OR REMEDY
- HIGH RESIDUAL RISK OF NON-COMPLIANCE

TYPES OF CDS

PERFORM -

- ACCEPTANCE REVIEW OF LA RESPONSE TO COMPLETE RR

  AND

- AS APPLICABLE TO INDIVIDUAL EP, SAFETY REVIEW

  AND

- DETAILED SAFETY REVIEW

  AND

- AT LEAST ONE REOP WILL HAVE A COMPARISON TO INDEPENDENT CONFIRMATORY ANALYSES AND TESTS
  - COMPARE LA ANALYSIS TO ANALYSIS CONDUCTED BY STAFF
  - USE METHODS DEVELOPED INDEPENDENTLY BY NRC
  - DATA AND/OR CONCLUSIONS OF STAFF MAY BE USED

FOCUSING THE APPLICATION OF SYSTEMATIC REGULATORY ANALYSIS

- CLEARLY, THE ENTIRE SRA PROCESS IS NOT APPROPRIATE FOR ALL REGULATORY REQUIREMENTS
- WHAT CRITERIA SHOULD BE USED TO ESTABLISH THE SCOPE OF THE ANALYSIS APPROPRIATE FOR EACH REGULATORY REQUIREMENT?
- OF ALL POTENTIAL CRITERIA, THE DOMINANT CRITERION IS PERFORMANCE RISK OR RISK OF NON-COMPLIANCE
- THAT IS THE CRITERION USED TO ESTABLISH THE COMPLIANCE DETERMINATION STRATEGY
- THAT IS WHY –

  STRATEGY TYPE SELECTION IS ONE OF THE MOST IMPORTANT STEPS IN THE ENTIRE SRA PROCESS

NRC COMPLIANCE DETERMINATION STRATEGY

PASS ID CODE: NS **PASS ID NUMBER: RRxxxx/NSyyyy**

- ESTABLISHES OVERALL APPROACH, SCOPE AND DEPTH OF THE NRC COMPLIANCE DETERMINATION PROGRAM FOR A REGULATORY REQUIREMENT
- BASED ON, AND CONSISTENT WITH, THE STRATEGY TYPE SELECTION
- TAILORS THE STRATEGY TO THE NEEDS OF THE INDIVIDUAL REGULATORY REQUIREMENT

NRC COMPLIANCE DETERMINATION STRATEGY
(CONT'D)

- AS A MINIMUM, TAKES INTO CONSIDERATION:
  - RELATIVE RISK OF NON-COMPLIANCE OF THE REGULATORY REQUIREMENT
  - FEASIBILITY OF REDUCING, COMPENSATING FOR, OR REMEDYING KEY ADVERSE EFFECTS AND KEY TECHNICAL UNCERTAINTIES
  - LIKELY DEGREE OF RESIDUAL RISK
  - FEASIBLE COMPLIANCE DETERMINATION METHODS
  - CHARACTERISTICS OF RELATED TECHNICAL REVIEW COMPONENTS AND/OR INFORMATION REQUIREMENTS
  - AVAILABLE (OR ANTICIPATED) RESOURCES

PRODUCTS OF NRC COMPLIANCE DETERMINATION STRATEGY ANALYSIS
(PAPD STEP 7)

11.1. NRC COMPLIANCE DETERMINATION STRATEGY PASS ID NUMBER
11.2. ASSOCIATED REGULATORY ELEMENTS OF PROOF SET
11.3. TOPIC OF THE NRC COMPLIANCE DETERMINATION STRATEGY
11.4. COMPLIANCE DETERMINATION STRATEGY
11.5. REFERENCES FOR STRATEGY
11.6. RATIONALE FOR STRATEGY
11.7. REFERENCES FOR STRATEGY AND RATIONALE
11.8. COMMENTS/OBSERVATIONS
11.9. REFERENCES FOR COMMENTS/OBSERVATIONS

PADB VER. 2

NRC COMPLIANCE DETERMINATION METHODS

PASS ID CODE: NC **PASS ID NUMBER: RRxxxx/NCyyyy**

HOW THE NRC WILL DETERMINE THAT EACH REGULATORY ELEMENT OF PROOF HAS OR HAS NOT BEEN MET. INCLUDES THOSE INVESTIGATIVE OR EVALUATIVE PROCEDURES, TECHNIQUES, TESTS, METHODS, OR ANY OTHER MODES OF INQUIRY, OR ANY COMBINATION THEREOF, THAT MAY BE USED WITHIN THE CONTEXT OF THE NRC REGULATORY PROGRAM, ..

NRC COMPLIANCE DETERMINATION METHODS
(CONT'D)

- FOR EVERY "WHAT" (I.E., EACH REOP AND TRC), THERE MUST BE AT LEAST ONE "HOW" IN THE NRC CDM
- REOP METHODS AND THE SUPPORTING TRC'S ARE DEVELOPED ITERATIVELY
- DETERMINATION METHODS ARE LIMITED TO THE TYPES SPECIFIED IN THE STRATEGY AND ARE DEVELOPED TO THE LEVEL OF DETAIL CONSISTENT WITH THE STRATEGY
- DEFINES METHODS ACCEPTABLE (APPROVED) FOR USE BY THE NRC -- DOES NOT COMMIT THE NRC TO THE USE OF ANY ONE METHOD
- SPECIFIES ACCEPTANCE CRITERIA

PRODUCTS OF NRC COMPLIANCE DETERMINATION METHODS ANALYSIS
(PAPD STEP 7)

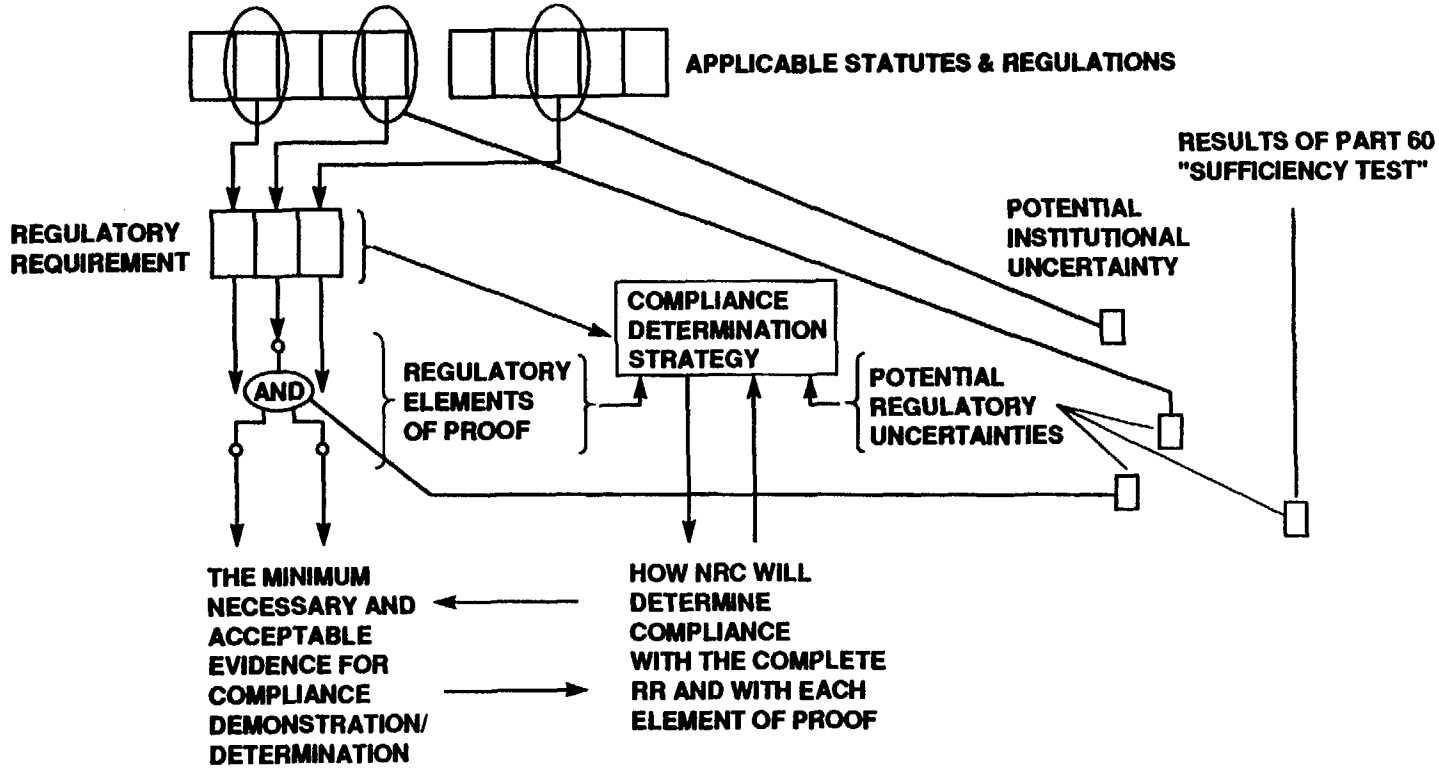
Section 12

a. Individual Compliance Determination Method PASS ID No.
b. Associated Individual Regulatory Element of Proof or Technical Review Component
c. Parent Individual NRC Compliance Determination Method
d. Topic of the Individual NRC Compliance Determination Method
e. Essential Expertise
f. Support Expertise
g. Individual Compliance Determination Method Description
h. Rationale for Individual Determination Method
i. References for Description and Rationale
j. Other Determination Methods Considered, Then Excluded
k. Rationales for Exclusion
l. References for Other Methods and for Rationales
m. Compliance Determination Contingency Method
n. Rationale for Contingency Determination Method
o. References for Contingency Method and Rationale
p. Candidate Technical Uncertainty Identifiers
q. Overall Comments/Observations
r. References for Comments/Observations

PADB Ver 2

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

REQUIREMENTS AND COMPLIANCE DETERMINATION



TECHNICAL REVIEW COMPONENTS

PASS ID CODE: RC

PASS ID NUMBER: RRxxxx/RCyyyy

DEFINE THE RESULTS OF SITE CHARACTERIZATION AND/OR DESIGN ANALYSES THAT ARE APPROPRIATE FOR DEMONSTRATION/DETERMINATION OF COMPLIANCE WITH THEIR PARENT REGULATORY ELEMENT OF PROOF.

TOGETHER, REOP AND TECHNICAL REVIEW COMPONENTS DEFINE

(1) WHAT MUST BE DEMONSTRATED, AND

(2) WHAT, IN THE VIEW OF THE NRC STAFF, IS THE MINIMUM NECESSARY AND ACCEPTABLE EVIDENCE TO BE PROVIDED IN THE LA FOR THAT DEMONSTRATION.

TECHNICAL REVIEW COMPONENTS
(CONT'D)

THUS, TECHNICAL REVIEW COMPONENTS (RC) ARE:

- THE INFORMATION (DATA, DESIGNS, AND/OR ANALYSES) NECESSARY TO REVIEW A DOE DEMONSTRATION OF COMPLIANCE AND/OR TO SUPPORT A NRC DETERMINATION OF COMPLIANCE WITH AN INDIVIDUAL END-POINT REOP, AND

- THE SUPPORTING MATERIAL NECESSARY TO VERIFY THE TECHNICAL ADEQUACY OF THAT INFORMATION AND THEIR INPUT DATA

- PUBLISHED IN THE F&CRG

TECHNICAL REVIEW COMPONENTS
[CONT'D]

- DO NOT HAVE THE FORCE OF LAW
- DO NOT NECESSARILY REPRESENT THE DEPTH (DETAIL) OF ANALYSIS REQUIRED BY DOE OR NRC
- DEFINE DEPTH OF ANALYSIS AND SUPPORTING INFORMATION TO BE PROVIDED IN LA
- <u>CANNOT</u> BE A SOURCE OF REGULATORY OR TECHNICAL UNCERTAINTIES

TECHNICAL REVIEW COMPONENTS
[CONT'D]

- FOLLOW FROM "DOE SHALL PROVIDE: "
- THE GROUP OF TRC ASSOCIATED WITH A SINGLE "END-POINT" REOP IS CALLED A "SET" (PASS ID CODE = TS)
- DEVELOPED IN TEXTUAL FORMAT
- LOGIC DIAGRAM PROVIDED IF THE SET CONTAINS AN "OR" RELATIONSHIP
- DISPLAYS LOGICAL INTERRELATIONSHIPS BETWEEN TECHNICAL REVIEW COMPONENTS IN THE SET
- IDENTIFIES (BUT DOES NOT DEFINE) RELATIONSHIPS TO BE USED IN THE DEMONSTRATION/DETERMINATION PROCESS USING A "ROLL-UP" PROCESS

TECHNICAL REVIEW COMPONENT EXAMPLES

INFORMATION EXAMPLES

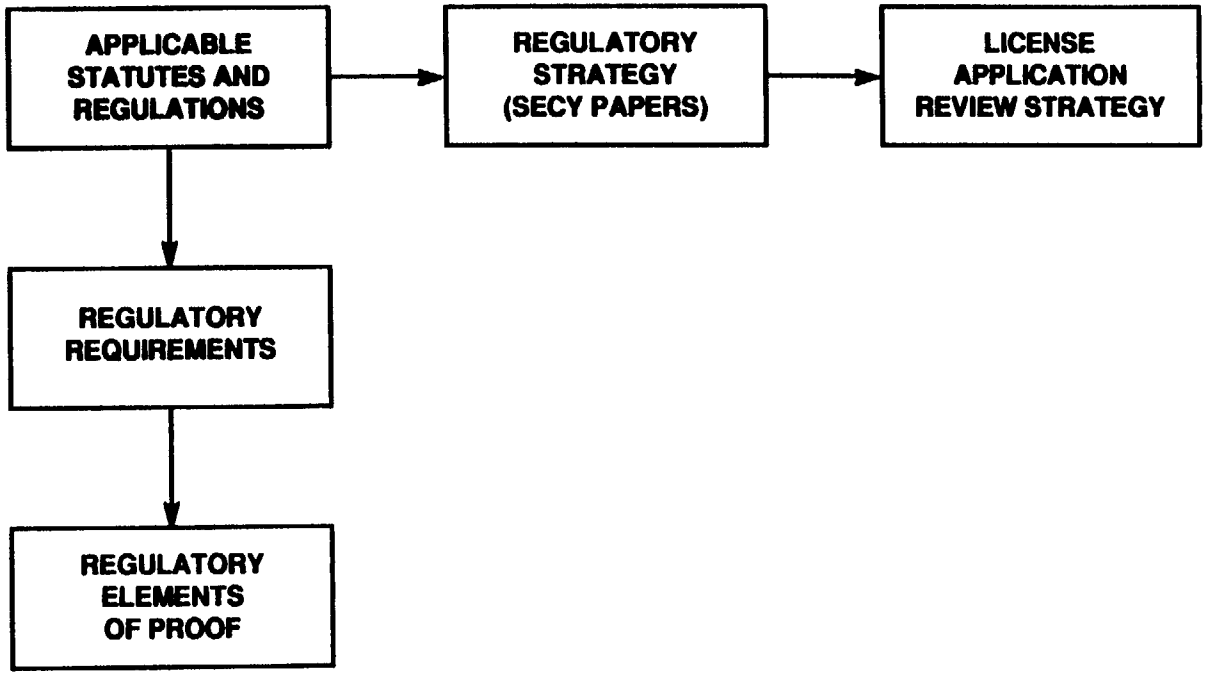
- IDENTIFICATION OF EACH STRUCTURE, SYSTEM, AND COMPONENT IMPORTANT TO SAFETY.
- IDENTIFICATION AND CHARACTERIZATION OF THE NATURAL PHENOMENA ANTICIPATED AT THE GEOLOGIC REPOSITORY OPERATIONS AREA.

SUPPORTING MATERIAL EXAMPLE

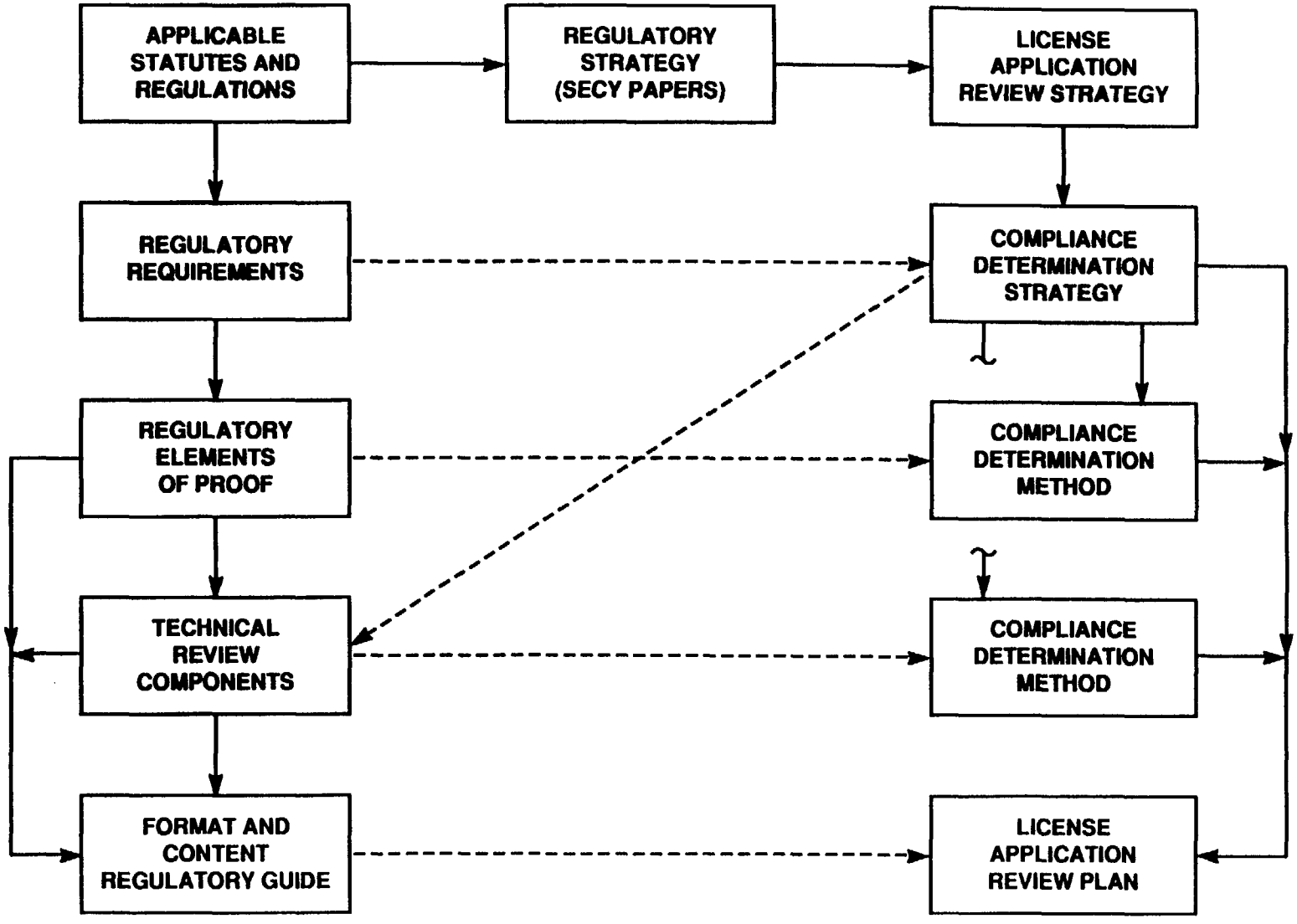
- THE SUPPORTING DATA PLUS AN EXPLANATION OF THE RATIONALE, CRITERIA, ASSUMPTIONS AND ANY OTHER BASES FOR DECISIONS OR CONCLUSIONS MADE IN THE PROCESS OF DEVELOPING THE CONCEPTUAL MODEL OF CONTROLLED AREA STRUCTURAL DEFORMATION DURING THE QUATERNARY PERIOD.

FURTHER EXPLANATION OF THE DESIRED ANALYTICAL RESULTS OR SUPPORTING MATERIAL MAY BE ADDED.

RELATIONSHIPS OF LEGAL AND STRATEGIC INSTRUMENTS



RELATIONSHIPS OF LEGAL, STRATEGIC AND SRA INSTRUMENTS



PRODUCTS OF TECHNICAL REVIEW COMPONENTS ANALYSIS (PAPD STEP 3b)

6.1. Technical Review Component Set PASS ID Number
6.2. Parent Individual Regulatory Element of Proof
6.3. Topic of the Technical Review Components Set
6.4. When Action Required
6.5. Rationale for When Action Required
6.6. References for When Action Required Rationale
6.7. Technical Review Components Set Hierarchy
6.8. Rationale for Logic Relationships
6.9. References for Logic Relationships Rationale
6.10. Overall Comments/Observations
6.11. References for Comments/Observations
6.12. Individual Technical Review Components
   a. Individual Technical Review Component PASS ID Number
   b. Parent PASS ID [Set (TS) or Individual Technical Review Component (RC)]
   c. Topic of the Individual Technical Review Component
   d. Individual Technical Review Component Keywords
   e. Individual Technical Review Component Text
   f. References for RC Text
   g. Rationale for Individual Technical Review Component
   h. References for Individual RC Rationale
   i. Technical Review Component--Issue Correlation
   j. Comments/Observations
   k. References for Comments/Observations

TECHNICAL UNCERTAINTIES

PASS ID CODE: UN

PASS ID NUMBER: RRxxxx/UNyyyy

LACK OF CERTITUDE AS TO

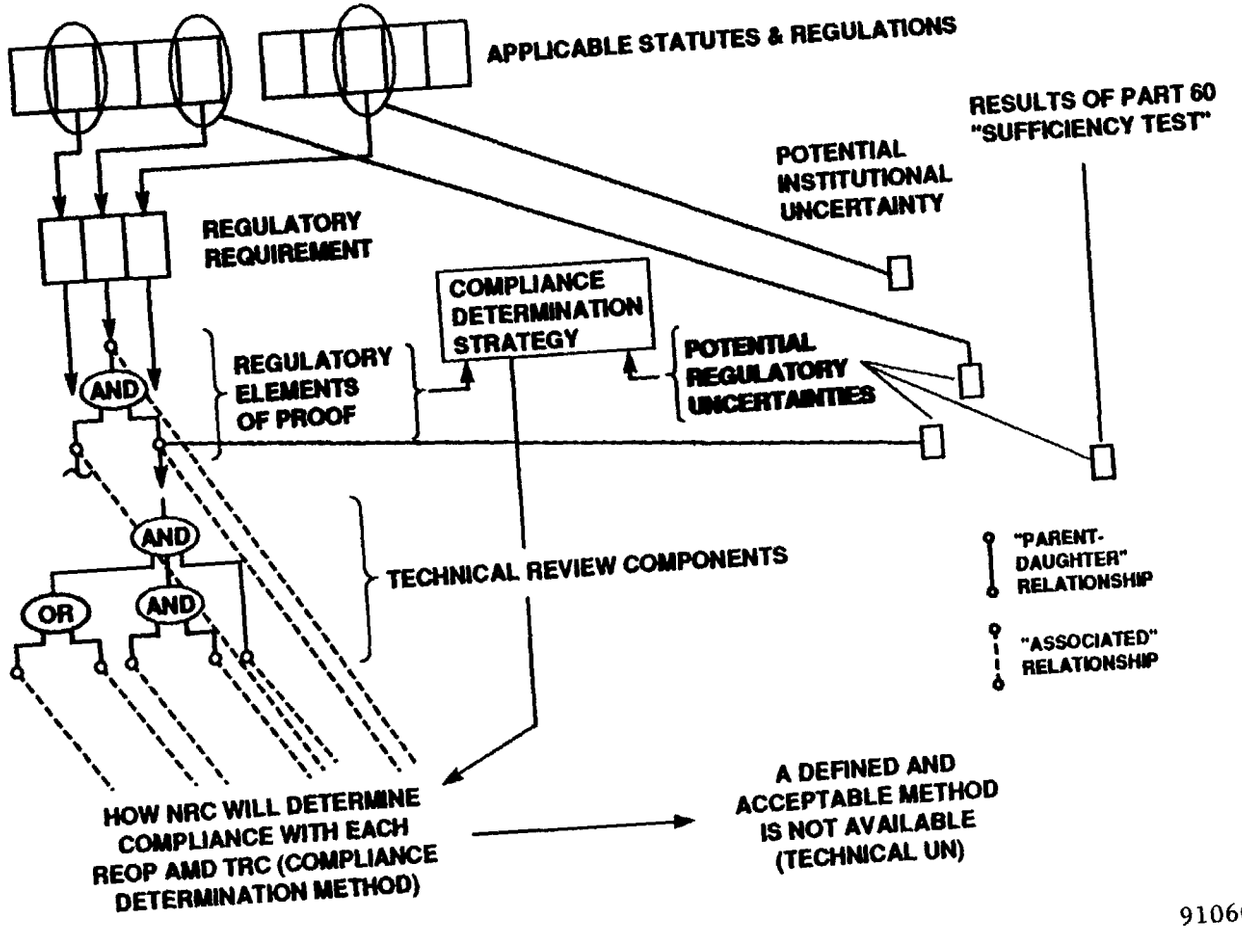
(1) HOW TO DEMONSTRATE (DOE ACTION) OR DETERMINE (NRC ACTION) COMPLIANCE,

(2) HOW TO ACCEPTABLY REDUCE A (PREVIOUSLY IDENTIFIED) TECHNICAL UNCERTAINTY, OR

(3) HOW TO OBTAIN THE REQUISITE INFORMATION FOR EITHER PURPOSE

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

TECHNICAL UNCERTAINTIES



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POTENTIAL COMPOSITE UNCERTAINTY DEFINITION

AN UNCERTAINTY CONSTRUCTED FROM, IN GENERAL, THE MOST DEMANDING PROPERTIES FROM A SET OF CORRELATED, HIGHLY SIMILAR INDIVIDUAL UN

- THE FOCUS FOR UN REDUCTION METHOD ANALYSIS
- IF COMPOSITE PROPERTIES ARE TECHNICALLY INFEASIBLE, THE SET WILL BE DIVIDED

ANALYST'S WORKING DATABASES

- 1ST STAGE -- "ORIGINAL" UNCERTAINTY AND INFORMATION REQUIREMENT LISTS; CORRELATION LOGS [CORRELATE TO "ORIGINALS"]

- 2ND STAGE -- CORRELATED UNCERTAINTY AND CORRELATED INFORMATION REQUIREMENT DATABASES [CORRELATE TO "ORIGINALS"]

- 3RD STAGE -- CORRELATE TO COMPOSITES, WHEN CONSTRUCTED

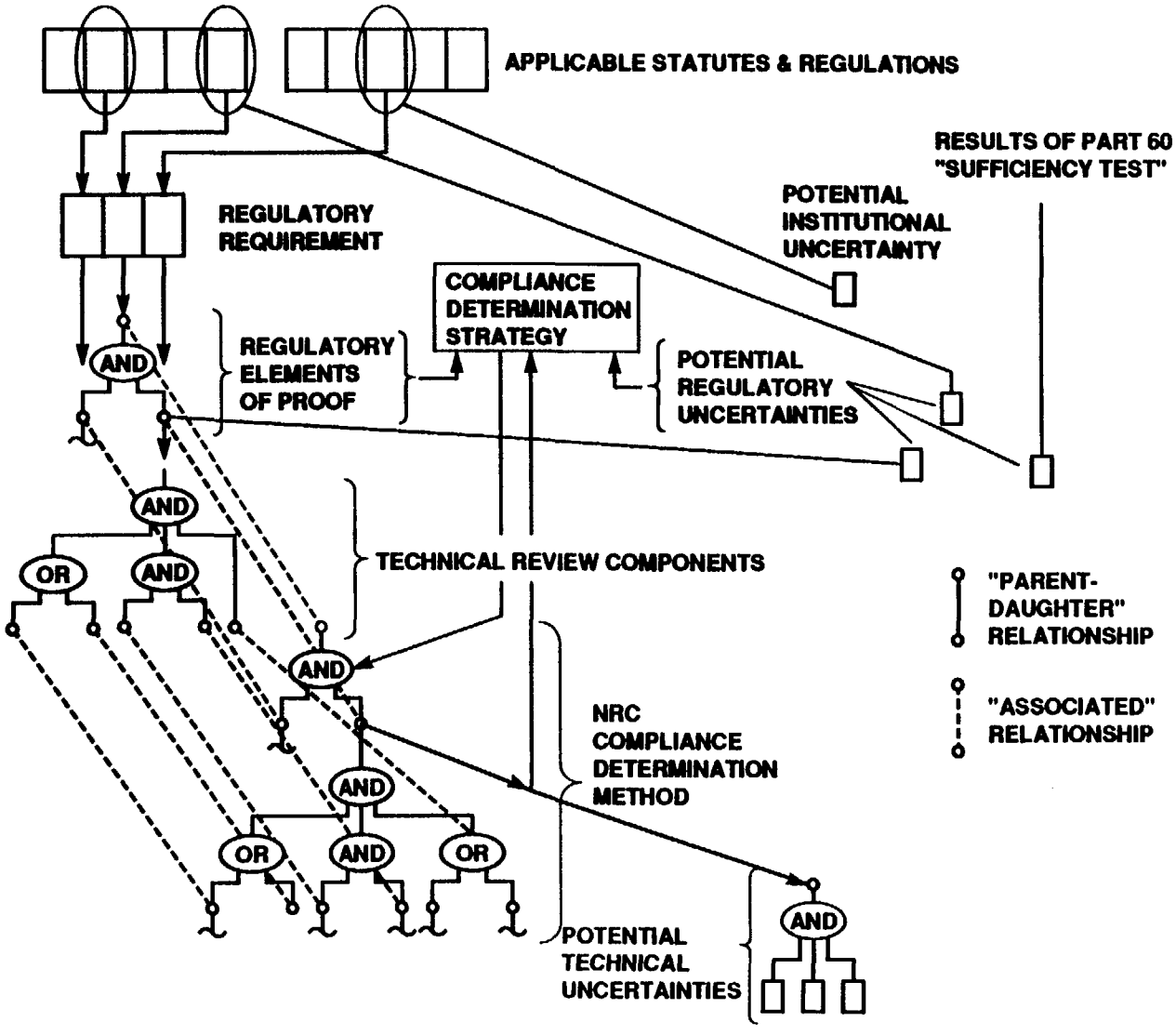
PRODUCTS OF POTENTIAL COMPOSITE UNCERTAINTY DEFINITION
(PAPD STEP 10)

Section 15

a. Potential Composite Uncertainty PASS ID Number
b. Parent Original NRC Uncertainty
c. Associated Matching Uncertainties
d. Topic of the Potential Composite Uncertainty
e. Potential Composite Uncertainty Type
f. Potential Composite Uncertainty Text
g. Rationale for Content of Potential Composite Uncertainty
h. References for Text and Rationale
i. Comments/Observations
j. References for Comments/Observations

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

REQUIREMENTS, COMPLIANCE DETERMINATION & UNCERTAINTIES



COMPLIANCE DETERMINATION METHODS INTEGRATION

PASS ID CODE: MI

PASS ID NUMBER: RRxxxx/MIyyyy

LINKS INDIVIDUAL REOP AND ASSOCIATED COMPLIANCE DETERMINATION METHOD TO ONE OR MORE MODELS IN WHICH THE CDM WOULD BE USED.

THIS PLUS CDM - INFORMATION REQUIREMENT LINK, WHERE APPLICABLE, COMPLETE IDENTIFICATION OF TOP-TO-BOTTOM RELATIONSHIPS AND TRACEABILITY FOR INDIVIDUAL MODELS THAT WAS BEGUN IN PAPD STEP 5, REOP INTEGRATION

ENABLES RAPID IMPACT ASSESSMENT OF PROPOSED CHANGE IN A GIVEN CDM OR MODEL

PROVIDES MEANS TO ENSURE THAT A CHANGE IN A CDM CODE MODULE IS INTEGRATED IN ALL APPLICATIONS OF THAT MODULE

COMPLETES STRUCTURE OF PERFORMANCE ASSESSMENT ROLL-UP IF THAT OPTION IS CHOSEN

PRODUCTS OF COMPLIANCE DETERMINATION METHODS INTEGRATION
(PAPD STEP 9)

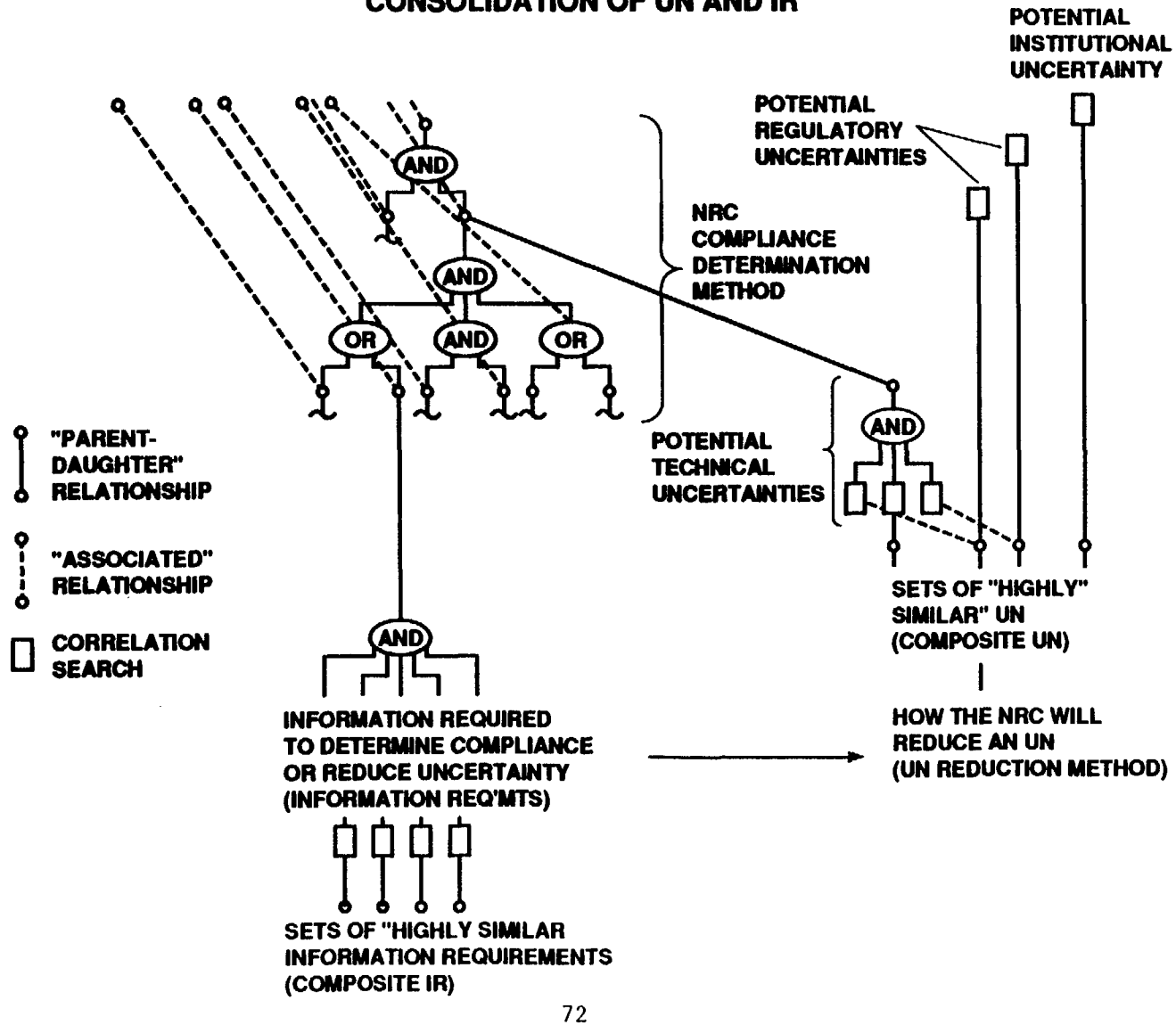
Section 13

a. Compliance Determination Methods Integration PASS ID Number
b. Associated Regulatory Elements of Proof Integration
c. Individual Compliance Determination Method--Regulatory Element of Proof Integration Linkages
d. Rationales for Integration Linkages
e. References for Linkage Rationales
f. Composite Information Requirements Linkages
g. Comments/Observations
h. References for Comments/Observations

PADB Ver. 2

SYSTEMATIC REGULATORY ANALYSIS PRODUCTS AND THEIR RELATIONSHIPS

CONSOLIDATION OF UN AND IR



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PASS ID CODE: IR

PASS ID NUMBER: RRxxxx/IRyyyy

INFORMATION REQUIRED TO EXECUTE A DOE COMPLIANCE DEMONSTRATION METHOD, A NRC COMPLIANCE DETERMINATION METHOD, OR A NRC UNCERTAINTY REDUCTION METHOD. INCLUDES BUT IS NOT LIMITED TO FACTS, TEST DATA, ANALYSES, PLANS, PROCEDURES AND/OR RECORDS.

- DEVELOPMENT PROCESS IS SIMILAR TO THAT FOR UNCERTAINTIES
- APPLICABILITY AND DEPTH OF IR IS BASED ON THE COMPLIANCE DETERMINATION STRATEGY FOR THE PARENT RR
- DEPTH OF DETAIL LIMITED TO WHAT WOULD BE DETERMINED (MEASURED, OBSERVED, RECORDED, ETC.) IN THE LAB OR FIELD, OR FROM HISTORICAL RECORDS
- RELEVANCE IS ASSURED BY TRACEABILITY TO THE PARENT REGULATION AND/OR STATUTE

u. References for Comments/Observations

COMPOSITE INFORMATION REQUIREMENT DEFINITION

PASS ID CODE: CI

PASS ID NUMBER: RRxxxx/CIyyyy

AN INFORMATION REQUIREMENT CONSTRUCTED FROM, IN GENERAL, THE MOST DEMANDING PROPERTIES FROM A SET OF CORRELATED, HIGHLY SIMILAR INDIVIDUAL INFORMATION REQUIREMENTS (IR)

- THE BASIS FOR STUDIES AND/OR LAB AND FIELD INVESTIGATIONS (IF NECESSARY FOR UNCERTAINTY REDUCTION OR COMPLIANCE DETERMINATION)

- IF COMPOSITE PROPERTIES ARE TECHNICALLY INFEASIBLE, THE SET WILL BE DIVIDED

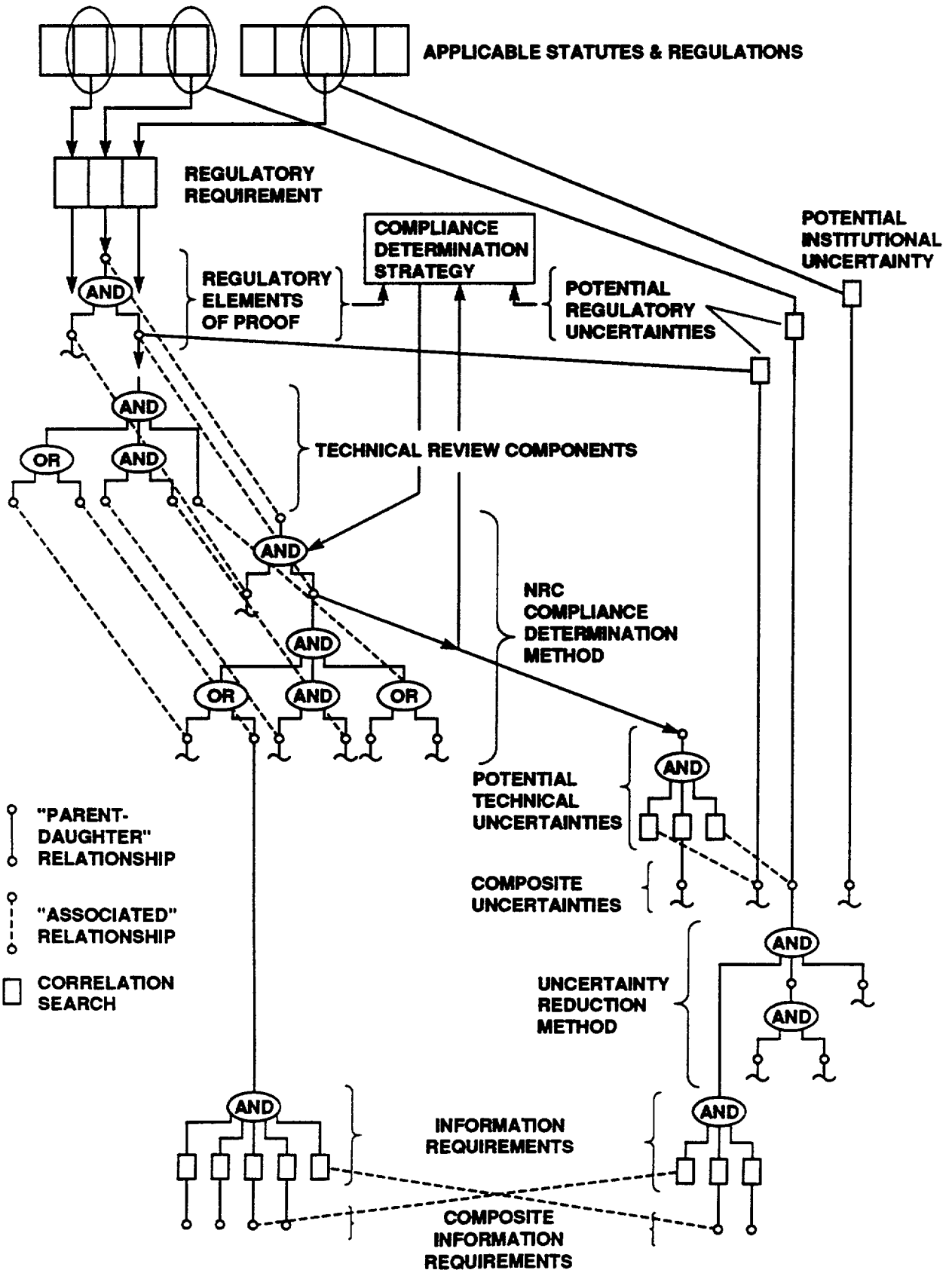
PRODUCTS OF COMPOSITE INFORMATION REQUIREMENT DEFINITION
(PAPD STEP 14)

Section 22

a. Composite Information Requirement PASS Identification Number
b. Parent Original Information Requirement
c. Associated Matching Information Requirements
d. Topic of the Composite Information Requirement
e. Composite Information Requirement Text
f. Rationale for Content of Composite Information Requirement
g. References for Information Requirement Text and Rationale
h. Composite Information Requirement Action Agencies
i. Rationale for Selection of Action Agencies
j. References for Action Agencies Rationale
k. Comments/Observations
l. References for Comments/Observations

PADB Ver. 2

NRC SRA PRODUCTS & THEIR RELATIONSHIPS



DOE AND/OR STATE

INFORMATION RECORDED

RELATED ISSUES RECORDS
(PART OF PAPD STEPS 11 AND 12)

Section 4

a. Related Issue PASS ID Number
b. Related Issue Source
c. Topic of the Related Issue
d. Related Issue Identifier
e. Correlation with NRC Regulatory Requirement(s)
f. Related Issue Text
g. Overall Comments/Observations
h. References for Text and Comments/Observations

COMPLIANCE DEMONSTRATION/EVALUATION STRATEGY
(PART OF PAPD STEPS 11 and 12)

Section 9

a. Demonstration/Evaluation Strategy PASS ID Number
b. Associated Regulatory Elements of Proof Set
c. Relationship to Related Issues
d. Topic of Demonstration/Evaluation Strategy
e. Demonstration/Evaluation Agency
f. Demonstration/Evaluation Strategy
g. Rationale for Strategy
h. References for Relationships, Strategy and Rationale
i. Comments/Observations
j. References for Comments/Observations

COMPLIANCE DEMONSTRATION/EVALUATION METHODS
(PART OF PAPD STEPS 11 and 12)

10.1. DOE Individual Compliance Demonstration Methods

a. DOE Compliance Demonstration Method PASS ID Number
b. Related Compliance Demonstration Strategy Identifier
c. Associated Individual Regulatory Element of Proof or Technical Review Component
d. Parent DOE Compliance Demonstration Method
e. Topic of the DOE Compliance Demonstration Method
f. DOE Issue(s) Addressed
g. Individual Compliance Demonstration Method Description
h. DOE Rationale for Individual Demonstration Method
i. References for Issues Addressed, Method and Rationale
j. DOE Contingency Demonstration Method
k. DOE Rationale for Contingency Method
l. References for Contingency Method and Rationale
m. Candidate Technical Uncertainty Identifiers
n. DOE Demonstration Method Review and Acceptance Status
o. DOE Compliance Demonstration Status
p. Overall Comments/Observations
q. References for Status and Comments/Observations

COMPLIANCE DEMONSTRATION/EVALUATION METHODS
(PART OF PAPD STEPS 11 and 12)
(CONT'D)

10.2. Affected Party Individual Compliance Evaluation Methods

a. Affected Party Compliance Evaluation Method PASS ID Number
b. Related Compliance Evaluation Strategy Identifier
c. Associated Individual Regulatory Element of Proof or Technical Review Component
d. Parent Affected Party Compliance Evaluation Method
e. Topic of the Affected Party Compliance Evaluation Method
f. Affected Party Issue(s) Addressed
g. Individual Evaluation Method Description
h. Candidate Technical Uncertainty Identifiers
i. Comments/Observations
j. References for Description and Comments/Observations

DOE UNCERTAINTY REDUCTION METHODS
(PART OF PAPD STEP 11)

Section 17

a. DOE Uncertainty Reduction Method PASS ID Number
b. Parent DOE Uncertainty
c. Topic of the DOE Uncertainty Reduction Method
d. DOE Uncertainty Reduction Method Description
e. Rationale for DOE Uncertainty Reduction Method
f. References for Description and Rationale
g. DOE Contingency Methods
h. Rationale for Contingency Methods
i. References for Contingency Methods and Rationale
j. DOE Candidate Technical Uncertainty Identifiers
k. Overall Comments/Observations
l. References for Comments/Observations

PROGRAM

PLANNING

PRODUCTS OF INDIVIDUAL NRC PROGRAM ANALYSIS
(PAPD STEPS 15b, 16 and 17)

23.1. Individual NRC Program PASS ID Number (PAPD Step 15b)
23.2. Parent Record
23.3. Topic of the Individual NRC Program
23.4. Alternative Individual Program Analysis
- a. Alternative Program PASS ID Number
- b. Subject Individual Program Identifier
- c. Topic of the Alternative Individual Program
- d. Alternative Individual Program Keywords
- e. Alternative Program Description
- f. Activity Interactions and Resources
- g. Rationale for Alternative Program
- h. References for Description and Rationale

23.5. Individual Program Costs, Schedules and Lead Times (PAPD Step 16)
23.6. References for Costs, Schedules and Lead Times
23.7. Alternative Programs Attributes Analysis (PAPD Step 17)
23.8. Recommended Individual NRC Program
23.9. Rationale for Attributes Analysis and Recommendation
23.10. References for Attributes Analysis, Recommendation, and Rationale
23.11. Overall Comments/Observations
23.12. References for Comments/Observations

PRODUCTS OF INTEGRATED OVERALL NRC PROGRAMS ANALYSIS

(PAPD STEPS 18, 19 and 20)

24.1. NRC Overall Programs (PAPD Step 18)

- 24.1.1. Recommended NRC Overall Information Requirements Program
  - 24.1.1.1. Information Requirements Program PASS ID Number
  - 24.1.1.2. Information Requirements Program Integration Rationale
  - 24.1.1.3. Overall Information Requirements Program Description
  - 24.1.1.4. Overall Program Costs, Schedules and Networks
  - 24.1.1.5. References for Rationale, Description and Costs/Schedules
- 24.1.2. Recommended NRC Overall Uncertainty Reduction Program
  - 24.1.2.1. Uncertainty Reduction Program PASS ID Number
  - 24.1.2.2. Uncertainty Reduction Program Integration Rationale
  - 24.1.2.3. Overall Uncertainty Reduction Program Description
  - 24.1.2.4. Overall Program Costs, Schedules and Networks
  - 24.1.2.5. References for Rationale, Description and Costs/Schedules

PRODUCTS OF INTEGRATED OVERALL NRC PROGRAMS ANALYSIS

(PAPD STEPS 18, 19 and 20) [CONT'D]

24.1.3. Recommended NRC Compliance Determination Program
- 24.1.3.1. Compliance Determination Program PASS ID Number
- 24.1.3.2. Compliance Determination Program Integration Rationale
- 24.1.3.3. Overall Compliance Determination Program Description
- 24.1.3.4. Overall Program Costs, Schedules and Networks
- 24.1.3.5. References for Rationale, Description and Costs/Schedules

24.1.4. Recommended NRC Overall Research Program Plan
- 24.1.4.1. Research Program PASS Identification Number
- 24.1.4.2. Research Program Integration Rationale
- 24.1.4.3. Overall Research Program Description
- 24.1.4.4. Overall Program Costs, Schedules and Networks
- 24.1.4.5. References for Rationale, Description and Costs/Schedules

PRODUCTS OF INTEGRATED OVERALL NRC PROGRAMS ANALYSIS

(PAPD STEPS 18, 19 and 20) [CONT'D]

24.2. NRC Regulatory Requirement Programs (PAPD Step 19)

- 24.2.1. Regulatory Requirement Program Summary PASS ID Number
- 24.2.2. Topic of the Regulatory Requirement
- 24.2.3. Associated Key Milestones
- 24.2.4. Program Costs, Schedules and Networks
- 24.2.5. Regulatory Requirement Program Summary Description
- 24.2.6. References for Costs/Schedules and Description

24.3 Total NRC Program (PAPD Step 20)

- 24.3.1. Total NRC Program PASS Identification Number
- 24.3.2. Key Program Interrelationships
- 24.3.3. Total Program Summary Network
- 24.3.4. Rationale for Total Program
- 24.3.5. References for Program Interrelationships and Rationale

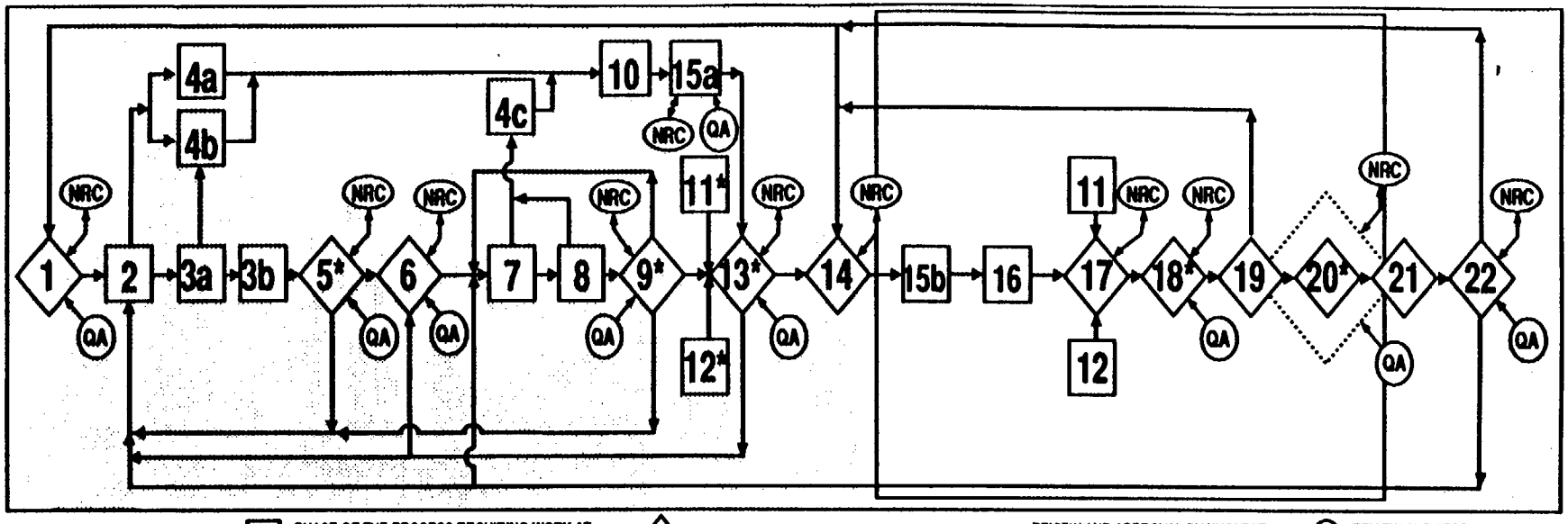
QA STATUS RECORDS

Section 25

a. QA Status PASS Identification Number

b. Parent or Associated Record

c. Program Architecture Process Step Completed



* Input to PADB following review and approval

X PHASE OF THE PROCESS REQUIRING WORK AT AND INPUT FROM THE PROGRAM ELEMENTS

X PHASE OF THE PROCESS REQUIRING INTEGRATION

NRC REVIEW AND APPROVAL BY NUCLEAR REGULATORY COMMISSION

QA REVIEW AND APPROVAL BY QUALITY ASSURANCE

1. Identify Potentially Applicable Statutes and Regulations
2. Analyze and Identify Regulatory Requirements

3a. Identify Regulatory Elements of Proof and Define Logic Structure

3b. Identify Technical Review Components and Define Logic Structures

4a. Identify and Correlate Institutional Uncertainties

4b. Identify and Correlate Regulatory Uncertainties

4c. Identify and Correlate Technical Uncertainties

5. Review, Revise and Integrate Regulatory Requirements, Regulatory Elements of Proof, and Technical Review Components
6. Select Subset of Regulatory Requirements for Further Analysis Based on Time-Critical Nature
7. Identify Basic Approach for Compliance Determination Methods
8. Identify and Correlate Information Requirements for Compliance Determination
9. Review, Revise and Integrate Compliance Determination Methods and Associated Information Requirements
10. Define NRC Composite Uncertainties; Identify Uncertainty Components
11. Obtain DOE "Issues", Compliance Demonstration Methods, Information Needs, Uncertainties and Uncertainty Reduction Methods
12. Obtain State, Tribe, and Other Affected Parties "Issues", Compliance Evaluation Methods†, Information Needs, and Uncertainties
13. Identify and Correlate Information Requirements for Uncertainty Reduction; Rank NRC Composite Uncertainties
14. Define Composite Information Requirements; Make Initial Selection of Composite Information Requirements for NRC Action; Identify Other Action Agencies

15a. Analyze Alternative Uncertainty Reduction Methods, Draft the Postulated Uncertainty Reduction Language (PURL) for Recommended Rulemakings, and Submit to NRC for Review.

15b. Define Alternative NRC Programs for Each Composite Information Requirement, Uncertainty Reduction, and Compliance Determination

16. Develop Costs, Schedules, and Lead Times for Alternative NRC Programs
17. Analyze and Perform Tradeoffs of Alternative NRC Programs
18. Recommend Overall NRC Programs Including Overall Research Program Plan
19. Develop and Display the Network and Critical Path for Each Regulatory Requirement
20. Develop and Display Network for Total Program
21. Control and Document Program Structure and Changes
22. Conduct the NRC program

†It is assumed that at least one affected party will request information to perform an independent "compliance evaluation".

WP 05/90

PROGRAM ARCHITECTURE PROCESS DIAGRAM

910605

PROGRAM

MANAGEMENT

OPEN ITEM RECORDS
(PAPD STEPS 7, 8, 11, 13, 14, 15a, 17, and 19)

Section 26

a. Open Item PASS Identification Number
b. Topic of the Open Item
c. Open Item
d. Open Item Action Agency
e. Open Item Completion Date [Date Due, then Date Completed]
f. References for Open Item
g. Open Item Disposition
h. Comments/Observations
i. References for Comments/Observations

EVALUATION FINDINGS

PASS ID CODE: EF

PASS ID NUMBER: RRxxxx/EFyyyy

NRC STAFF JUDGMENT THAT REFLECTS THE MERITS OF THE APPLICANT'S INFORMATION AND ANALYSES TO ADDRESS THE REGULATORY ELEMENTS OF PROOF AND THUS, THE REGULATORY REQUIREMENT.

- CONTAINED IN THE NRC SAFETY EVALUATION REPORT WHICH IS SUBMITTED TO THE LICENSING BOARD

- THIS RECORD WILL IDENTIFY AND SUMMARIZE THE FINDINGS APPLICABLE TO EACH INDIVIDUAL REGULATORY ELEMENT OF PROOF

EVALUATION FINDINGS
(PAPD STEP 22)

Section 8

a. Evaluation Finding PASS ID Number
b. Associated Regulatory Element of Proof
c. Parent Evaluation Finding
d. Topic of the Evaluation Finding
e. Summary of Evaluation Finding
f. Comments/Observations
g. References for Summary and Comments/Observations

PASS

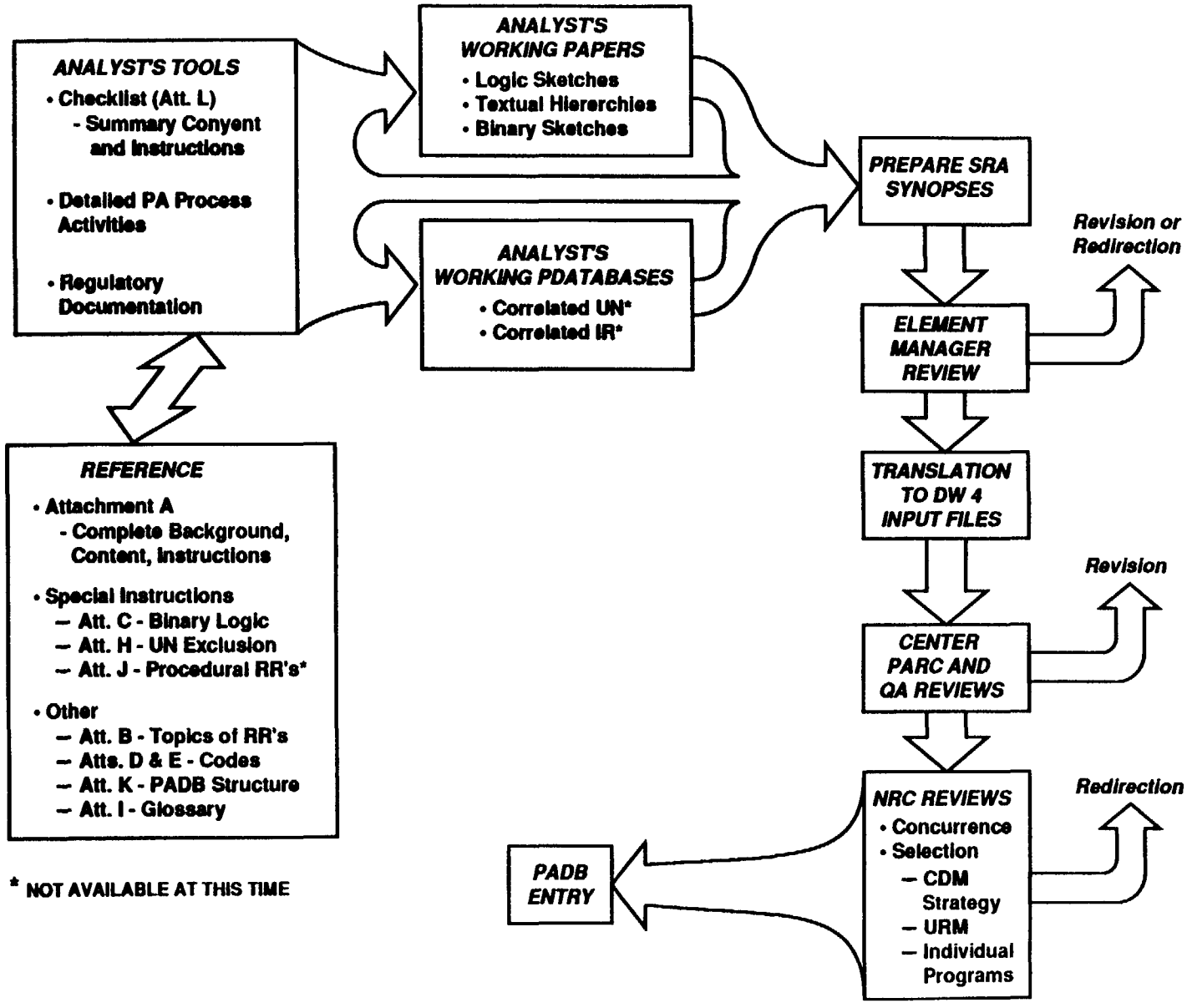
PROGRAM ARCHITECTURE SUPPORT SYSTEM

PASS IS A COMPUTER-BASED SYSTEM COMPRISED OF:

- PROGRAM ARCHITECTURE RELATIONAL DATABASE (PADB)
- MAINFRAME HARDWARE AND SOFTWARE NEEDED FOR PADB
  - CONSTRUCTION
  - PROTECTION
  - INTERROGATION
  - MANAGEMENT
- NETWORK HARDWARE AND SOFTWARE NEEDED FOR --
  - CONTROLLED REMOTE INTERROGATION
  - INTERFACING WITH NUDOC, LSS AND OTHER REMOTE DATABASES

PASS IS THE NRC INSTITUTIONAL MEMORY FOR THE HLW PROGRAM AND A KEY TOOL IN PREPARATION FOR THE HEARINGS.

PA DATABASE ENTRY PREPARATION PROCESS



* NOT AVAILABLE AT THIS TIME

SUMMARY

- THE PIECES OF SRA STRUCTURE FIT INTO A LOGICAL FRAMEWORK
- STEPS ARE NOT PURELY SEQUENTIAL
  - GENERAL SEQUENCE IS:
    RR, REOP, UN, CDS, TRC, CDM, IR
- PADB THOROUGHLY LINKS WITHIN AND BETWEEN STRUCTURAL LEVELS
- PROCESS IS GOVERNED BY PROCEDURES
- SRA ALLOWS DOCUMENTATION, INTÉGRATION AND CONTROL

CONCERNS ABOUT SRA

PURPOSE OF BRIEF

- EXAMINE NATURE AND STATUS OF SRA CONCERNS

STEP 1 IDENTIFY WHAT THE REGULATION REQUIRES

- QUESTIONS OF INTENT, COMPLETENESS OR JURISDICTION?

STEP 2 CONSOLIDATE REQUIREMENTS FROM STEP 1 INTO COMMON TOPICS

STEP 3 DETERMINE THE INTERRELATIONSHIPS AMONG THE REQUIREMENTS WITHIN EACH STEP 2 TOPIC

- QUESTIONS CONCERNING THE INTERRELATIONSHIPS?

STEP 4 ESTABLISH A GENERAL PLAN TO BOUND THE EFFORT AND INFORMATION ACCEPTABLE TO SHOW COMPLIANCE WITH EACH TOPIC

STEP 5 SPECIFY THE DETAILED INFORMATION NECESSARY TO SHOW COMPLIANCE WITHIN THE BOUNDS OF STEP 4

- DEFINE INTERRELATIONSHIPS AMONG ITEMS OF INFORMATION

STEP 6 USING STEP 4, SPECIFY THE TECHNIQUES TO BE USED FOR ACCEPTING AND CONFIRMING THE INFORMATION FROM STEP 5

- QUESTIONS OF "HOW TO"?

STEP 7 EXAMINE QUESTIONS FROM STEPS 1, 3 AND 6: CONSOLIDATE, ATTEMPT TO ANSWER

- QUESTIONS OF "HOW TO"?

STEP 8 DEFINE THE INFORMATION NEEDED TO ANSWER QUESTIONS FROM STEP 7

- QUESTIONS OF HOW TO?

STEP 9 DOCUMENT RESULTS OF STEPS 1 TO 8 IN MANNER WHICH ALLOWS QA VERIFICATION, INTEGRITY OF INFORMATION, EXAMINATION OF INTERRELATIONSHIPS AND ARCHIVING

STEP 10 PROVIDE RESULTS OF STEPS 1 TO 8 TO DOE AS GUIDANCE FOR PREPARATION OF A LICENSE APPLICATION

STEP 11 PROVIDE RESULTS OF STEPS 1 TO 8 TO NRC STAFF TO GUIDE LICENSE APPLICATION REVIEW

STEP 12 REPEAT AS NECESSARY UNTIL YOU FEEL BETTER

- PUT IN FEEDBACK LINES WHEREVER YOU WANT THEM

STEP 7 UNCERTAINTIES (UN) AND THEIR METHODS OF REDUCTION (URM)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 8 INFORMATION REQUIREMENTS (IR)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 9 PROGRAM ARCHITECTURE SUPPORT SYSTEM (PASS) AND PROGRAM ARCHITECTURE DATABASE (PADB)

STEP 10 FORMAT AND CONTENT REGULATORY GUIDE (F & CRG)

STEP 11 LICENSE APPLICATION REVIEW PLAN (LARP)

STEP 12 STEPS 1 THROUGH 15a OF THE TWENTY-TWO STEP PROGRAM ARCHITECTURE PROCESS

ORIGINS OF CONCERNS

- INITIAL SRA EFFORTS HAD 'START-UP' PROBLEMS
  - CHANGES IN TERMS AND POLICIES
  - LEARNING ABOUT DATABASE DEVELOPMENT
  - A FIRST-TIME EFFORT
- HEARSAY - MOST SRA WORK HAS BEEN DONE BY RELATIVELY FEW
- FOUNDATION OF SRA WAS PRIMARILY REGULATORY NOT TECHNICAL
- TIME WAS NEEDED TO DEVELOP EFFECTIVE COMMUNICATIONS BETWEEN NRC AND CNWRA

CONCERN #1
SRA IS ALL CLERICAL WORK

PERCEPTIONS/NATURE OF CONCERN

- LITTLE OR NO TECHNICAL KNOWLEDGE REQUIRED FOR
  - ISOLATING REGULATORY TEXT, IDENTIFYING REGULATORY REQUIREMENTS AND REGULATORY ELEMENTS OF PROOF AND DEFINING LOGICAL INTERRELATIONSHIPS
  - WRITING SYNOPSES
  - FILLING OUT TEMPLATES AND LOADING THE DATABASE

STATUS/OBSERVATIONS

- TOP LEVEL STRUCTURE DEVELOPMENT EMPHASIZED REGULATORY/INSTITUTIONAL ISSUES
  - LARGELY COMPLETE
  - ALL FOLLOW-ON SRA STRUCTURE REQUIRES TECHNICAL EXPERTISE/EFFORT (CDS, CDM, TRC, IR)

CONCERN #2
SRA PRODUCES NO USEFUL PRODUCTS

PERCEPTIONS/NATURE OF CONCERN

- BUILDING THE FOUNDATION TOOK LONGER THAN MANY EXPECTED
  - SOME QUESTION THE PURPOSE OR VALIDITY OF RFA/ROC/RR-REOP
- ANALYZING 10 CFR PART 60 FOR INSUFFICIENCIES CONSUMED MORE ATTENTION THAN IT MERITED
- SRA PRODUCTS ARE LARGE AND/OR LACKING IN SUBSTANCE
- CNWRA TECHNICAL PRODUCTS ARE NOT INFLUENCED BY SRA

STATUS/OBSERVATIONS

- DEVELOPMENT OF SRA FOUNDATION WAS NECESSARY
  - PROVIDED BASIS FOR FOCUSING HLW PROGRAM
- CONFIDENCE IN THE REGULATION IS VITAL
- SRA WAS INTENDED NEITHER TO INFLATE NOR CONSTRAIN THE SIZE OF ITS PRODUCTS
- SRA SERVES AS A SOURCE OF TECHNICAL TASKING AND PROVIDES A MEANS TO DOCUMENT RESULTS

CONCERN #3
SRA DICTATES "HOW" WORK IS TO BE DONE

PERCEPTIONS/NATURE OF CONCERN

- TECHNICAL STAFF IS FORCED TO CHANNEL THINKING TO MATCH RESTRICTIVE SRA FORMATS

- SRA INTERFERES WITH "GOOD SCIENCE" AND PREVENTS TECHNICAL STAFF FROM DOING WHAT THEY WERE TRAINED TO DO

STATUS/OBSERVATIONS

- RESTRICTIVE FORMATS HAVE BEEN REMEDIED - CONTENT OF DATA ENTRY REMAINS THE SAME
  - DIRECT WORKSTATION INTERACTION WITH MAINFRAME COMPUTER
  - RATIONALES/DECISIONS/METHODS RECORDED IN DATABASE - BACKGROUND AND SUPPORTING INFORMATION IS REFERENCED

- SRA WAS DESIGNED TO SUPPORT "GOOD SCIENCE"
  - HELPS DEFINE AND SCOPE WORK
  - PROMOTES TECHNICAL EFFORT BEING DONE IN ACCORDANCE WITH ACCEPTED SCIENTIFIC AND ENGINEERING DISCIPLINES AND TECHNIQUES
  - PROVIDES A MEANS TO DOCUMENT WORK

CONCERN #4
SRA IS TOO HARD AND INFLEXIBLE

PERCEPTIONS/NATURE OF CONCERN

- STRUCTURED INPUTS ARE RESTRICTIVE, COMPLICATED AND 'UNFRIENDLY'
- THE DATABASE IS MYSTERIOUS AND NO ONE KNOWS HOW TO USE IT
- THE 22-STEP PROCESS IS TOO COMPLICATED

STATUS/OBSERVATIONS

- MANY 'GROWING PAINS' IN DEVELOPING PROCEDURES TO EFFICIENTLY BUILD AND USE THE DATABASE
  - AN INTERACTIVE INTERFACE WILL 'HIDE' THE TECHNICAL DIFFICULTIES INHERENT IN MAINFRAME COMPUTER OPERATIONS
- READY NOW FOR NRC/CNWRA PARTICIPATION IN DATABASE USE AND DEVELOPMENT
- THE 22-STEP PROCESS IS A STRATEGIC VIEW

CONCERN #5
SRA/PA DATABASE PROVIDE NOTHING MORE THAN AN ENCYCLOPEDIA

PERCEPTIONS/NATURE OF CONCERN

- TOOK 10 CFR PART 60 APART AND PUT IT BACK TOGETHER IN A DIFFERENT ORDER - MAYBE EVEN INCORRECTLY
- CAN FIND THE SAME INFORMATION IN A GOOD LIBRARY

STATUS/OBSERVATIONS

- APPROVED PROCEDURES WERE USED, AND EXAMINATION WAS RIGOROUS
  - REVIEW BY NRC CONTINUES
- DATABASE PROVIDES RELATIONAL TIES AND SEARCH CAPABILITY TO ALLOW EXAMINATION OF INFORMATION IN MANY COMBINATIONS AND FROM MANY PERSPECTIVES
  - RELATIONAL TIES BECOME INCREASINGLY VALUABLE
  - DATABASE CONTENT IS PRIMARILY RATIONALES/DECISIONS/METHODS

CONCERN #6
SRA IS A MEANS FOR THE CENTER TO CONTROL THE NRC

PERCEPTIONS/NATURE OF CONCERN

- 22-STEP PROCESS DIAGRAM SHOWS NRC INVOLVEMENT ONLY AT CERTAIN POINTS
- NRC STAFF HAS NOT BEEN PROVIDED USER ID'S FOR PASS
- SOME SRA PRODUCTS DID NOT HAVE ENOUGH NRC INVOLVEMENT

STATUS/OBSERVATIONS

- 22-STEP PROCESS REQUIRES CONTINUOUS NRC INVOLVEMENT FOR POLICY/STRATEGY/DEVELOPMENT DECISIONS
  - SRA AND THE PA DATABASE BELONG TO THE NRC
- TIME IS RIPE FOR BOTH NRC AND CENTER TO START USING PASS
- FUTURE SRA PRODUCTS WILL BE BEST DEVELOPED BY NRC/CENTER GROUPS

CONCERN #7
MUST BE A SYSTEM ENGINEER TO UNDERSTAND SRA

PERCEPTIONS/NATURE OF CONCERN

- THE 22-STEP PROCESS IS TOO HARD TO UNDERSTAND
- NOT REALISTIC TO EXPECT TECHNICAL STAFF TO DEVELOP SYSTEM ENGINEERING EXPERTISE

STATUS/OBSERVATIONS

- 22-STEP PA PROCESS IS NOT MEANT TO BE USED DIRECTLY IN DAY-TO-DAY WORK: IT IS A STRATEGIC OVERALL HLW PROGRAM PLAN
- TECHNICAL STAFF SHOULD UNDERSTAND HOW CURRENT WORK FITS INTO THE OVERALL LICENSING PROCESS
  - SYSTEM ENGINEERING IS INTENDED TO PROVIDE A DYNAMIC FRAMEWORK FOR EFFECTIVE INTEGRATION AND CONTROL

SUMMARY

- SRA IS A DYNAMIC FRAMEWORK FOR COORDINATING THE LICENSING PROCESS AS EFFICIENTLY AS POSSIBLE - IT WAS DESIGNED TO HELP
- SRA HAS EXPERIENCED MANY 'START-UP' PROBLEMS
- WE HAVE MISUNDERSTOOD, MISREPRESENTED AND MISUSED SRA
- A CRUCIAL NEED FOR THE SUCCESS OF SYSTEM ENGINEERING AND SRA IS GOOD COMMUNICATIONS
- PASS AND THE PA DATABASE PROVIDE A LONG TERM RECORD OF RATIONALES, DECISIONS AND METHODS USED IN THE HLW PROGRAM

SUMMARY AND CONCLUSION

THE REQUIREMENT

- LARGE-SCALE, COMPLEX, FIRST-OF-A-KIND SOCIOTECHNICAL SYSTEM
- 10,000 YEAR SYSTEM LIFE IS UNPRECEDENTED
- EXCEPTIONALLY BROAD MIX OF TECHNICAL DISCIPLINES ("STOVEPIPES") TO BE INTEGRATED
- CONGRESSIONAL 3-YEAR MANDATE
- NUCLEAR REGULATORY COMMISSION HAS RECOGNIZED THE FOLLOWING NEEDS:
  - "STREAMLINE" THE LICENSING PROCESS
  - PROVIDE TIMELY GUIDANCE TO THE DOE
  - MINIMIZE ISSUES TO BE ADJUDICATED AT THE HEARING
  - MAKE MOST EFFECTIVE USE OF LIMITED NRC RESOURCES

THE PROCESS

- THE SRA PROCESS PROVIDES FOR:
  - A SYSTEMATIC IDENTIFICATION OF REPOSITORY SYSTEM REQUIREMENTS
  - A LOGICAL PROCESS TO DEVELOP THE LEGAL AND TECHNICAL MEANS TO SATISFY NRC REGULATORY PROGRAM NEEDS

THE METHODS

DEFINE REQUIREMENTS ON THE APPLICANT

- ANALYZE APPLICABLE STATUTES AND REGULATIONS FOR TOPICAL CONTENT AND COMPLETENESS
- IDENTIFY AND REDUCE INSTITUTIONAL AND REGULATORY UNCERTAINTIES [UN & URM]
- CONSOLIDATE AND COMPLETE SYSTEM AND LICENSE APPLICATION REQUIREMENTS [RR]
- DEFINE COMPLIANCE DEMONSTRATION REQUIREMENTS [REOP]

THE METHODS
(CONT'D)

DEFINE NRC COMPLIANCE DETERMINATION APPROACH

- SELECT APPROPRIATE COMPLIANCE DETERMINATION STRATEGY TYPES
- TAILOR A STRATEGY FOR EACH REGULATORY REQUIREMENT WITHIN THE BOUNDS OF ITS STRATEGY TYPE [CDS]
- DEFINE COMPLIANCE DETERMINATION METHOD(S) TO BE USED BY NRC [CDM]
- IDENTIFY THE MINIMUM INFORMATION NEEDED TO IMPLEMENT CDM'S [TRC]

THE METHODS
(CONT'D)

DEFINE ADDITIONAL NRC PROGRAM NEEDS

- IDENTIFY AND DEFINE KEY TECHNICAL UNCERTAINTIES [UN]
- SELECT UNCERTAINTY REDUCTION METHODS [URM]
- IDENTIFY INFORMATION REQUIREMENTS [IR] FOR
  - UNCERTAINTY REDUCTION
  - NRC INDEPENDENT EVALUATION OF COMPLIANCE [STRATEGY TYPES 4 AND 5 ONLY]

THE PRODUCTS

- INPUT TO FORMAT AND CONTENT REGULATORY GUIDE (REOP AND TRC)
- INPUT TO LICENSE APPLICATION REVIEW PLAN (CDS AND CDM)
- BASIS FOR NRC ENGINEERING, GEOLOGIC AND RESEARCH PROGRAM PLANNING (CDM, URM AND IR)
- DOCUMENTATION OF THE INFORMATION, DECISIONS AND RATIONALES NEEDED IN THE HEARING (ALL ABOVE)

THE INTEGRATED WHOLE

- A SYSTEMATIC PROCESS FOR ASSESSMENT OF NRC STATUTORY AND REGULATORY RESPONSIBILITIES IN A COMPREHENSIVE, STRUCTURED MANNER

COMPLIANCE DETERMINATION STRATEGY (CDS)

DEVELOPMENT

PURPOSE OF PRESENTATION

- REVIEW BASIC SRA PROCESS
- DEFINE CDS
- EXPLAIN DEVELOPMENT OF A CDS
  - SELECTION OF CDS TYPE
  - STRATEGY DEVELOPMENT
  - SYNOPSIS
  - USE OF PASS
  - PROPOSALS FOR NRC/CNWRA GROUP CDS DEVELOPMENT TECHNIQUES

WHAT'S THE JOB?

HOW CAN WE BEST PREPARE OURSELVES TO LICENSE A REPOSITORY?

WHAT BOUNDS THE JOB?

- THE STATUTE - NUCLEAR WASTE POLICY ACT, AS AMENDED
- THE REGULATION - 10 CFR PART 60
- THE TIME LIMIT - 3 YEARS
- THE NATURE OF THE PROBLEM
  - MANY UNKNOWNS
  - MANY TECHNICAL DISCIPLINES
  - A "FIRST-TIME" EFFORT
  - CAN'T OBTAIN "PROOF" IN THE NORMAL SENSE

THE IMPLICATIONS

- THE NRC MUST BE EXTREMELY WELL-ORGANIZED WHEN THE LA IS SUBMITTED
- SURPRISES MUST BE MINIMIZED
  - BOTH DOE AND NRC MUST HAVE CLEAR UNDERSTANDING OF WHAT NEEDS TO BE DONE
  - PRE-LICENSING GUIDANCE MUST BE THOROUGH AND PRECISE
- MUST BE PREPARED FOR LITIGATION

WHAT IS A LOGICAL, SYSTEMATIC WAY TO APPROACH THE TASK?

STEP 1 IDENTIFY WHAT THE REGULATION REQUIRES

- QUESTIONS OF INTENT, COMPLETENESS OR JURISDICTION?

STEP 2 CONSOLIDATE REQUIREMENTS FROM STEP 1 INTO COMMON TOPICS

STEP 3 DETERMINE THE INTERRELATIONSHIPS AMONG THE REQUIREMENTS WITHIN EACH STEP 2 TOPIC

- QUESTIONS CONCERNING THE INTERRELATIONSHIPS?

STEP 4 ESTABLISH A GENERAL PLAN TO BOUND THE EFFORT AND INFORMATION ACCEPTABLE TO SHOW COMPLIANCE WITH EACH TOPIC

STEP 5 SPECIFY THE DETAILED INFORMATION NECESSARY TO SHOW COMPLIANCE WITHIN THE BOUNDS OF STEP 4

- DEFINE INTERRELATIONSHIPS AMONG ITEMS OF INFORMATION

STEP 6 USING STEP 4, SPECIFY THE TECHNIQUES TO BE USED FOR ACCEPTING AND CONFIRMING THE INFORMATION FROM STEP 5

- QUESTIONS OF "HOW TO"?

STEP 7 EXAMINE QUESTIONS FROM STEPS 1, 3 AND 6: CONSOLIDATE, ATTEMPT TO ANSWER

- QUESTIONS OF "HOW TO"?

STEP 8 DEFINE THE INFORMATION NEEDED TO ANSWER QUESTIONS FROM STEP 7

- QUESTIONS OF HOW TO?

STEP 9 DOCUMENT RESULTS OF STEPS 1 TO 8 IN MANNER WHICH ALLOWS QA VERIFICATION, INTEGRITY OF INFORMATION, EXAMINATION OF INTERRELATIONSHIPS AND ARCHIVING

STEP 10 PROVIDE RESULTS OF STEPS 1 TO 8 TO DOE AS GUIDANCE FOR PREPARATION OF A LICENSE APPLICATION

STEP 11 PROVIDE RESULTS OF STEPS 1 TO 8 TO NRC STAFF TO GUIDE LICENSE APPLICATION REVIEW

STEP 12 REPEAT AS NECESSARY UNTIL YOU FEEL BETTER

- PUT IN FEEDBACK LINES WHEREVER YOU WANT THEM

RESULT

- A LOGICAL PATH TO REPOSITORY LICENSING
  - SIMILAR TO OTHER NRC LICENSING PROCEDURES
  - TIES TO REGULATORY STRATEGY, SITE CHARACTERIZATION PLAN, ETC.
- DOCUMENTED, CROSS-LINKED INFORMATION
- A METHOD DESIGNED FOR ITERATION AND FEEDBACK
- GUIDANCE TO DOE AND NRC STAFFS IS EASILY DERIVED FROM THIS PROCESS
- SYSTEM ENGINEERING APPLIED TO REPOSITORY LICENSING

DEFINING SRA

STEP 1 IDENTIFY WHAT THE REGULATION REQUIRES

- QUESTIONS OF INTENT, COMPLETENESS OR JURISDICTION?

STEP 2 CONSOLIDATE REQUIREMENTS FROM STEP 1 INTO COMMON TOPICS

STEP 3 DETERMINE THE INTERRELATIONSHIPS AMONG THE REQUIREMENTS WITHIN EACH STEP 2 TOPIC

- QUESTIONS CONCERNING THE INTERRELATIONSHIPS?

STEP 4 ESTABLISH A GENERAL PLAN TO BOUND THE EFFORT AND INFORMATION ACCEPTABLE TO SHOW COMPLIANCE WITH EACH TOPIC

STEP 5 SPECIFY THE DETAILED INFORMATION NECESSARY TO SHOW COMPLIANCE WITHIN THE BOUNDS OF STEP 4

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STEP 11 PROVIDE RESULTS OF STEPS 1 TO 8 TO NRC STAFF TO GUIDE LICENSE APPLICATION REVIEW

STEP 12 REPEAT AS NECESSARY UNTIL YOU FEEL BETTER

- PUT IN FEEDBACK LINES WHEREVER YOU WANT THEM

STEP 1 REGULATORY TEXT (RT)
- THE QUESTIONS ARE REGULATORY AND INSTITUTIONAL UNCERTAINTIES (UN)

STEP 2 REGULATORY REQUIREMENT (RR)

STEP 3 REGULATORY ELEMENTS OF PROOF (REOP) AND REGULATORY ELEMENTS OF PROOF SET (PS)
- THE QUESTIONS ARE REGULATORY UNCERTAINTIES (UN)

STEP 4 COMPLIANCE DETERMINATION STRATEGY (CDS)

STEP 5 TECHNICAL REVIEW COMPONENT (TRC) AND TRC SET (TS)

STEP 6 COMPLIANCE DETERMINATION METHOD (CDM)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 7 UNCERTAINTIES (UN) AND THEIR METHODS OF REDUCTION (URM)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 8 INFORMATION REQUIREMENTS (IR)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 9 PROGRAM ARCHITECTURE SUPPORT SYSTEM (PASS) AND PROGRAM ARCHITECTURE DATABASE (PADB)

STEP 10 FORMAT AND CONTENT REGULATORY GUIDE (F & CRG)

STEP 11 LICENSE APPLICATION REVIEW PLAN (LARP)

STEP 12 STEPS 1 THROUGH 15a OF THE TWENTY-TWO STEP PROGRAM ARCHITECTURE PROCESS

WHAT DO I NEED TO KNOW ABOUT THE TWENTY-TWO STEP PROCESS?

- IT EXISTS AS A REPRESENTATION OF THE COMPLETE HLW PROGRAM
- EACH STEP HAS DETAILED INSTRUCTIONS WHICH CAN BE REFERENCED AS NECESSARY (TOP-001-02)
- IF YOU ARE PUZZLING OVER THE TWENTY-TWO STEP PROCESS ON A DAILY BASIS, YOU'RE PROBABLY TRYING TO SOLVE THE WRONG PUZZLE

OPTIONS - A SENSITIVITY

- SRA HELPS DEFINE AREAS FOR STUDY
- INVESTIGATE USING STANDARD SCIENTIFIC AND ENGINEERING TECHNIQUES
- IDENTIFY, EVALUATE & SELECT TECHNICAL OPTIONS USING STANDARD PROCEDURES
- DOCUMENT RATIONALE AS IN OTHER NRC LICENSING ACTIONS
- PASS PROVIDES THE MEANS FOR DOCUMENTING THESE ACTIONS
- PA RELATIONAL DATABASE PROVIDES A PLACE FOR DOCUMENTING AND LINKING THESE ACTIONS

HOW DOES MY WORK FIT INTO THIS PROCESS?

- TECHNICAL EXPERTISE AND RESULTS OF SCIENTIFIC AND ENGINEERING INVESTIGATION ARE REQUIRED FOR TRC, CDS, CDM, UN AND IR DEVELOPMENT

- PASS IS ANOTHER MEANS OF DOCUMENTING THE RESULTS OF TECHNICAL WORK

- SOUNDLY DEVELOPED F & CRG, AND LARP ARE NECESSARY FOR A QUALITY AND TIMELY LICENSE APPLICATION AND REVIEW

  - SRA ALSO SUPPORTS RULEMAKING AND OTHER REGULATORY GUIDANCE

- THE PROCESS CAN HELP FOCUS THE HLW PROGRAM

- DON'T NEED TO BE A SYSTEMS ENGINEER TO WORK WITHIN FRAMEWORK PROVIDED BY SRA

DEFINE CDS

PURPOSE OF CDS

IDENTIFY AND GENERALLY DESCRIBE THE TYPE(S) OF LICENSE APPLICATION REVIEW FOR A SPECIFIC REGULATORY REQUIREMENT

WHERE DOES A CDS COME FROM?

- A CONSIDERATION OF THE SCOPE AND DEPTH OF EFFORT NEEDED TO DETERMINE COMPLIANCE WITH A GIVEN REGULATORY REQUIREMENT (RR/REOP STRUCTURE)
  - EFFORT MAY BE BOUNDED BY TECHNICAL NEEDS; AVAILABILITY OF TIME, MANPOWER AND FISCAL RESOURCES; OR THE RISK OF NON-COMPLIANCE WITH PERFORMANCE OBJECTIVES
- A CONSIDERATION OF ASSOCIATED UNCERTAINTIES
- A CONSIDERATION OF THE EXTENT OF INFORMATION REQUIRED FROM THE APPLICANT TO SHOW COMPLIANCE (TECHNICAL REVIEW COMPONENTS)
- A CONSIDERATION OF POTENTIAL COMPLIANCE DETERMINATION METHODS (CDM) TO BE APPLIED BY THE NRC

DEVELOPMENT OF A CDS

TWO STAGES

- SELECTION OF CDS TYPE
- STRATEGY DEVELOPMENT

SELECTION OF CDS TYPE

CHOOSE THE OVERALL TYPE OF LICENSE APPLICATION REVIEW (TYPE OF CDS) FOR A SPECIFIC REGULATORY REQUIREMENT

TYPES OF LICENSE APPLICATION REVIEWS (CDS)

TYPE 1 -	ACCEPTANCE REVIEW	LA RELATED COMPLIANCE REVIEWS
TYPE 2 -	PROCEDURAL REVIEW	LA PROCEDURAL RELATED
TYPE 3 -	SAFETY REVIEW (SEE 10 CFR 60.31)	RADIOLOGICAL SAFETY OR WASTE ISOLATION RELATED
TYPE 4 -	DETAILED SAFETY REVIEW AND COMPARISON TO CONFIRMATORY ANALYSES	HIGH POTENTIAL RISK OF NON-COMPLIANCE WITH RR/PERFORMANCE OBJECTIVES
TYPE 5 -	COMPARISON TO INDEPENDENT CONFIRMATORY ANALYSES AND TESTS	HIGHEST POTENTIAL RISK OF OF NON-COMPLIANCE--MOST DIFFICULT TO REDUCE RISK OR HIGHEST RESIDUAL RISK

10 CFR PART 60.31
CONSTRUCTION AUTHORIZATION

- SAFETY - REASONABLE ASSURANCE THAT REPOSITORY CAN FUNCTION WITHOUT UNREASONABLE RISK TO HEALTH AND SAFETY OF PUBLIC
  - DOE HAS DESCRIBED THE REPOSITORY
    - GEOLOGIC SETTING
    - NATURE OF WASTE
    - REPOSITORY DESIGN
    - CONSTRUCTION PROCEDURES
    - COMPONENTS RELATED TO HEALTH AND SAFETY
  - SITE AND DESIGN COMPLY WITH PERFORMANCE OBJECTIVES AND CRITERIA IN SUBPART E
  - QA PROGRAM COMPLIES WITH SUBPART G
  - PERSONNEL TRAINING PROGRAM COMPLIES WITH SUBPART H
  - EMERGENCY PLAN COMPLIES WITH SUBPART I
  - OPERATING PROCEDURES TO PROTECT HEALTH AND TO MINIMIZE DANGER TO LIFE OR PROPERTY ARE ADEQUATE

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION

1. SELECTION CRITERIA FOR LICENSE APPLICATION (LA) REGULATORY REQUIREMENT

- DOE MUST DEMONSTRATE COMPLIANCE, OR
- RR AFFECTS CONTENT OR DOCKETING SUBMITTAL OF LA.

- RR TO BE ADDRESSED IN COMPLIANCE REVIEW AND
- FINDINGS WILL BE MADE IN THE SER.

TYPE OF CDS

PERFORM ACCEPTANCE REVIEW ONLY

- REVIEW LA RESPONSE TO RR FOR ACCEPTABILITY FOR DOCKETING; I.E., FOR --
  - COMPLETENESS AS PRESCRIBED BY F&CRG
  - CONSISTENCY WITH BASIC REQUIREMENTS OF PART 60 AND NWPAA
- DO NOT REVIEW LA RESPONSE FOR ADEQUACY

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION
(CONT'D)

2. SELECTION CRITERIA FOR LA PROCEDURAL REGULATORY REQUIREMENT

- RELATED TO LA
- ONLY PROCEDURAL IN NATURE
- NOT RELATED TO RADIOLOGICAL SAFETY OR WASTE ISOLATION

TYPE OF CDS

PERFORM PROCEDURAL REVIEW ONLY

- REVIEW LA RESPONSE TO RR FOR COMPLIANCE WITH PROCEDURAL REQUIREMENT

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION
(CONT'D)

3. SELECTION CRITERIA FOR RR RELATED TO SAFETY/ISOLATION

- COMPLIANCE IS NECESSARY TO MAKE SAFETY DETERMINATION
- APPLIES TO RRs THAT EMBODY SUBPARTS E, G, H, AND I

TYPES OF CDS

PERFORM -

- ACCEPTANCE REVIEW OF LA RESPONSE TO COMPLETE RR,

  AND

- SAFETY REVIEW AS DEFINED IN 10 CFR 60.31

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION (CONT'D)

4. SELECTION CRITERIA FOR RR THAT PRESENTS HIGH POTENTIAL RISK OF NON-COMPLIANCE

- HIGH POTENTIAL RISK OF NON-COMPLIANCE WITH RR,

  AND

- POTENTIAL FOR NON-COMPLIANCE WITH ONE OR MORE PERFORMANCE OBJECTIVES
- RISK CAUSED BY ONE OR MORE "KEY ADVERSE EFFECTS" OR "KEY TECHNICAL UNCERTAINTIES"

TYPES OF CDS

PERFORM

- ACCEPTANCE REVIEW OF LA RESPONSE TO COMPLETE RR

  AND

- AS APPLICABLE TO INDIVIDUAL REOP, SAFETY REVIEW

  AND

- AT LEAST ONE REOP WILL HAVE A DETAILED SAFETY REVIEW AND COMPARISON TO CONFIRMATORY ANALYSES
  - EXPANSION OR EXTENSION OF SAFETY REVIEW
  - FOCUS ON ASSESSMENT OF EACH KEY ADVERSE EFFECT AND KEY TECHNICAL UNCERTAINTY AND HOW IT IS REDUCED, COMPENSATED FOR, OR REMEDIED
  - USE METHODS DEVELOPED BY DOE OR OTHER (NON-NRC) PARTIES

COMPLIANCE DETERMINATION STRATEGY TYPE SELECTION (CONT'D)

5. SELECTION CRITERIA FOR RR PRESENTS HIGHEST POTENTIAL RISK OF NON-COMPLIANCE

- RISK IS MOST DIFFICULT TO REDUCE, COMPENSATE FOR, OR REMEDY
- HIGH RESIDUAL RISK OF NON-COMPLIANCE

TYPES OF CDS

PERFORM -

- ACCEPTANCE REVIEW OF LA RESPONSE TO COMPLETE RR

  AND

- AS APPLICABLE TO INDIVIDUAL REOP, SAFETY REVIEW

  AND

- DETAILED SAFETY REVIEW

  AND

- AT LEAST ONE REOP WILL HAVE A COMPARISON TO INDEPENDENT CONFIRMATORY ANALYSES AND TESTS
  - COMPARE LA ANALYSIS TO ANALYSIS CONDUCTED BY STAFF
  - USE METHODS DEVELOPED INDEPENDENTLY BY NRC
  - DATA AND/OR CONCLUSIONS OF STAFF MAY BE USED

FOCUSING THE APPLICATION OF SYSTEMATIC REGULATORY ANALYSIS

- CLEARLY, THE ENTIRE SRA PROCESS IS NOT APPROPRIATE FOR ALL REGULATORY REQUIREMENTS

- WHAT CRITERIA SHOULD BE USED TO ESTABLISH THE SCOPE OF THE ANALYSIS APPROPRIATE FOR EACH REGULATORY REQUIREMENT?

- THE DOMINANT CRITERION IS PERFORMANCE RISK OR RISK OF NON-COMPLIANCE

- THAT IS THE CRITERION USED TO SELECT THE COMPLIANCE DETERMINATION STRATEGY TYPE

- THAT IS WHY —

  CDS TYPE SELECTION IS ONE OF THE MOST IMPORTANT STEPS IN THE ENTIRE SRA PROCESS

TYPE OF LA REVIEW (CDS) SELECTION CONSIDERATIONS

- AVOID ESCALATION OF CDS TYPE
- ADVERSE EFFECTS OR TECHNICAL UNCERTAINTIES JUDGED TO POSE HIGH POTENTIAL RISKS OF NON-COMPLIANCE WITH PERFORMANCE OBJECTIVES ARE REFERRED TO AS KEY ADVERSE EFFECTS AND KEY TECHNICAL UNCERTAINTIES
- SELECTION OF CDS TYPE IS A JUDGMENT CALL
- CHANGES TO THE SELECTED TYPE ARE EXPECTED AS THE HLW PROGRAM MATURES
- WHEN SELECTING CDS TYPE, FIRST CONSIDER THE OVERALL INTENT OF THE RR; THEN CONSIDER EACH REGULATORY ELEMENT OF PROOF (REOP)
- EACH CDS TYPE IS INCLUSIVE OF THE TYPES BENEATH IT
- EACH REOP HAS A CDS TYPE, BUT NO REOP CDS TYPE MAY BE MORE COMPREHENSIVE THAN THE OVERALL TYPE CHOSEN FOR THE RR
- THERE IS A SIMPLE WORKSHEET - IT WORKS !

CDS TYPE SELECTION PROCEDURE

1. ASSIGN SELECTION GROUPS (NRC & CNWRA STAFF)

2. REVIEW THE DESIGNATED REGULATORY REQUIREMENT

3. READ SELECTION GUIDANCE AND COMPLETE TRAINING

4. STUDY PERTINENT BACKGROUND INFORMATION

5. EVALUATE THE RR AND SELECT THE CDS TYPE

   - USE WORKSHEET

6. PREPARE TABLES BASED ON WORKSHEETS

   - LIST OF KEY ADVERSE EFFECTS ON COMPLIANCE
   - LIST OF KEY TECHNICAL UNCERTAINTIES
   - LIST OF CDS TYPE FOR EACH RR

7. CONDUCT INTEGRATION REVIEW

8. CONDUCT TECHNICAL REVIEW

9. PREPARE REPORT

10. CONDUCT MANAGEMENT REVIEW

PERTINENT BACKGROUND MATERIAL

- RR/REOP REPORT
- STATEMENT OF CONSIDERATIONS FOR 10 CFR PART 60
- RATIONALE AND STAFF ANALYSIS OF COMMENTS ON PROPOSED RULE 10 CFR PART 60, NUREG 0804
- DOE SITE CHARACTERIZATION PLAN (LICENSING STRATEGIES TO RESOLVE ISSUES IN CHAPTER 8)
- NRC SITE CHARACTERIZATION ANALYSIS
- KEY SITE-SPECIFIC TOPICS UNDER
- UNCERTAINTIES IN CNWRA 90-003 AND SECY-90-207, ENC 5
- TECHNICAL POSITION TOPICS IN ENC 8 OF SECY-88-285
- STAFF TECHNICAL POSITIONS AND STAFF POSITIONS
- MAJOR YUCCA MOUNTAIN SITE ISSUES IN SECY-87-137
- OTHERS IDENTIFIED BY THE SELECTION GROUP

STRATEGY DEVELOPMENT
FOR A SPECIFIC REGULATORY REQUIREMENT

1. ASSIGN A PASS ID AND IDENTIFY RELATIONSHIPS TO PARENT DATABASE ELEMENTS

2. DEFINE THE TYPE OF LA REVIEW (CDS) (FROM THE TYPING WORKSHEET)

3. PROVIDE THE RATIONALE AND REFERENCES FOR CHOOSING THE CDS TYPE

   - DESCRIBE THE RR INCLUDING THE PRESENCE OF ANY KEY ADVERSE EFFECTS OR TECHNICAL UNCERTAINTIES OR OTHER UNUSUAL ASPECTS

   - FOR TYPE 3: EXPLAIN WHY TYPE 4 OR 5 WAS NOT CHOSEN

   - FOR TYPES 4 AND 4 A DESCRIPTION OF ANY KEY ADVERSE EFFECTS
     - POTENTIAL RISK
     - EVIDENCE AND LOGIC SUPPORTING PERCEPTION OF RISK
     - PERFORMANCE OBJECTIVES/CRITERIA WHICH ARE JEOPARDIZED
     - EXPLAIN WHY THE KEY ADVERSE AFFECT IS <u>MOST</u> DIFFICULT TO REMEDY (TYPE 5)

   - FOR TYPES 4 AND 5 A DESCRIPTION OF ANY KEY TECHNICAL UNCERTAINTIES
     - POTENTIAL RISKS/IMPACTS
     - LOGIC SUPPORTING PERCEPTION OF RISK
     - PERFORMANCE OBJECTIVES WHICH ARE JEOPARDIZED
     - EXPLAIN WHY THE KEY TECHNICAL UNCERTAINTY IS <u>MOST</u> DIFFICULT TO REMEDY (TYPE 5)

STRATEGY DEVELOPMENT (CONTINUED)

4. CONSTRUCT CDS TEXT

   - DO NOT INCLUDE PRE-LICENSING ACTIVITIES
   - PREPARE A LIST OF EACH TYPE OF LA REVIEW APPLICABLE FOR THE RR WITH ASSOCIATED REOPs
   - INCLUDE SPECIFIC REVIEWS, TESTS, MODELS ETC. IF:
     - THEY ARE STANDARD PRACTICE
     - THEY EXIST NOW, OR
     - THEY ARE DESCRIBED IN NRC OR CNWRA PLANS

5. PROVIDE RATIONALE FOR STRATEGY

   - TYPES 3, 4 AND 5 ONLY
   - THIS IS NOT A REPORT OF RATIONALE FOR CDS TYPE SELECTION
   - EXPLAIN BASIS FOR SCOPE AND APPROACH
     - FOR EXAMPLE, JUSTIFICATION FOR CHOICE OF SPECIFIC REVIEWS, TESTS, MODELS, ETC.
   - GERMANE POSITIVE COMMENTS/OBSERVATIONS
   - REFERENCES
   - ANALYST AND DATE

6. SOURCE OF CDS DEVELOPMENT PROCEDURE IS TOP-001-02

CDS SYNOPSIS

- THE LINK BETWEEN THE RELATIONAL DATABASE AND THE STAFF
- PRESENTS MAINFRAME COMPUTER DATA IN ORGANIZED, READABLE FORMAT
- AN EFFICIENT TOOL FOR USE BY PROFESSIONAL STAFF
  - DEVELOPMENT
  - REVIEW
  - APPROVAL

USE OF PASS

- RR/REOP AND MOST UNCERTAINTY DATA ARE IN RELATIONAL DATABASE
- WORK EXPERIENCE HAS LED TO SIGNIFICANT OPTIMIZATION AND IMPROVEMENTS IN FRIENDLINESS
- CENTER IS ANXIOUS TO PROVIDE INSTRUCTION TO POTENTIAL USERS
  - PREFER INDIVIDUAL OR SMALL GROUP
  - TAILORED TO THE IMMEDIATE TASK
  - USER FEEDBACK NEEDED
- PASS WORKS - ITS TIME FOR NRC/CENTER TO USE/IMPROVE IT

PROPOSALS FOR NRC/CNWRA GROUP CDS DEVELOPMENT

- CDS TYPE SELECTION CAN BE DONE VIA TELECONFERENCE/MEETINGS
- CDS DEVELOPMENT
  - NRC HAS LEAD
  - DEVELOP/MATURE INDIVIDUAL CDS IN THE PROGRAM ARCHITECTURE DATABASE
  - CNWRA ASSUME RESPONSIBILITY FOR DATA ENTRY
  - GROUP MEMBERS VIEW CDS VIA PASS-COMMENT BY TELEPHONE/FAX ETC.
  - WHEN DEVELOPMENT IS COMPLETE, NRC/CNWRA CONDUCT TECHNICAL/MANAGEMENT REVIEWS IN PARALLEL
  - AFTER CONCURRENCE/APPROVAL, CDS IS PLACED UNDER CONFIGURATION MANAGEMENT/CHANGE CONTROL IN PADB

SUMMARY

- PROTOTYPE CDS DEVELOPMENT PROCEDURES ARE READY
  - WORK EXPERIENCE WILL CAUSE MODIFICATION/IMPROVEMENT
- GROUPS FOR FIRST THREE EXAMPLES HAVE BEEN ESTABLISHED
- READY TO TRAIN ON AND WORK WITHIN PASS
- GENTLEMEN, START YOUR ENGINES!

In this segment we shift from the processes and tools that systems engineers use to integrate systems to the processes and tools that systems engineers can use to integrate their work. It is not the integration of systems that is of interest here, it is the integration of work which in turn produces the integration of systems. How do systems engineers lead teams of specialty engineers to assure that contributions are made to an overall effort in an effective and efficient way?

We saw that as engineering fragmented into specialty disciplines, communication across specialties has become increasingly difficult. If you add to that the usual problems when human try to perform as teams, the need for processes and tools to achieve group consensus is clear and increasing.

NOTES

SYSTEMS INTEGRATION

Just as there are Systems Engineering Tools and Practices for Integrating system components

There are Systems Engineering Tools and Practices for Integrating the Engineering and Scientific Work

S. E. M. →

The good news is that tools and practices have been developed specifically to aid groups in integrating their work and achieving consensus. They are called Group Consensus Methodologies.

NOTES

SYSTEMS INTEGRATION

The need:

- Methodologies that integrate the efforts of people working on one system who have little language or experience in common with each other thereby creating difficulty for the Systems Engineer to integrate the work effort

The Solution:

- The Consensus Methodologies Which Make Possible And Practical The
  - Generation of ideas
  - Clarification of ideas
  - Structuring of ideas
  - Interpreting Structures of Ideas
  - Amending of Ideas

Much of the work in consensus methodologies has been accumulating over the past 20 years or so. For an excellent summary and presentation by one of the prime movers in this area see Warfield (Warfield, John N., A Science of Generic Design: Managing Complexity Through Systems Design. Volume I and II. Salinas, California: Intersystems Publications, 1990. ISBN 0-914195-49-1). (Ref. 21)

NOTES

SYSTEMS INTEGRATION

The Enemies of Integrating work effort

- Linkage Escalation
- Double Loop Problems (Complex Problems) vs. simple problems

S. E. M. →

There are two major "enemies" that have been identified when it comes to working in groups. The first has been called "linkage escalation" and the second has been called by a variety of names such as "wicked problems", "double loop problems", and "complex problems." Both tend to work against teamwork and group consensus. Both are related to each other.

NOTES

Linkage Escalation

- What it is
- How it works against us
- Can it be avoided?
- Can it be minimized?

S. E. M. →

The first "enemy" is linkage escalation. Linkage escalation is a natural "tax" we have to pay when we work in groups. It is unavoidable. It can be minimized.

NOTES

SYSTEMS INTEGRATION

Lack of substantive knowledge (content) is often not the major impediment to solving complex system design problems

Linkage escalation occurs naturally in working on complex systems. If it is not understood and provided for, it may dominate the work efforts and guarantee failure

It most group settings it is not content knowledge that prevents groups from functioning. Most members have sufficient specialty knowledge to accomplish whatever mission the group has. And it is not the usual group meeting problems that have been well identified and studied (such as one member dominates, other don't talk at all, group think, etc.). The real problem is that group members may be well trained (have content knowledge) in their specialties but lack training about how to work in groups (lack group process knowledge).

NOTES

Linkage Escalation

- Individual Problem Solver and problem as defined by that person
- If problem is beyond capability of problem solver a problem solving team is formed to work on problem
- Escalation occurs when
  - team members who form group have content knowledge but may not know how to make a group work effectively together as a problem solving team
  - team members bring values, policies, or practices of their own organizations, groups, discipline with them
  - team members try to jointly define the system and problem
  - a proposed solution itself results in a new problem in same or another system

Linkage escalation occurs when one individual recognizes that a problem or design task is too great to be accomplished without assistance and asks others to join in the effort. As soon as other with content knowledge join the group there may be sufficient content knowledge but no one may know how to run a group meeting. Who is in charge? How are decisions made? What happens when there are different views? Who keeps the records of meetings and how are these circulated?

A second form of escalation occurs when participants view the problem or system. They each bring with them the practices, values, and policies of the organizational units they came from. A third form of escalation occurs when they each view the problem or system from their own viewpoints (or their organizational viewpoint) and the definition and understanding of the system is different for each. The final form of escalation occurs when the solution offered by the group may itself when implemented produce a new problem in another system or in the same system.

NOTES

Double Loop Problems

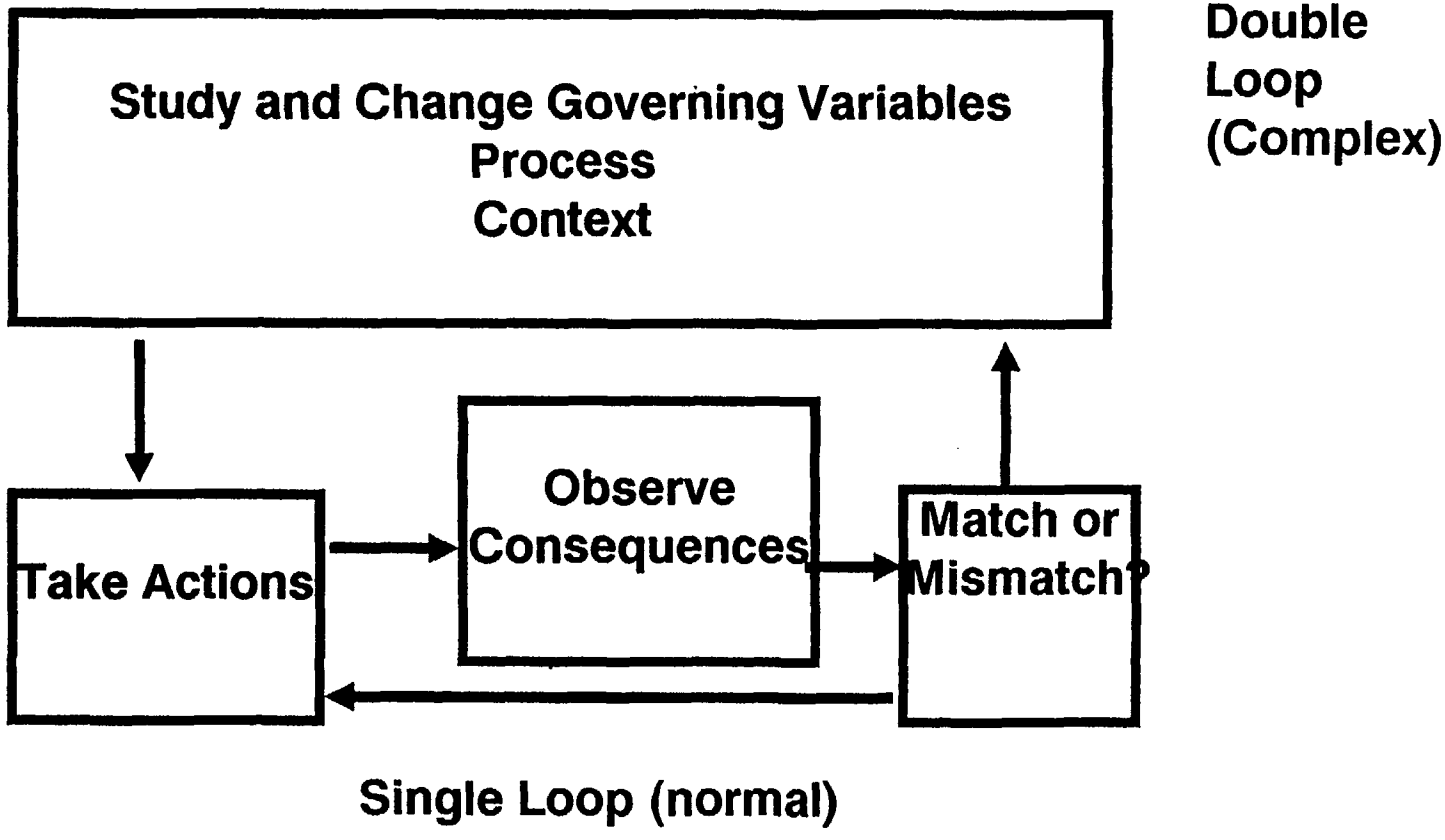
- Content Knowledge
- Process Knowledge
- Context Knowledge

Double loop problems are problems that are complex rather than simple. Simple problems can be solved by content knowledge alone. They are often found in Class A technological systems. When problems increase in size and complexity to the point where additional people must become involved, we find content knowledge is not enough. Context and process knowledge become essential as well. Put differently, complex problems require additional players and additional players introduce linkage escalation. Some players may not even be interested in problem solving. They may be more interested in preserving organizational stability and continuity, individual power, prestige, and influence, etc.

NOTES

SYSTEMS INTEGRATION

The Double Loop



In this figure, we see both a single loop (normal problem) and a double loop (complex) problem. For the single loop, the problem is defined and one individual works on it, action is taken, and the problem is either solved or reworked until it is. content knowledge is pretty much all that is required.

In the double loop problem, the process starts out the same but the entire study and change process is embedded in a larger process wherein the context of the problem solving and the process of problem solving now enter into the search for a solution. The problem has become complex because content knowledge itself is no longer sufficient to guide a search for a successful solution.

NOTES

SYSTEMS INTEGRATION

Process Knowledge (and Methodologies) are Essential

Consensus Methodologies Meet the Need

S. E. M. →

Process knowledge is required by systems engineers (and all engineers) so that work in a group setting becomes productive (effective and efficient).

NOTES

Consensus Methodologies

- Ideawriting (Brainstorming)
- Nominal Group Technique (NGT)
- Delphi Technique
- Intepretive Structural Modeling
- Options Field Method
- Options Profile Method
- Trade off Analysis Method

S. E. M. →

There are many consensus methodologies that have been developed over the past 20 years. Listed here are seven of the most well known.

NOTES

SYSTEMS INTEGRATION

The Delta Charts and Delta Charting approach to Consensus Methodologies

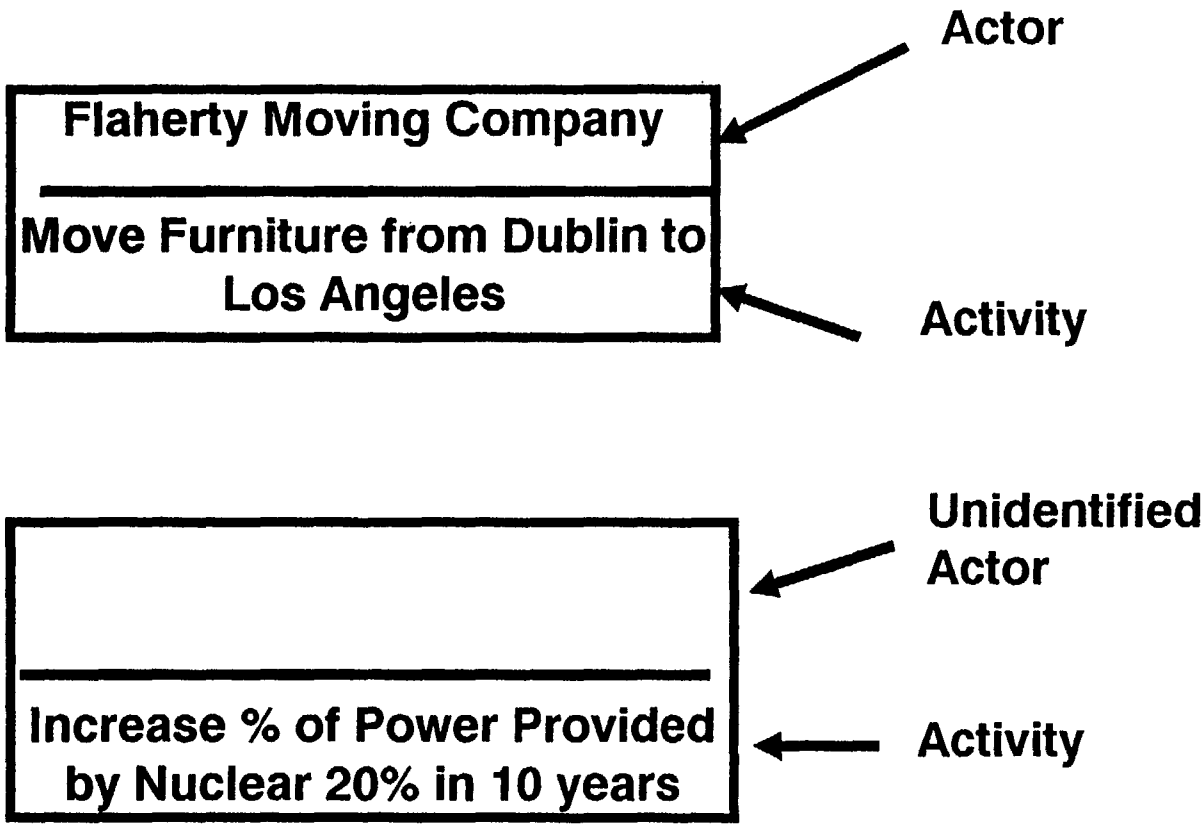
- Common Language
- Compact Description
- Clarity of Sequencing
- Nesting
- Comparison with English

S. E. M. →

Delta charts are one way of presenting the consensus methodologies. The advantages in using delta charting are considerable. The presentation is standardized across all methodologies and a common, compact language and description are used. The charts show sequencing of activities and nesting when it occurs. Delta charts are also close enough to ordinary English that they can be easily followed and understood.

NOTES

DELTA CHARTING: Portraying an Activity

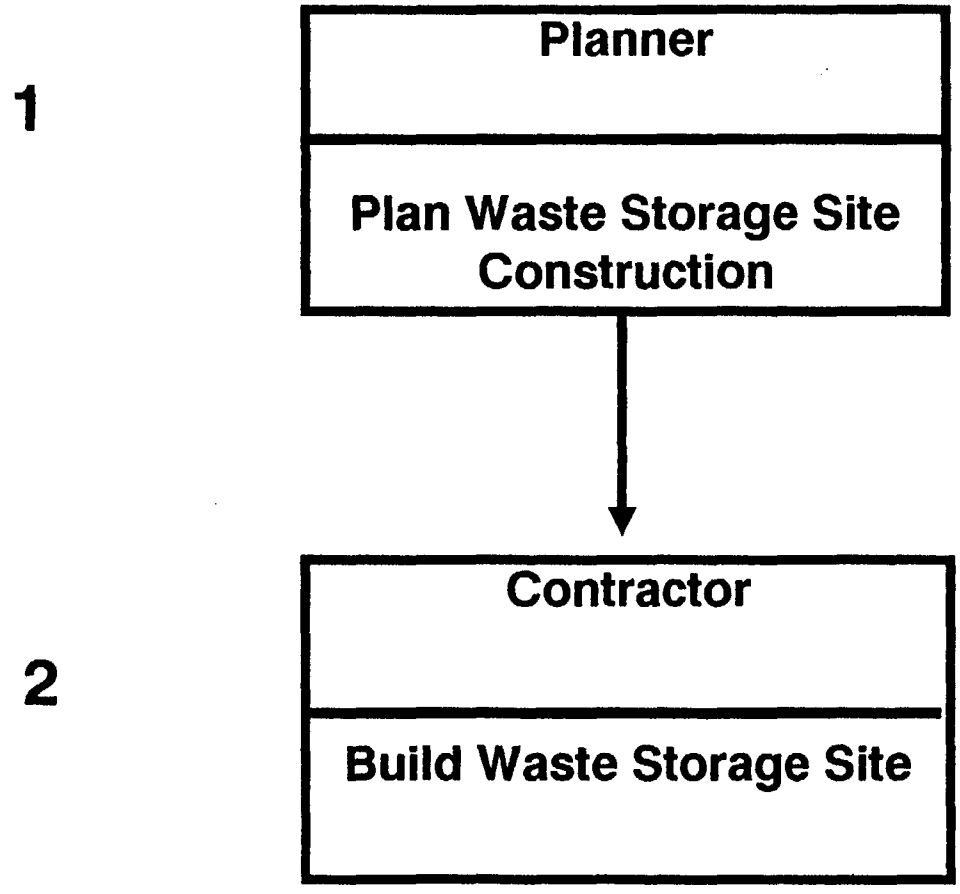


S. E. M. →

Delta charts are used to portray activities and those responsible (if known) for carrying out the activities.

NOTES

DELTA CHARTING: Portraying Time Sequence

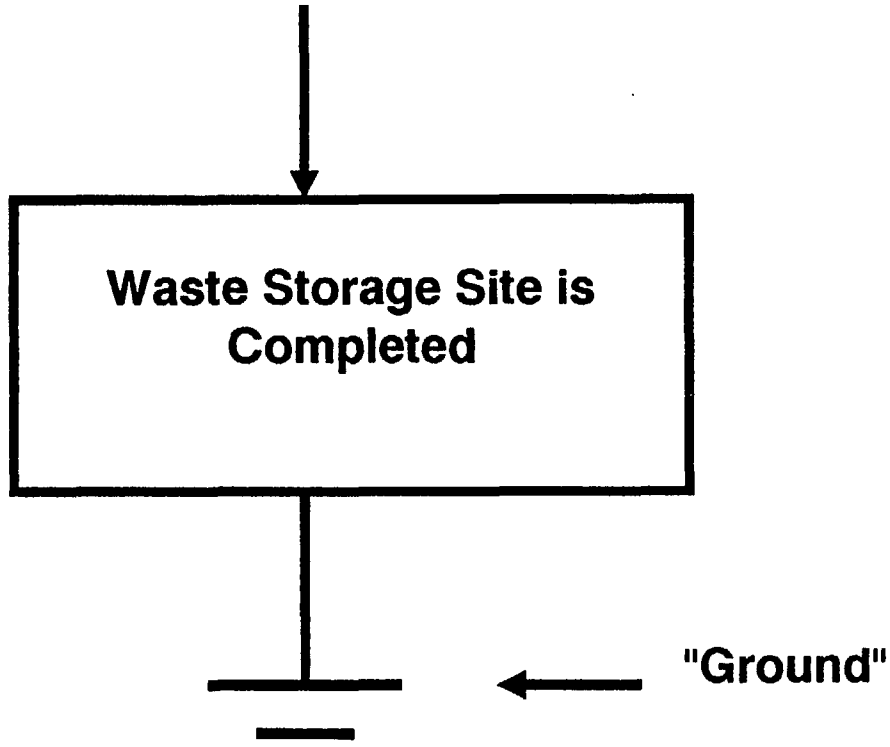


S. E. M. →

Delta charts also are good at portraying sequences.

NOTES

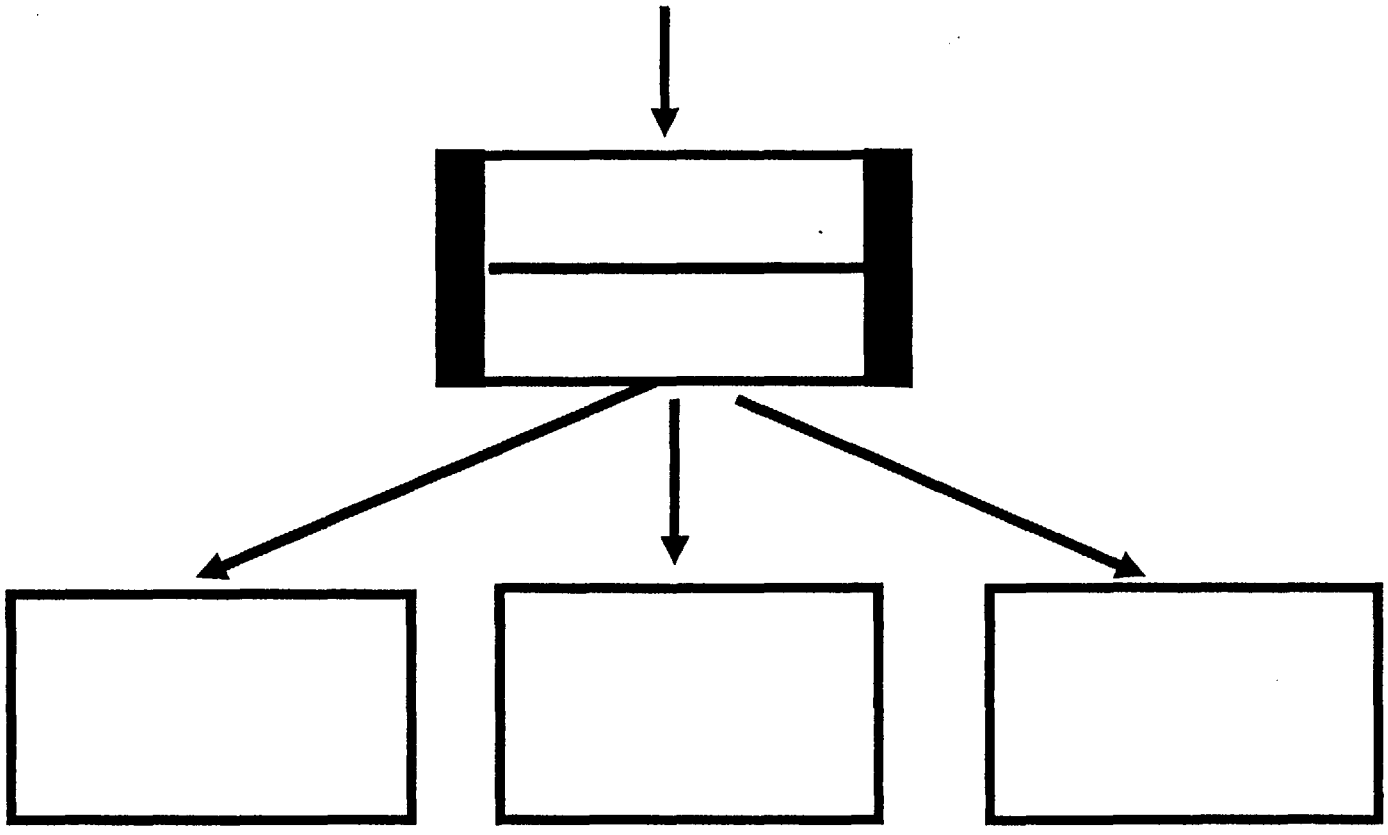
DELTA CHARTING: Concluding Event



Every methodology must have an ending. Delta charts portray ending events (concluding events) with a "ground" symbol similar to the ground symbol used in electrical diagrams.

NOTES

DELTA CHARTING: Portraying a Decision

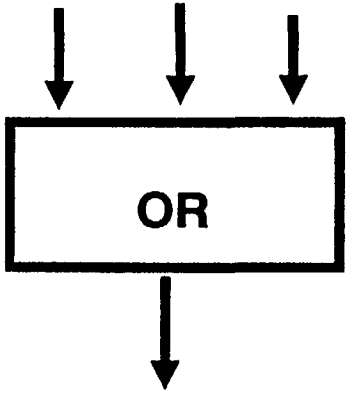


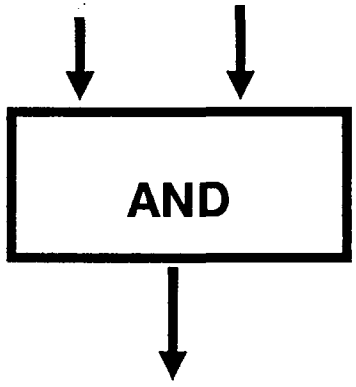
S. E. M. →

Delta charting portrays a decision showing a decision "box" and then the alternatives facing the decision maker. A decision can be taken on any branch and the flow continues from that branch.

NOTES

DELTA CHARTING: Logic Boxes





Delta charts also provide for logic boxes such as the "and" and "or" logic functions.

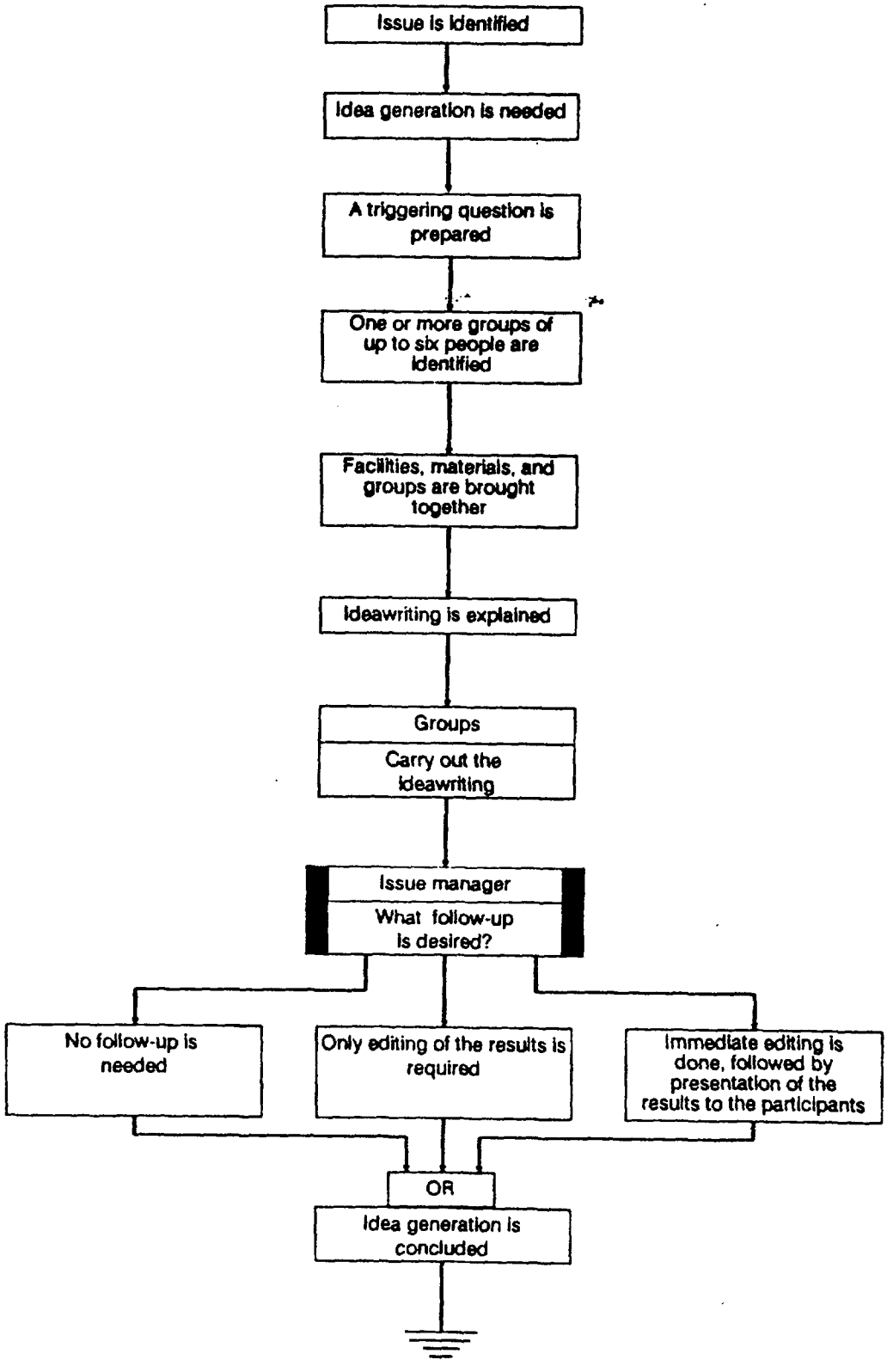
NOTES

IDEAWRITING

S. E. M. →

The first of the group consensus methodologies we will look at is idea writing (sometimes called Brainwriting).

NOTES



DELTA chart of ideawriting process. Copyright © 1982 SGSR.

S. E. M. →

As we follow this delta chart we see the steps in the process of idea writing. This method is especially useful when there is a need to generate ideas about an issue, system, or problem. A simple trigger question is prepared or explained to a group who then individually write their ideas on a sheet of paper for 5 to 10 minutes. The lists of ideas are put into a "hat" and exchanged among group members and members write more on the list based on what they see so far. This process is continued until no additional ideas emerge. The lists are then collected, aggregated, edited and a single list is presented to the group as a whole for discussion.

NOTES

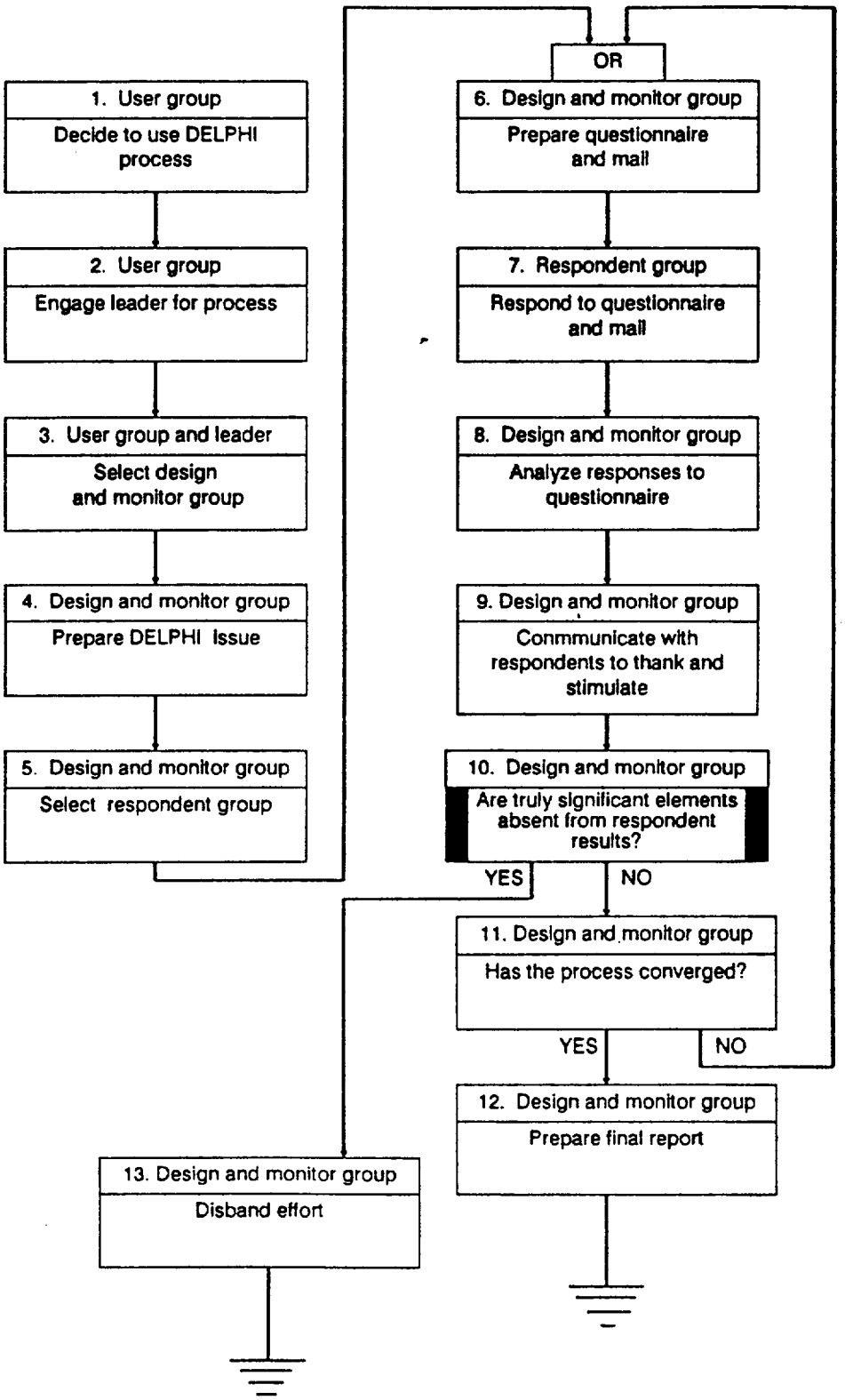
THE DELPHI TECHNIQUE

The Delphi Technique. This technique was developed by Helmer and Dalkey at the RAND Corporation in the 60's and 70's. It is especially useful when you need numerical estimates and there is no know way to arrive at them other than using expert opinion. This technique makes use of the N Heads rule. There is at least as much information in N heads as there is in one and probably more. The challenge is to get that information out.

The Delphi technique is based on assembling a panel of experts and then asking them for their estimates anonymously and iteratively. All estimates are made in secret and who makes what estimate is never revealed. The results of each round is feed-back to the experts as the basis for making the next round of estimates. The process stops after three rounds. You then take the 63rd percentile as the answer of the group.

There have been some reports suggesting the Delphi technique has flaws but these findings have been traced back to studies that used "modified Delphi techniques." There is only one proper way to do the Delphi. If it is followed research suggests that the Delphi is an excellent way to obtain estimates that may be otherwise impossible to obtain and as the same time it avoids the well known pitfalls associated with working with groups.

NOTES



DELTA chart of DELPHI process. Copyright © 1982 SGSR.

S. E. M. →

This Delta chart outlines the Delphi process using the mails to conduct each Delphi Round.

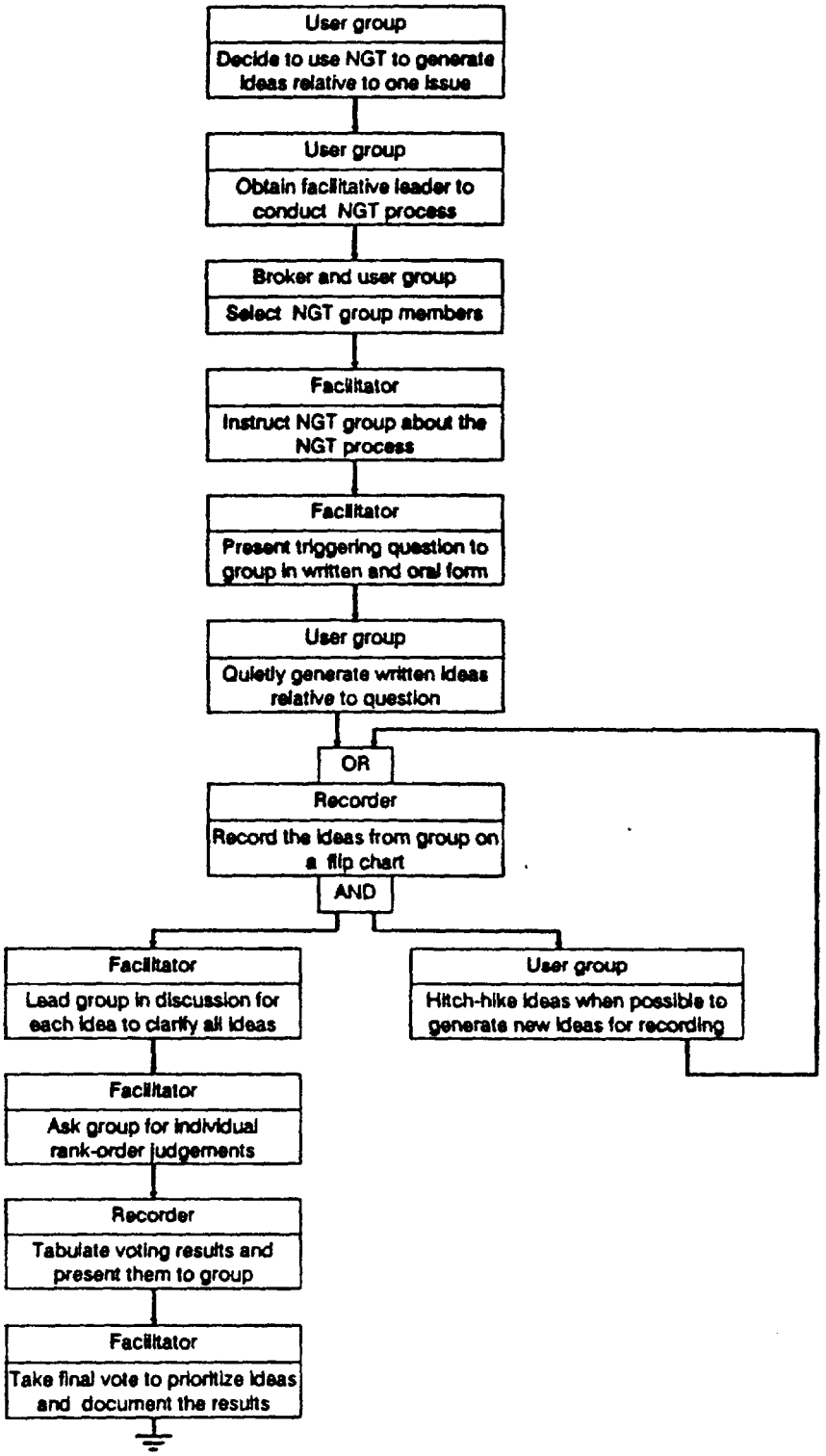
NOTES

NOMINAL GROUP TECHNIQUE

S. E. M. →

The Nominal Group Technique. Where there is a need to generate ideas, solution, etc., a group is assembled and each member of the group is asked to write down ideas on a sheet of paper. A trigger question is asked to stimulate the list of ideas each member writes. The group develops the trigger question. Then after the lists have been written each group member in turn, one by one, reads one item of his/her list. After each group member has read the first item, the process repeats. Each time the process repeats members read an item off their list as long as it has not been suggested already. The list of items is recorded on a board or somewhere where each group member can see the list as it evolves. As all the items on a members list have been presented (or already listed by another group member), and there are no more to present, the member simply passes when it is his/her turn. When all members have passed the group then rank the ideas according to relevance or usefulness. They do this individually. These rankings are then combined by a voting scheme to produce a final list of ideas ranked in order of importance.

NOTES



DELTA chart of nominal group technique. Copyright © 1982 SGSR.

S. E. M. →

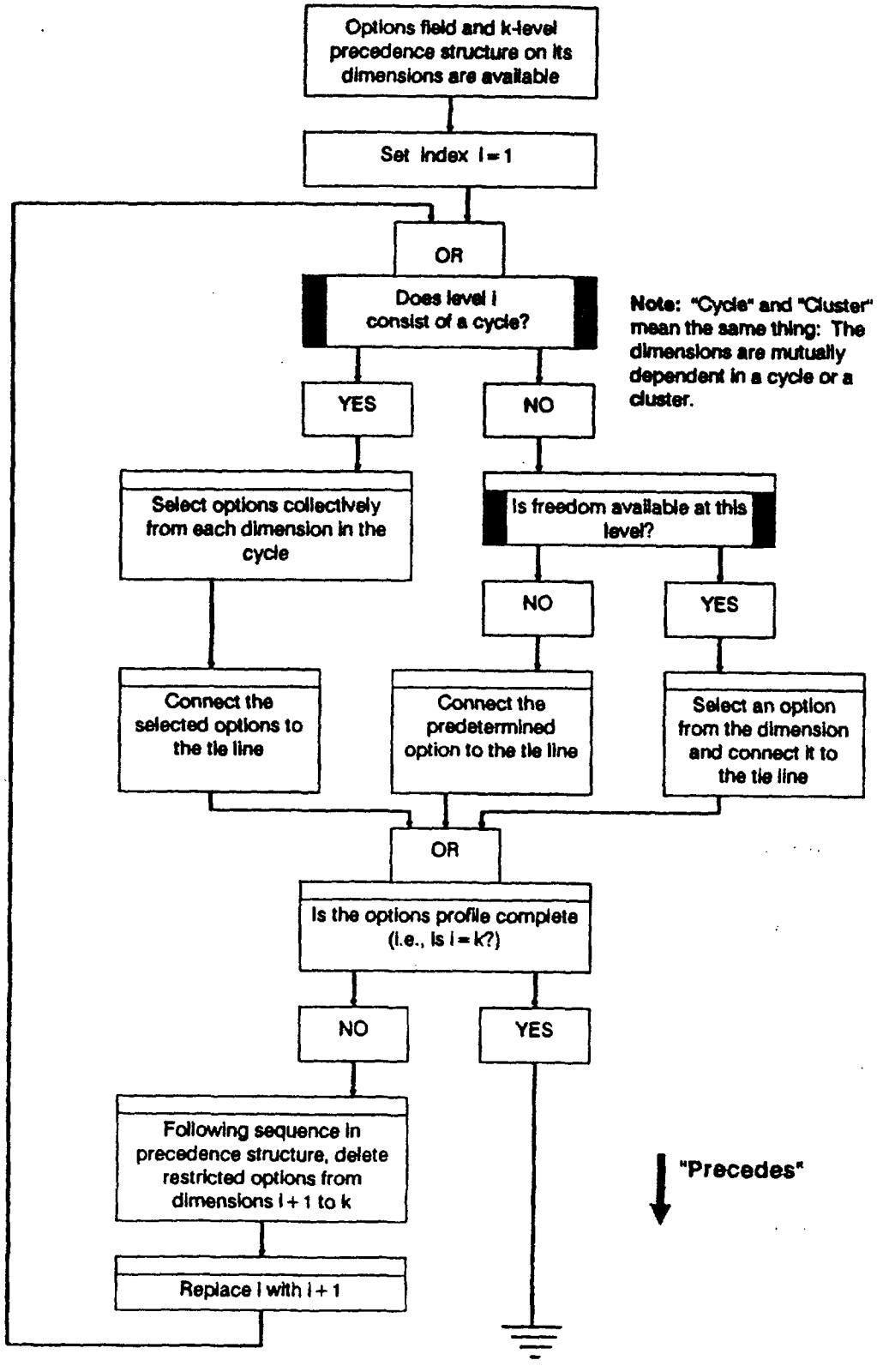
The Delta chart shown here presents the Nominal Group Technique (NGT).

NOTES

THE OPTIONS PROFILE METHOD

The Options Profile Method (OPM) is a method for developing a top down design. You must begin with an options field (which portrays all the conceived dimensions of a prospective design, includes the simple options available in each dimension, and shows the clusters of interdependent dimensions). At the conclusion of this method you end up with a specification of all of the options selected to form one alternative design. Each time process is repeated it in effect generates another new design alternative for consideration.

NOTES



DELTA chart of options profile methodology. Copyright © 1982 SGSR.

S. E. M. →

This Delta Chart Illustrates the Options Profile Method of generating alternatives.

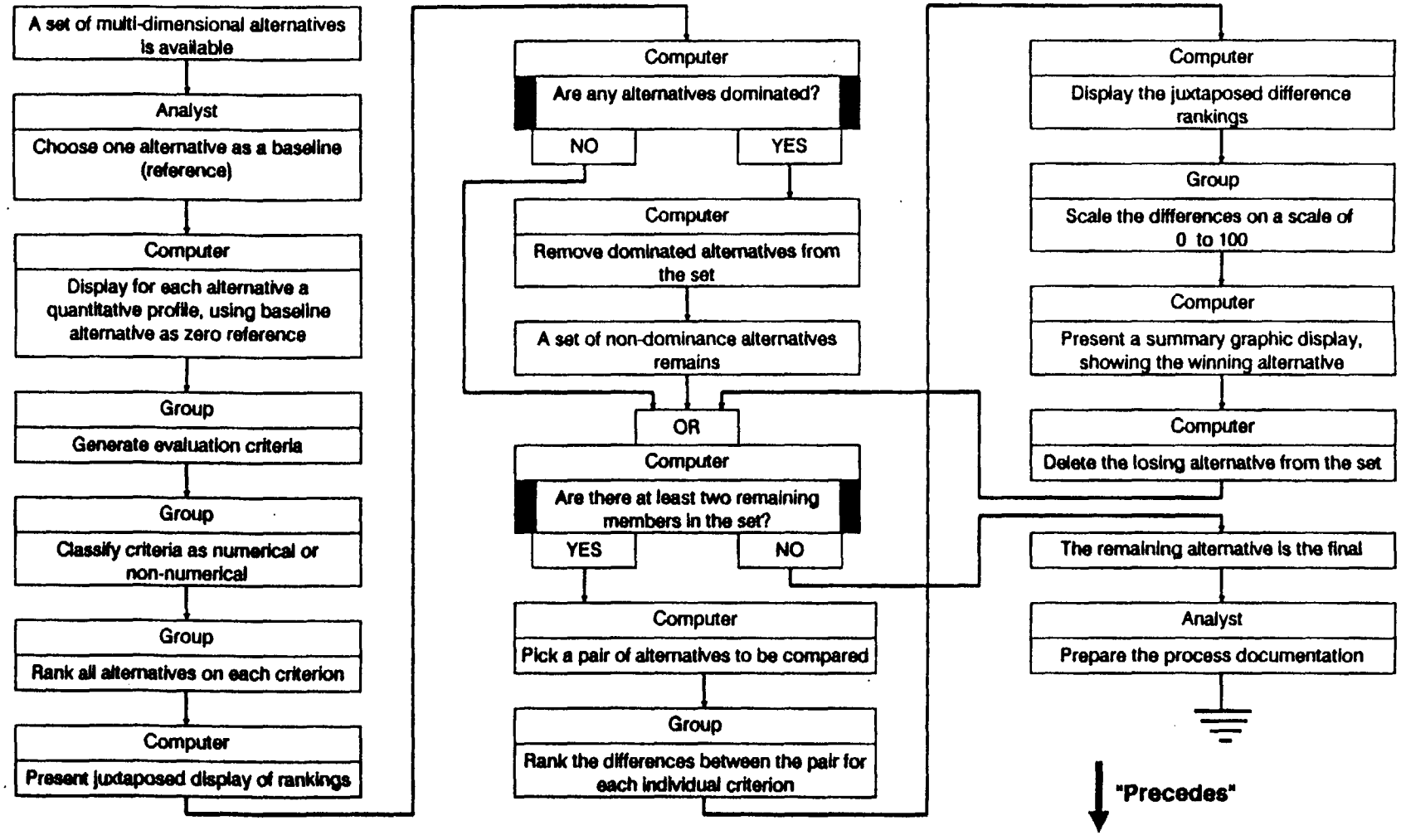
NOTES

The Trade-off Analysis Method

The Tradeoff Analysis method is a way of documenting how an alternative was selected from among a set of alternatives using tradeoffs as the basis for selection. It also shows graphically the basis for the selection. The results are easily interpreted and communicated to interested parties. This method is especially suited to situations where the decision will be a major one and involves a large and long term commitment. Often many people are involved and wish to see the basis for the decision. Also the number of alternatives is typically ten or less.

The method is well suited for governmental applications since it develops a choice through the use of a well defined technique that can involve many different interested parties. At the same time is documents the steps and procedures so that they can be retraced if desired.

NOTES



DELTA chart of tradeoff analysis. Copyright © 1982 SGSR.

S. E. M. →

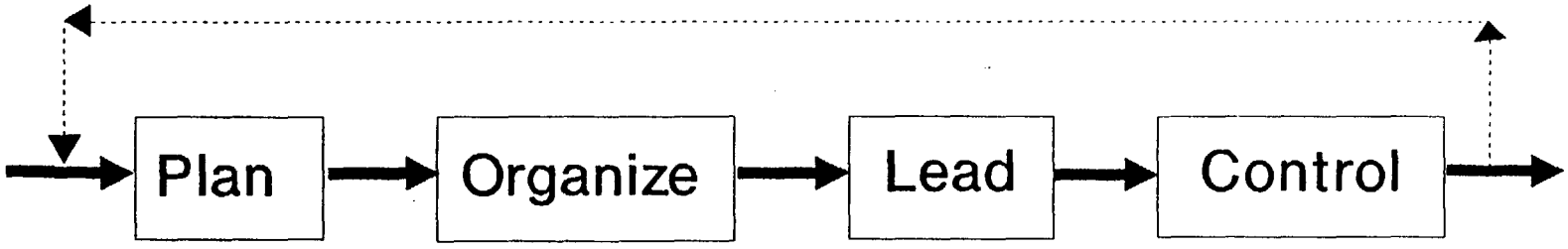
The Delta chart for the Tradeoff analysis method of alternative selection.

NOTES

"The Control Function"

Session IV

The Management Process



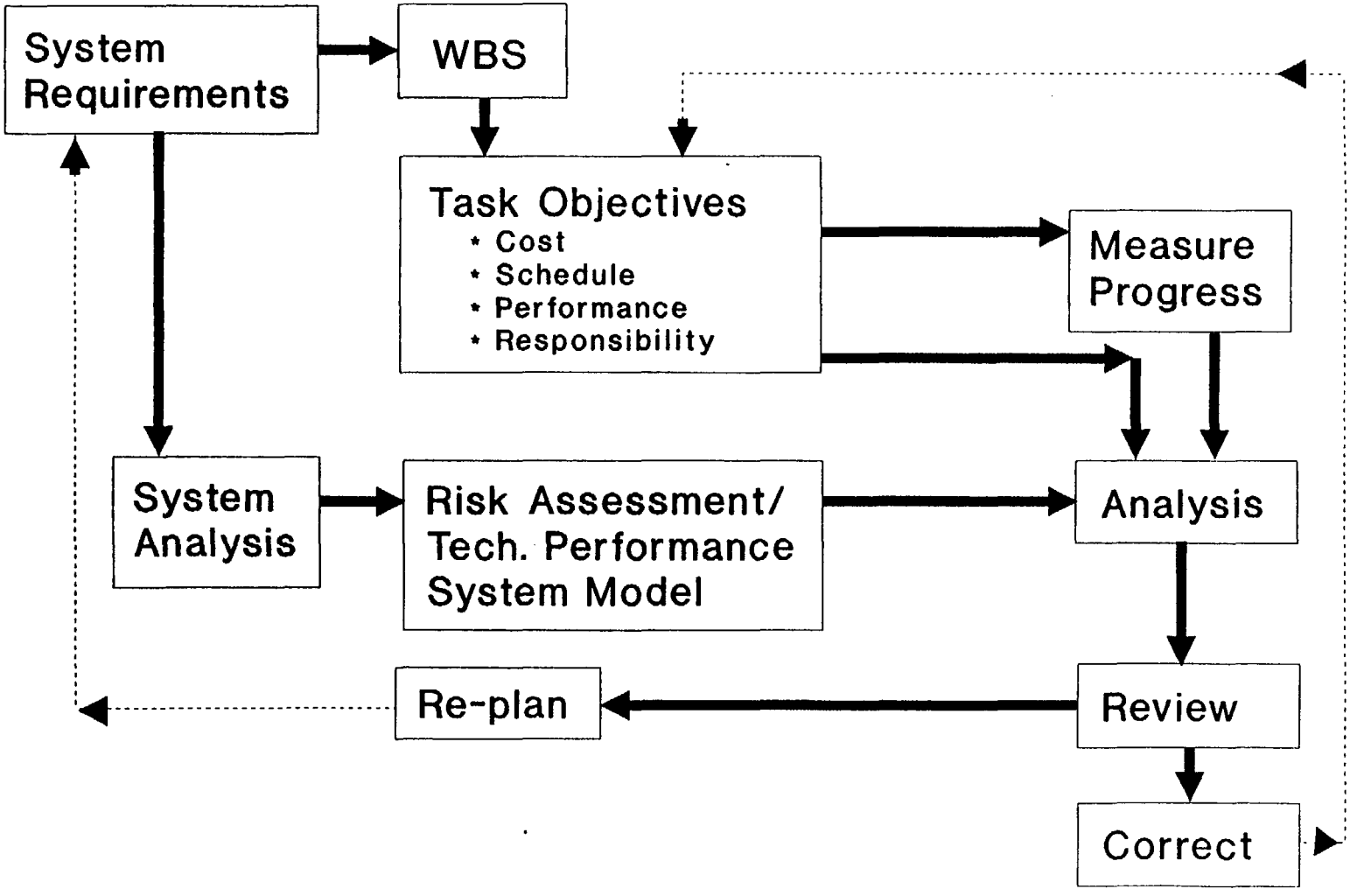
Plan	Organize	Lead	Control
* Prescribe a course of action	* Arrange & relate work for people	* Cause people to take effective action	* Measure progress & effect change
* Projections * Goals * Critical needs * Policies * Sequencing * Scheduling * Budgeting * Procedures * Specific actions	* Structure * Delegate * Operations	* Deciding * Motivating * Communicating * Staffing * Developing	* Criteria * Sampling * Analysis * Replan * Correcting

THE CONTROL FUNCTION

NOTES

The functional flow for the management process is shown again to put the control activities in context. Note that the purpose of control is not only to measure progress against the plan but also to effect change. The simple feedback loop shown to return to the beginning to cause changes in the whole process. In reality changes may be required in planning, organization and/or motivating and even in the control function itself. Changes may be indicated not only because of a deviation of performance from plans but also because of external or exogenous changes.

The Control Process



THE CONTROL PROCESS

NOTES

The control aspect is here shown as a process. The system requirements and functional analysis led to the work breakdown structure/ requirements allocation which led to the definition of work packages. We will look at how accomplishments against the allocated requirements in the form of work packages are measured.

Neither the program plan nor other segments of the program or system are static. As results come in the actual performance will be different from the planned and the overall system requirements may change so that continuing analysis will be necessary. The program and the system will be dynamic, especially during the early stages. As the program matures, changes become more pervasive and expensive. The tracking system mentioned earlier and the relational data base structure become increasingly important as the program and system become larger and more complex.

MANAGEMENT REVIEW AND CONTROL

PROJECT MANAGEMENT

- SETS POLICY AND DIRECTION
- IDENTIFIES PROGRAM ISSUES
  - COMPETITIVE POSTURE
  - CUSTOMER RELATIONS
  - PROGRAM ALTERNATIVES
  - INTERBRANCH COORDINATION
  - CORPORATE POLICY
- ASSIGNS RESPONSIBILITY FOR PROGRAM GOALS
- ALLOCATES RESOURCES
  - PERSONNEL
  - FACILITIES
  - BUDGETS
- CONTROLS TEAMING AND SUBCONTRACTING ACTIVITIES
- EVALUATES IMPACT OF RISKS ON PROGRAM COMMITMENTS
- INTEGRATES PROGRAM DEFINITION

SYSTEM ENGINEERING MANAGEMENT

- DEVELOPS REQUIREMENTS
- IDENTIFIES TECHNICAL ISSUES
  - PERFORMANCE
  - EFFECTIVENESS CRITERIA
  - ACCEPTABLE LEVELS OF RISK
- DEFINES TASKS
  - ANALYSES
  - TRADE STUDIES
  - RISK ASSESSMENT
- ALLOCATES COST TARGETS
  - DESIGN-TO-COST
  - LIFE CYCLE COST
- TRACKS PERFORMANCE, COST, AND SCHEDULE ACHIEVEMENT
- EVALUATES IMPACT OF RISKS ON OPERABILITY, CAPABILITY, COST, AND SCHEDULE
- INTEGRATES SYSTEM DEFINITION

REVIEW AND CONTROL

NOTES

Project Management responsibilities and the subordinate SEM responsibilities are listed here. The task of tracking performance is listed but from the previous discussions we realize that this is a shared responsibility with other organizational entities and in a sub-functional sense also.

FORMAL PROCEDURES

- SCHEDULE
  - NETWORKS
- COST
  - VARIANCE REPORTS
- PERFORMANCE
  - TRACKING
- REVIEWS & REPORTS
- C/SCS
- TRADE-OFF STUDIES
  CONTINGENCY ANALYSIS
  SENSITIVITY
- CONFIGURATION ~ MATERIAL
  ~ DOCUMENT ~ STANDARD

FORMAL PROCEDURES

NOTES

There are several well developed, formal control measurement procedures to adapt to any project. The major categories in which measurements will be made are Cost, Schedule and Performance. In addition there should be controls on such things as functional descriptions, requirements allocations, work breakdown structures and work packages, schedules, specifications, subcontracts, standards, materials, documents, drawings and their releases, even the control process itself should be subject to control. The general process for accomplishing the latter controls is known as configuration management.

Imagine a large program involving thousands of people and hundreds of sub-contractors working in many, geographically dispersed locations on tasks and products that must come together in form, fit, function, place and time to form a system or sub-system. If changes and deviations are allowed to happen in a "helter - skelter" manner, **CHAOS** will reign in short order. Means of measurement and control will be discussed in the following.

NETWORK SCHEDULING

ADVANTAGES:

- CRITICAL ACTIVITIES ≈ 10%
- COORDINATING & INTEGRATING DEVICE
- 5 - 20% TIME SAVED. ?? COST SAVED

SHORTCOMINGS:

- REALISM IN R&D
- GAMESMANSHIP
- COST ~ 0.2 TO 2% OF PROJECT COST
- ACCEPTANCE
- UPDATING

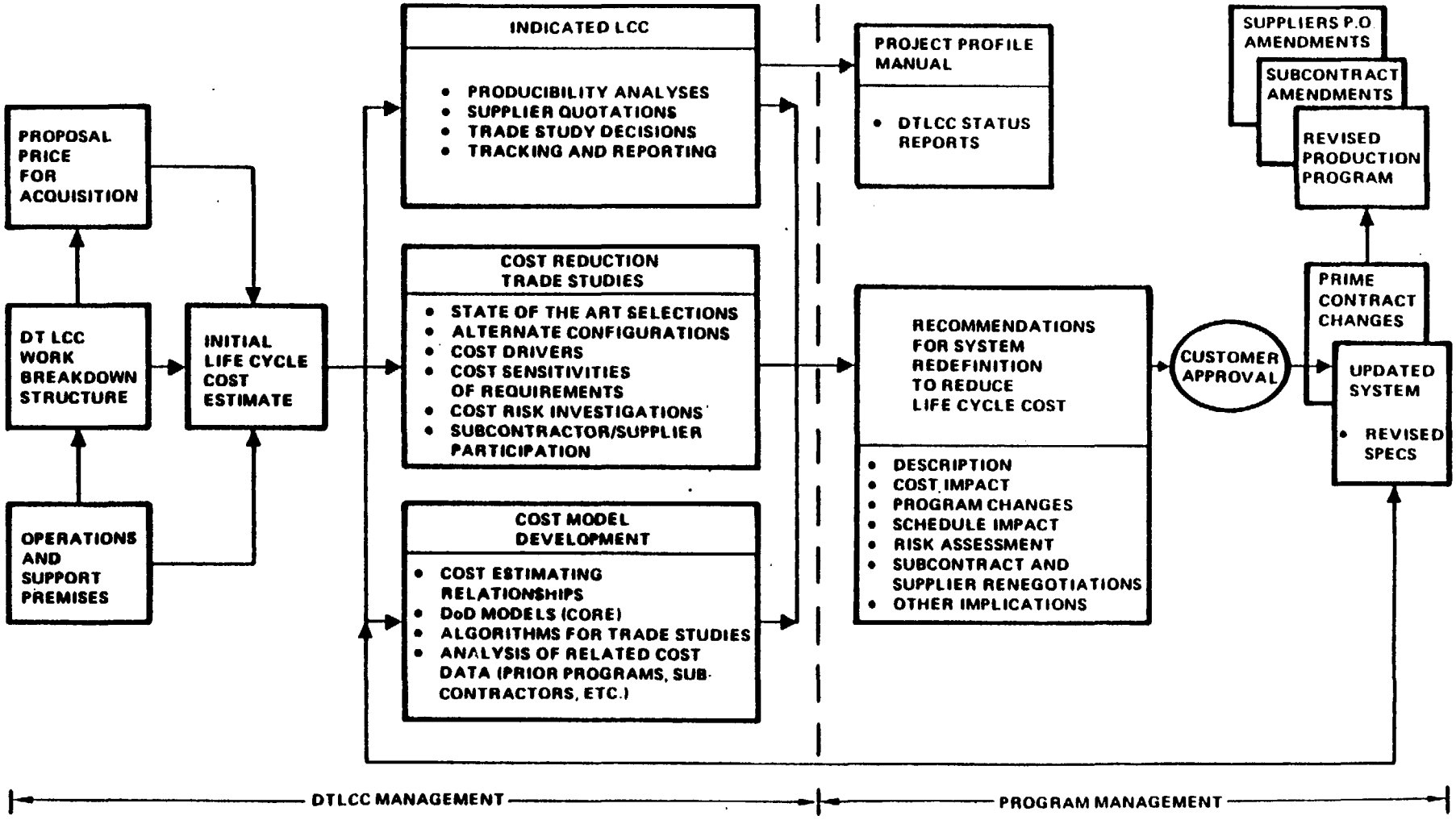
SCHEDULE TRACKING

Smaller programs may use Gantt charts or variations of them which show resource expenditures by work package or activity and by time period along with some indications of parallel and series activities. As projects get larger and more complex, PERT, Program Evaluation and Review Technique or CPM, Critical Path Method type scheduling procedures and extensions incorporating cost and performance will be employed. The accompanying chart shows some advantages and disadvantages to the application of such methods.

Regular reporting and adjustment is required to realize the benefits. Several sets of limits are generally established so that operative units have some flexibility in schedule and so that higher levels of supervision are alerted only when more serious violations of the schedule (or any part of the plan) are being violated.

NOTES

THE DESIGN-TO-LIFE-CYCLE-COST PROCESS



LIFE CYCLE COST CONTROL

The cost section of the plans requirements allocation can be further divided into the costs of each element, subsystem, etc., by phases in its life cycle (design, production, integration, maintenance and repair, phase out and salvage) to provide a life cycle cost projection. Then variations from the plan at any stage can be evaluated in terms of life cycle totals.

Specific work packages can be tracked for timed cost expenditures in much the same way and with the same general tracking and reporting limits as in the case of schedules.

Performance Measurement Basic Parameters

* BCWS - Budgeted Cost of Work Scheduled
* BCWP - Budgeted Cost of Work Performed
  (Earned Value)
* ACWP - Actual Cost of Work Performed
* BAC - Budget At Completion
* EAC - Estimate At Completion

BASIC PARAMETERS

NOTES

The opposing chart lists the terms used in the well developed C/SCS, COST/SCHEDULE Control System.

VARIANCES

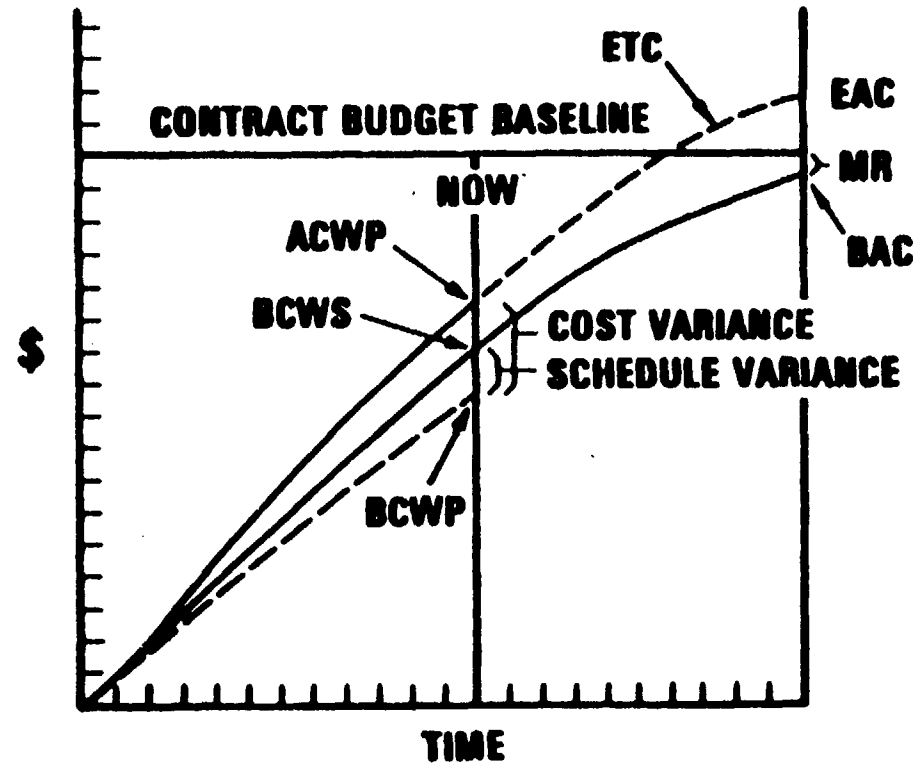
- Cost variance (CV) = BCWP—ACWP
- Schedule variance (SV) = BCWP—BCWS
- Cost variance (%) $= \frac{BCWP - ACWP}{BCWP} \times 100$
- Schedule variance (%) $= \frac{BCWP - BCWS}{BCWS} \times 100$

VARIANCES

The major cost and schedule variances, both in dollar terms, are defined here. Cost variance (CV) is the difference between the budgeted cost of the work performed (BCWP, the earned value) and the actual cost of the work performed (ACWP). Schedule variance (SV) is the difference between the BCWP and the budgeted cost of the work scheduled (BCWS).

NOTES

PERFORMANCE MEASUREMENT DATA



S. E. M. →

C/SCS MEASUREMENT DATA

The preceding terms and some others are shown on the diagram.

NOTES

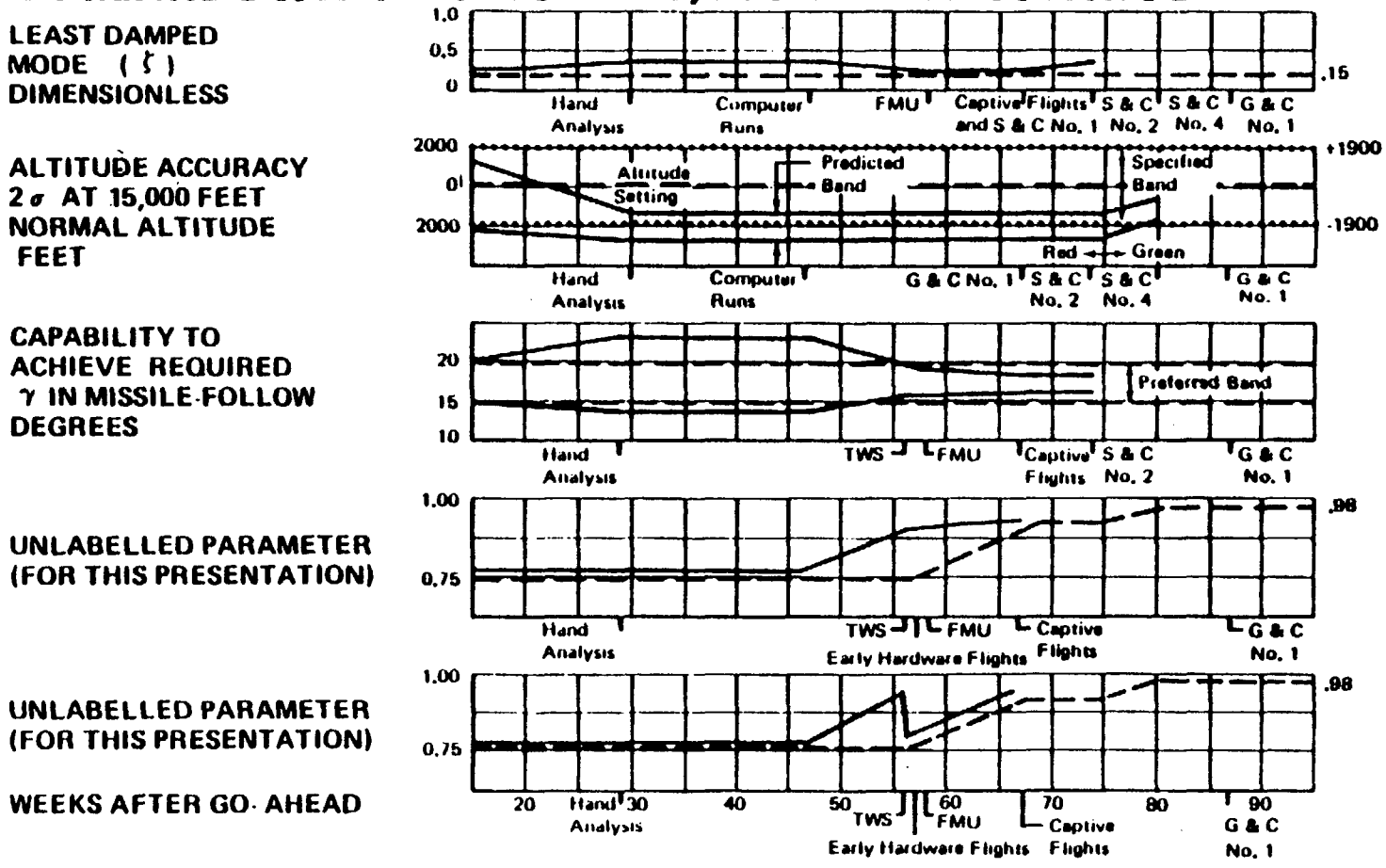
* ETC - EXPECTED TOTAL COST

* MR - MANAGEMENT RESERVE

The project depicted is in questionable shape with both cost and schedule variances being negative. This shows up in an ETC which exceeds the budgeted cost at completion and the contract budget baseline.

TECHNICAL PERFORMANCE TRACKING REPORT (SAMPLE PAGE)

WORK BREAKDOWN STRUCTURE 13,000 FLIGHT CONTROL



SYMBOLS

Specified or Firm Limits — — — —

Allocated or Flexible Limits • • • • • • • • • • • •

NOTE 1: Associated PERT Numbers Have Been Assigned to Each Verification Event.

NOTE 2: These TPT Parmeters Are on the Tap, but Are too Detailed for the Executive Tap.

TECHNICAL PERFORMANCE TRACKING

NOTES

Requirement allocations and work package specifications can have many stipulations. An actual record, now over twenty years old (to indicate how long such things have been in practice) is shown for a missile flight control system. Actual performance, measured or estimated, at each progressive stage of development is shown by the solid line. Specified limits and design goals are also shown.

Unlike cost and time expenditures which are additive in their impact on the program and system, performance measures must be combined in the mission analysis models discussed earlier in order to evaluate their effect on system and mission performance. For instance, a dollar saved on one work package can go directly toward a dollar over spent on another. But, a deficiency in the accuracy of a navigation sub-system, for example is not directly tradeable for an increase in vehicle range.

The Work Package - Contract

Spells out: Cost

Schedule

Performance

Trades

Through

Incentives, Penalties, Share Agreements, etc.

THE CONTRACT

In effect, the contract to a major or minor contractor provides the basis for trading off the performances in cost, schedule and technical achievement through the specification of penalties, incentives and share proportions for variations from specifications. Internal work packages are similarly evaluated by the program manager's system and program analysis model. In this manner a slip in schedule requiring more funds for make-up can be evaluated versus spending the same funds to improve an item of technical performance. The importance of relating the detailed requirement allocations to overall system performance and value to the mission is apparent.

NOTES

Other Control Procedures

* Document Specs & Control
* Material Review Board
* Standardization Control
* Change Control Board
*
*
*

OTHER CONTROL PROCEDURES

It is necessary to establish what are generally called "Baselines" or fixed descriptions of critical sections of the program or system so that everyone will be working on the same system. Change control boards review the proposed changes from the baseline and issue revisions on a periodic or an as-needed basis.

NOTES

SYSTEM ENGINEERING MANAGEMENT PLAN
PART I

TECHNICAL PROGRAM PLANNING AND CONTROL

- Organization and assignment of responsibility
- Contract work breakdown structure and specification tree
- Program risk analysis
- System test planning
- Decision and control process for engineering program integration
- Technical performance measurement
  - Parameters
  - Planning
  - Implementation
  - Relation to cost and schedule performance measurement
- Technical reviews
  - Requirements (functional baseline)
  - System design (allocated baseline)
  - Preliminary design
  - Critical design (product baseline)
- Subcontractor/vendor reviews
- Interface control
- Work authorization
- Documentation control

SEM PLAN

In many programs a System Engineering Management Plan (SEMP) is issued. It can consist of both a technical or product part as shown here and the system engineering process definition, shown on the following charts. Obviously, the plan becomes more detailed and complete as the program grows and matures. The particular program dictates the specific contents and emphasis. This generalized plan outline is used here to summarize the subjects addressed in this course.

NOTES

SYSTEM ENGINEERING MANAGEMENT PLAN
PART II

SYSTEM ENGINEERING PROCESS

- **MISSION REQUIREMENTS ANALYSIS**

OPERATIONAL CHARACTERISTICS MISSION OBJECTIVES THREAT ENVIRONMENTAL FACTORS MINIMUM ACCEPTABLE FUNCTIONS TECHNICAL PERFORMANCE FIGURES OF MERIT	↔	VALIDITY CONSISTENCY DESIRABILITY & AFFORDABILITY ATTAINABLE TECHNOLOGY RESOURCES HUMAN PERFORMANCE LIFE CYCLE COSTS

- **FUNCTIONAL ANALYSIS**

FUNCTIONAL REQUIREMENTS ALTERNATIVES TIME CRITICAL FUNCTIONS PERFORMANCE CRITERIA	↔	MISSION DEVELOPMENT AND TEST PRODUCTION DEPLOYMENT SUPPORT

- **ALLOCATION**

PERFORMANCE AND DESIGN REQUIREMENTS ALLOCATED TO — HARDWARE — COMPUTER PROGRAMS — DATA — FACILITIES — PERSONNEL	↔	TRADE STUDIES EFFECTIVENESS ANALYSES LIFE CYCLE COST RISK ASSESSMENT TIME LINE ANALYSES LOGISTIC SUPPORT ANALYSES

SYSTEM ENGINEERING PROCESS I

NOTES

Mission Requirements Analysis, Functional Analysis and Allocation were stressed in this course. They have direct counterparts in the product process and are also the steps being undertaken by CNWRA, as they will be presenting to you in their course which follows. The steps in the process are highly iterative and do not follow the linear progression indicated on these charts.

SYSTEM ENGINEERING MANAGEMENT PLAN
PART II

SYSTEM ENGINEERING PROCESS

- **SYNTHESIS**

CHOSEN SYSTEM CONFIGURATION PERFORMANCE DEVELOPMENT AND TEST PLANS OPERATIONAL CONCEPT	⟷	SPECIFICATIONS INTERFACE CONTROL DEVELOPMENT AND OPERATIONAL RESOURCES DATA

- **LOGISTIC ENGINEERING**

LOGISTIC SUPPORT ANALYSES — MAINTENANCE — REPAIR LEVELS — SUPPORT MODELS SUPPORT EQUIPMENT TRAINING EQUIPMENT	⟷	PERSONNEL REQUIREMENTS SPARES AND PROVISIONS TRAINING CONCEPTS FACILITIES REQUIREMENT FIELD SERVICE TECHNICAL DATA

- **LIFE CYCLE COST ANALYSIS**

DEVELOPMENT AND TEST PRODUCTION AND DEPLOYMENT OPERATIONS AND SUPPORT	⟷	WBS BREAKDOWNS FUNCTIONAL BREAKDOWNS DESIGN-TO-COST TARGETS

SYSTEM ENGINEERING PROCESS II

NOTES

The synthesis procedure which defines the program/product architecture, test and operational procedures is indicated. The system support functions are considered under the heading of "Logistics". And, in any system the overall costs are important to the program, the system and the situation that encompasses them all, the environment.

SYSTEM ENGINEERING MANAGEMENT PLAN PART II

SYSTEM ENGINEERING PROCESS

- **RISK MANAGEMENT**

ASSESSMENT CONSEQUENCES PROGRAM RESOURCES AND PLANS	↔	TEST AND EVALUATION PLAN TECHNOLOGY ALTERNATIVES UTILITY VALUES PROBABILITY OF SUCCESS MODEL

- **OPTIMIZATION**

TRADE-OFF STUDIES — REQUIREMENTS — CONFIGURATIONS — PROGRAM PREMISES SYSTEM/COST EFFECTIVENESS EFFECTIVENESS ANALYSES	↔	LIFE CYCLE COST MEASURES OF EFFECTIVENESS FIGURES OF MERIT RISK ASSESSMENT LOGISTICS ASSESSMENT REQUIREMENTS AND CONSTRAINTS

- **PRODUCTION ENGINEERING ANALYSIS**

PRODUCIBILITY TOOLING FACILITIES MATERIALS AND PROCESSES	↔	LONG-LEAD ITEMS MAKE OR BUY GOVERNMENT FURNISHED ITEMS QUALITY ASSURANCE FACILITIES AND MANUFACTURING CONSTRAINTS HIGH RISK PROCESSES

- **GENERATION OF SPECIFICATIONS**

SYSTEM SPECS ITEM SPECS INTERFACE CONTROL SPECS	↔	MILITARY SPECS AND STANDARDS COMMERCIAL SPECS STANDARDIZATION CONFIGURATION MANAGEMENT

SYSTEM ENGINEERING PROCESS III

NOTES

This course has not addressed the analyses that support the SEM process in detail. There is a sizeable and growing array of such analysis methods which can be very helpful in the Risk Management and Optimization considerations. Your specific program should define which of these will be useful. Because of the nature of NRC's concerns, as we understand them, some aspects of a full-blown SEM process have only been listed.

Unknowns That Plague Programs

	Unknowns	Assurances
Goals	* Will the goals satisfy the need? * Are they the best ones?	* Threat analyses * Cost and schedule credibility
Technical Factors	* Can the State-of-the-art technology achieve the goals? * Are all the requirements known?	* paper studies * Design reviews * Focused RDTE * Model tests * Prototyping * Test & evaluation
Internal Program Factors	* Can program plan and strategy meet the goals?	* Resources - Manpower skills - time - Facilities * Program strategy * Contingency planning
External Processes	* Will outside influences jeopardize the program? * will the system become obsolete before its time?	* Changing threat * Technological Obsolescence * Political Decisions * Funding changes

UNKNOWNS

Every program contains unresolved questions, undefined or unresolved issues, unknowns to be treated in the progress of the program. The unknowns that will be uncovered by analysis have been referred to as Known-Unknowns, unknowns that can be planned for or around.

The more worrisome occurrences are the events and developments that were not foreseen which have a large impact on the program or the system. These have been derisively called Unknown-Unknowns or "Unk-Unks". A study of the history of past programs can provide some direction in dealing with these when they will surely occur.

NOTES

ESSENTIAL CHARACTERISTICS OF AN EFFECTIVE SYSTEM ENGINEERING PROCESS

- PROVIDE A COMMONLY UNDERSTOOD COMMUNICATION SYSTEM TO DESCRIBE TOTAL SYSTEM AND END ITEM DESIGN AND DEVELOPMENT REQUIREMENTS.
- GIVE A CLEAR UNDERSTANDING OF ALL SYSTEM COMPONENT FUNCTIONAL INTERRELATIONSHIPS.
- INCREASE ASSURANCE THAT ALL SYSTEM REQUIREMENTS ARE IDENTIFIED AND MET IN COMPONENT DESIGNS.
- FACILITATE TRADE-OFF OF ALTERNATIVE DESIGN SOLUTIONS ON A TOTAL SYSTEM BASIS. DEFINE CRITERIA FOR SUCCESSFUL VERIFICATION OF SYSTEM PERFORMANCE.

AN EFFECTIVE SEM PROCESS

NOTES

Dr. Wilton Chase (Ref.19,Sect.B) lists some of the benefits of an effective SEM process above. We would emphasize the following for the application to the NRC program.

* **Provide traceability from regulatory requirements to overall system objectives.**

* **Provide for a program memory which is so important in investigations and in providing information to support future changes and decision making.**

OVERALL SUMMARY

SYSTEM EVALUATION, CHANGE CONTROL, AND THE LICENSING PROCESS ALL ARE AMENABLE TO SYSTEM ENGINEERING METHODS

SYSTEM ENGINEERING IS AN AID TO GOOD PROJECT MANAGEMENT, NOT A SUBSTITUTE FOR IT

ALL MEMBERS OF THE PROJECT TEAM SHOULD BE TRAINED IN WHAT SYSTEM ENGINEERING IS AND HOW TO USE ITS METHODS IN THEIR WORK

OVERALL SUMMARY

Over the period of the last two days we hope we have explained enough of the System Engineering Management process so that you can apply some of the procedures and more importantly the underlying thinking to your programs. This, however, is SEM 101 and we could only get through the first layer or top level. There is much, much more that has been developed and that is available.

Although the SEM process had its beginnings in "hard" systems and the DOD, it has been adapted and used in construction, space programs, other government departments, computer and information system applications and business in general, wherever large, complex, open systems are being developed.

The SEM process is the best developed, accepted and most complete and useful process of its kind. It is however an aid to and not a substitute for Program/Project management.

Extensive individual and group education and training as well as judicial selection of the procedures and specific methods of System(s) Engineering Management to use in your programs must be accomplished.

NOTES

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SYSTEMATIC REGULATORY ANALYSIS
A BASIC COURSE

Presented to the

NUCLEAR REGULATORY COMMISSION

NRC

by

THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

CNWRA

By: D. T. Romine
P. C. Mackin

JUNE 1991

SYSTEMATIC REGULATORY ANALYSIS

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A BASIC COURSE

CONTENTS

FIRST DAY

- INTRODUCTION
- REVIEW OF SYSTEMS ENGINEERING MANAGEMENT TRAINING
- WHY APPLY SYSTEM ENGINEERING TO THE REGULATORY PROCESS?
- DO-IT-YOURSELF REPOSITORY LICENSING
- DEFINING SRA
- THE BASIC STRUCTURE OF SRA
- CONCERNS ABOUT SRA
- SUMMARY AND CONCLUSION

SECOND DAY

- COMPLIANCE DETERMINATION STRATEGY (CDS) DEVELOPMENT

INTRODUCTION

PURPOSE

- ANSWER THE QUESTIONS:
  - WHAT IS SYSTEMS ENGINEERING?
  - WHO DOES IT?
  - HOW IS IT PERFORMED FOR A REGULATORY PROGRAM?
  - HOW IS IT LIMITED AND CONTROLLED?
  - HOW ARE THE RESULTS APPLIED?
  - WHAT DO WE DO NEXT?
- PROMOTE STAFF INVOLVEMENT/FEEDBACK

INTRODUCTION
(CONT'D)

GENERAL APPROACH

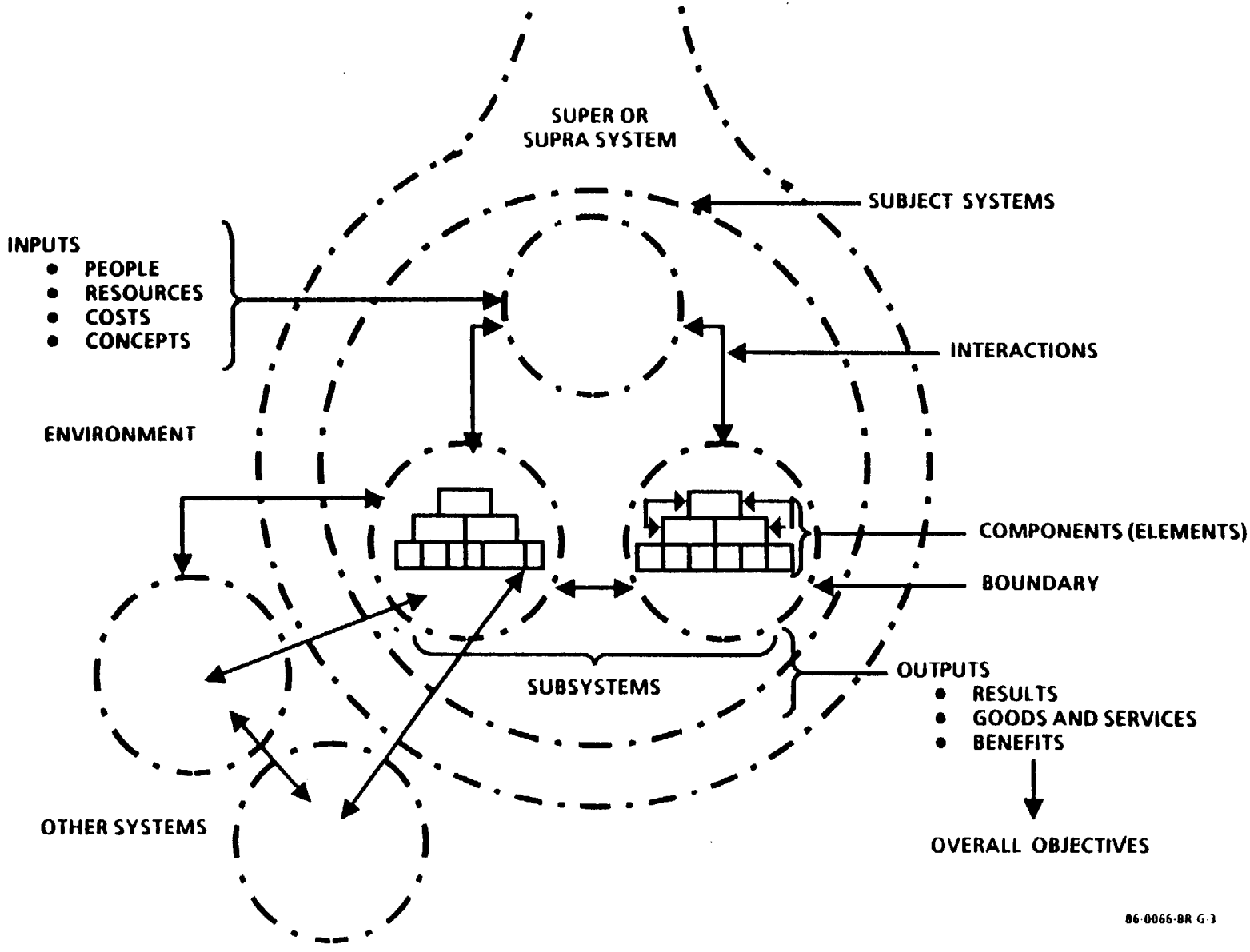
- DEVELOP GENERAL UNDERSTANDING OF SYSTEMS ENGINEERING
  - DOE IS USING SYSTEMS ENGINEERING MANAGEMENT
  - THE STAFF MUST UNDERSTAND IN ORDER TO INTERACT
- DEVELOP GENERAL UNDERSTANDING OF SRA
  - NEED AND NATURE
  - STRUCTURE AND RELATIONSHIPS (I.E., WHAT IT <u>IS</u>)
  - CONCERNS (I.E., WHAT IT IS <u>NOT</u>)
- DEVELOP UNDERSTANDING OF SRA SPECIFICS NEEDED FOR NEXT STEP

REVIEW OF SYSTEM ENGINEERING

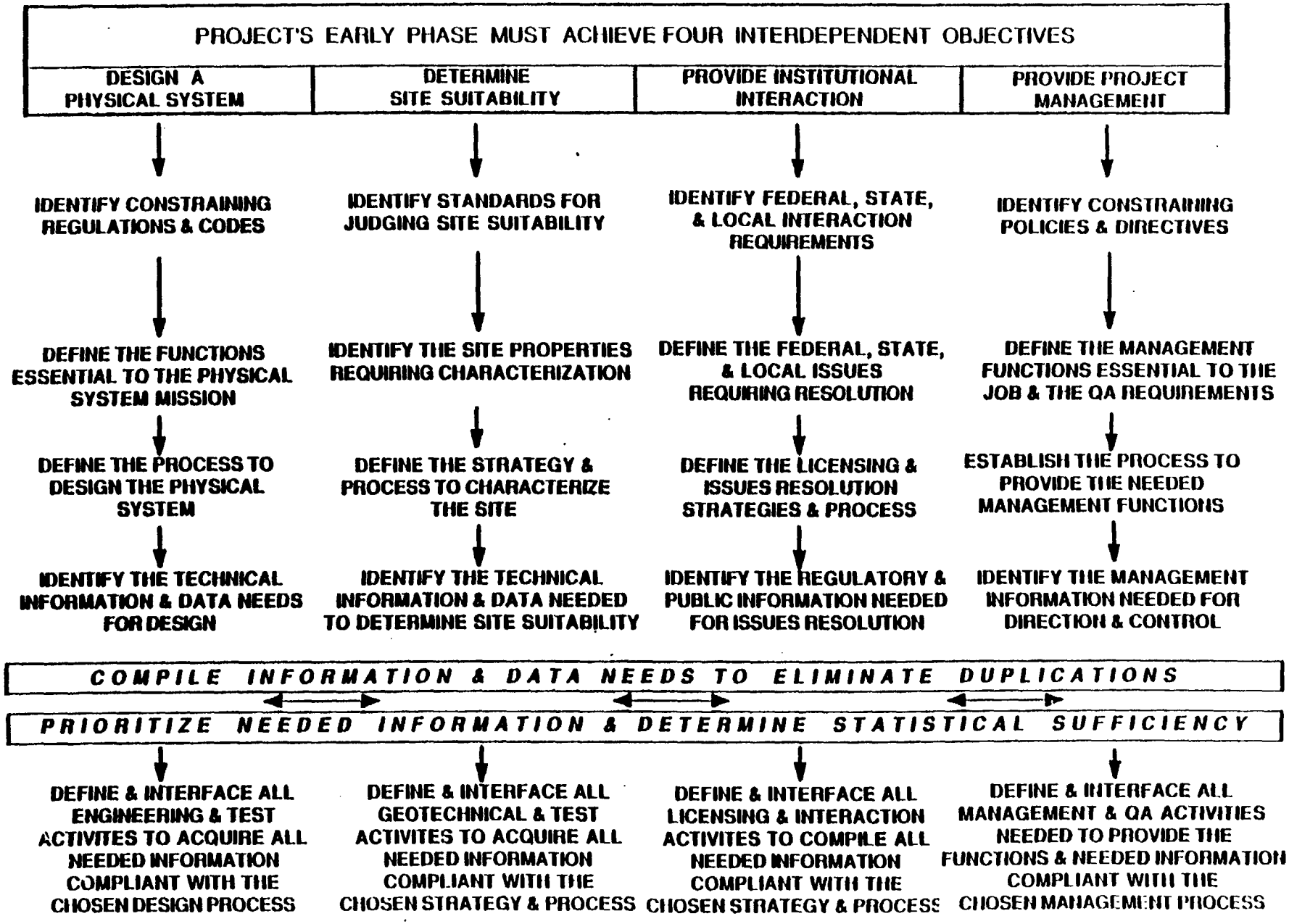
MANAGEMENT TRAINING

A SYSTEM PERSPECTIVE

THE SYSTEMS APPROACH



SYSTEMS APPROACH TO A HYPOTHETICAL NUCLEAR PROJECT



Technological Systems

- Class A: Systems Found in Physical Science
- Class B: Intellectual Technology (or products of Artificial Intelligence)
- Class C: Mix of Class A and Class B Systems

Performance of Class A Systems Can Be Described and Predicted

- (Physical scientists and engineers have primary standards as external referents)

Class B and Class C Systems Lack such referents.

- Length (made meaningfull by the existence of a primary standard of length)
- Time (made meaningful by the existence of a primary standard of time)
- Social Justice, Adequaate Safeguards to Assure Nuclear Power Safety (lack reliable and universal meaning. With no primary standards they are open to arbitrary and diverse interpretation)

Systems are Growing Progressively Large in Scale

Growing from Class C Technological Systems to Sociotechnical Systems

These systems have "design flaws" which are producing:

- loss of life
- contamination of the environment due to "accidents"
- mammoth cost overruns
- criminal behavior in enterprises causing financial setbacks to many people
- transportation "accidents"
- huge loans that cannot be repaid
- erosion of confidence in organizations

These Systems Are Large Scale

- numbers of people
- extent of influence of the system
- extent of the complexity of the system
- volume of information required to describe what is happening in the system
- number of interactions among system components
- the risk of disaster
- the extent of the consequences of failure of the system

The Nuclear Waste Repository

* Unique and Complex

* first of its kind (no prototypes. Design, build and turn on)

* Reasonable Assurance that safe waste isolation can be provided for 10,000 years (No external primary standard)

* Unprecedented oversight and control by various affected and interested parties

* Estimates that waste released at Cherynobl will cause 17,000 to 475,000 deaths worry people

* Repository will store 70,000 metric tons of heavy metal or equivalent. (This is more than has ever been assembled in one place before

* Will require stainless steel to last for 1,000 years (it's only been around for 50 years or so)

Large Scale Systems Have Special Needs

The Engineering (planning and design) and Management (control) are dependent upon the quality of human thought

All large scale systems involve problems and approaches that require thinking that is not aligned with "traditional", discipline oriented thought.

- Traditional Disciplines organize knowledge in "vertical slices" ("stovepipes")
- Complex problems and design tasks require knowledge to be applied "horizontally" across and beyond disciplines.

Current Situation

Engineering Disciplines that identify with products they create

- Aero, Bio, Computer, Mining, Nuclear, Petroleum, Paper, Software, etc.

Engineering Disciplines that identify with services they provide

- Logistics, Reliability, Safety, Test, Human Factors, Environmental, etc.

In a Nutshell

At the same time that systems are becoming larger and more complex

disciplines are becoming narrower and more specialized

Assessment

- 100 years ago a single engineer was responsible to conceive, design, and develop and even operate a simple engineering product

- 50 years ago it took a team of engineers to accomplish same task (but a chief engineer could still understand all the needed technologies)

- Today's situation

  - engineering product includes hardware, software, complex human and organizational interfaces

  - products can alter that global environment

  - systems are so complex that engineering teams involve many different organizations, located in different parts of the nation/world

  - a single individual cannot comprehend the whole system in any detail and it is impossible to check the work of team members without doing as much work as they have done and possessing their specialty skills

THE SYSTEMS PROBLEM AND THE SYSTEMS SOLUTION

The Problem:

- The greatest single concern is to find a way to bring large scale systems within the purview of the human mind.

The Solution:

- Systems Engineering and Systems Engineering Management

SYSTEMS INTEGRATION

Systems Engineering can integrate the technical aspects of systems (form, fit, function)

Systems Engineering can integrate the human side of systems

How do Systems Engineers integrate the work of those disciplinary, engineering and scientific specialists involved in planning and designing the technical and human aspects of systems?

STEP 1 REGULATORY TEXT (RT)
- THE QUESTIONS ARE REGULATORY AND INSTITUTIONAL UNCERTAINTIES (UN)

STEP 2 REGULATORY REQUIREMENT (RR)

STEP 3 REGULATORY ELEMENTS OF PROOF (REOP) AND REGULATORY ELEMENTS OF PROOF SET (PS)
- THE QUESTIONS ARE REGULATORY UNCERTAINTIES (UN)

STEP 4 COMPLIANCE DETERMINATION STRATEGY (CDS)

STEP 5 TECHNICAL REVIEW COMPONENT (TRC) AND TRC SET (TS)

STEP 6 COMPLIANCE DETERMINATION METHOD (CDM)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

WHY APPLY SYSTEM ENGINEERING TO THE REGULATORY PROCESS?

WHAT IS SYSTEM ENGINEERING?

PRIMARILY, IT IS A WAY OF THINKING

- TOTAL SYSTEM PERSPECTIVE
  - INTERFACES AND INTERACTIONS WITHIN THE SYSTEM AND WITH ITS OPERATING ENVIRONMENT
- TOTAL PROGRAM PERSPECTIVE
  - INTEGRATION OF THE WORK OF THE VARIOUS TECHNICAL DISCIPLINES ("STOVEPIPES")

THE OBJECTIVE, ALWAYS, IS TO DEVELOP THE MOST EFFECTIVE WAY TO SUCCESSFULLY PERFORM THE ASSIGNED JOB

WHAT IS SYSTEM ENGINEERING?
(CONT'D)

IT IS ALSO A SET OF TOOLS;

FOR EXAMPLE,

- METHODS OF ANALYSIS EVOLVED FROM THE BEGINNINGS OF INDUSTRIAL ENGINEERING
- OPERATIONS ANALYSIS DEVELOPED BY THE BRITISH DURING WORLD WAR II TO DEAL WITH LOGISTICS
- ELEMENTS OF RELIABILITY AND MAINTAINABILITY ENGINEERING DEVELOPED FOLLOWING THE WAR
- FAULT TREE ANALYSIS FROM BELL LABS

WHY USE SYSTEM ENGINEERING?

- BACKYARD PROJECTS CAN BE CARRIED IN THE MIND OF ONE PERSON

- TO ACCOMPLISH EVEN A BACKYARD PROJECT, AN INDIVIDUAL MUST HAVE IN MIND A --

  - PURPOSE

  - CONCEPT

  - DESIGN

  - PLAN

WHY USE SYSTEM ENGINEERING?
(CONT'D)

- WHEN THE PROJECT REACHES A LEVEL OF COMPLEXITY AND/OR REQUIRES A MIX OF SKILLS THAT ARE TOO MUCH FOR ONE PERSON, A MORE ORGANIZED APPROACH IS NEEDED

- THE GREATER THE COMPLEXITY, THE MORE SPECIALIZED THE SKILLS, THE GREATER THE NUMBER OF SKILLS, THE GREATER THE NEED FOR STRUCTURED ANALYSIS AND MANAGEMENT

- TO DO WHAT? TO DEFINE IN THE NECESSARY DETAIL, THE
  - PURPOSE
  - CONCEPT
  - DESIGN
  - PLAN

WHY USE SYSTEM ENGINEERING?
(CONT'D)

EXPERIENCE IN MANY PROGRAMS IN MANY DIFFERENT INDUSTRIES HAS DEMONSTRATED THAT:

- WITHOUT SYSTEMATIC ANALYSIS, IMPORTANT THINGS ARE OVERLOOKED UNTIL THEY BECOME VERY EXPENSIVE AND/OR TIME CONSUMING TO INCORPORATE

- WITHOUT FORMAL COORDINATION AND CONTROL OF INTERFACES, THINGS DON'T FIT TOGETHER

- IN A PROGRAM OF SIGNIFICANT DURATION, WITHOUT DOCUMENTATION OF DECISIONS AND RATIONALES, AT SOME POINT NO ONE KNOWS HOW OR WHY THE PROGRAM GOT TO WHERE IT IS

WHY APPLY SYSTEM ENGINEERING TO THE REPOSITORY REGULATORY PROCESS?

COMMISSIONER ROGERS PROBABLY SAID IT BEST:

- REPOSITORY . . IS A UNIQUE, FIRST-OF-A-KIND UNDERTAKING
- UNPRECEDENTED TIME PERIOD . . OVER WHICH THE REPOSITORY MUST . . PERFORM RELIABLY
- ONLY ONE SITE . . IS PERMITTED TO BE TECHNICALLY CHARACTERIZED
- THE STORED WASTE [MUST] BE RETRIEVABLE . .
- RESTRICTIONS ON THE USE OF A MRS
- COMMISSION DECISION ON A [CONSTRUCTION] LICENSE . . WITHIN THREE YEARS OF SUBMISSION . . OF AN APPLICATION
- AND LAST BUT NOT LEAST, THIS IS A HIGHLY VISIBLE, EMOTIONALLY CHARGED ISSUE THAT WILL BE RESOLVED IN THE POLITICAL ARENA AT LEAST AS MUCH AS IN THE TECHNICAL ARENA.

WHY APPLY SYSTEM ENGINEERING TO THE REPOSITORY REGULATORY PROCESS? (CONT'D)

THE COMMISSIONER CONCLUDES THAT NRC IS FORCED "TO STREAMLINE THE REPOSITORY LICENSING PROCESS TO THE MAXIMUM EXTENT FEASIBLE."

PARTICULAR OBJECTIVES ARE:

- REDUCE THE NUMBER OF ISSUES TO BE ADJUDICATED AT THE HEARING BY IDENTIFYING POTENTIAL LICENSING ISSUES AS EARLY IN THE PRE-APPLICATION PERIOD AS POSSIBLE
- ASSURE THAT CONFLICT OF INTEREST DOES NOT BECOME A LICENSING ISSUE
- ASSURE THAT THE NRC RESEARCH AND REGULATORY DEVELOPMENT PROGRAM IS DESIGNED AND IMPLEMENTED TO PROVIDE TIMELY GUIDANCE TO THE DOE

COMMISSIONER KENNETH C. ROGERS, "SYSTEMS ENGINEERING IN NRC'S HIGH LEVEL WASTE PROGRAM", A SPEECH TO FUEL CYCLE AND WASTE MANAGEMENT DIVISION, AMERICAN NUCLEAR SOCIETY, JUNE 13, 1988.

DO-IT-YOURSELF REPOSITORY LICENSING

PURPOSE OF BRIEFING

- PRESENT A SYSTEMATIC APPROACH TO REPOSITORY LICENSING
  - DIRECTED TOWARD NRC/CENTER TECHNICAL STAFFS

WHAT'S THE JOB?

HOW CAN WE BEST PREPARE OURSELVES TO LICENSE A REPOSITORY?

WHAT BOUNDS THE JOB?

- THE STATUTE - NUCLEAR WASTE POLICY ACT, AS AMENDED
- THE REGULATION - 10 CFR PART 60
- THE TIME LIMIT - 3 YEARS
- THE NATURE OF THE PROBLEM
  - MANY UNKNOWNS
  - MANY TECHNICAL DISCIPLINES WITH DIFFERENT TERMINOLOGIES
  - A "FIRST-TIME" EFFORT
  - CAN'T OBTAIN "PROOF" IN THE NORMAL SENSE

THE IMPLICATIONS

- THE NRC MUST BE EXTREMELY WELL-ORGANIZED WHEN THE LA IS SUBMITTED
- SURPRISES MUST BE MINIMIZED
  - BOTH DOE AND NRC MUST HAVE CLEAR UNDERSTANDING OF WHAT NEEDS TO BE DONE
  - PRE-LICENSING GUIDANCE MUST BE THOROUGH AND PRECISE
- MUST BE PREPARED FOR LITIGATION

WHAT IS A LOGICAL, SYSTEMATIC WAY TO APPROACH THE TASK?

STEP 1 IDENTIFY WHAT THE REGULATION REQUIRES

- QUESTIONS OF INTENT, COMPLETENESS OR JURISDICTION?

STEP 2 CONSOLIDATE REQUIREMENTS FROM STEP 1 INTO COMMON TOPICS

STEP 3 DETERMINE THE INTERRELATIONSHIPS AMONG THE REQUIREMENTS WITHIN EACH STEP 2 TOPIC

- QUESTIONS CONCERNING THE INTERRELATIONSHIPS?

STEP 4 ESTABLISH A GENERAL PLAN TO BOUND THE EFFORT AND INFORMATION ACCEPTABLE TO SHOW COMPLIANCE WITH EACH TOPIC

STEP 5 SPECIFY THE DETAILED INFORMATION NECESSARY TO SHOW COMPLIANCE WITHIN THE BOUNDS OF STEP 4

- DEFINE INTERRELATIONSHIPS AMONG ITEMS OF INFORMATION

STEP 6 USING STEP 4, SPECIFY THE TECHNIQUES TO BE USED FOR ACCEPTING AND CONFIRMING THE INFORMATION FROM STEP 5

- QUESTIONS OF "HOW TO"?

STEP 7 EXAMINE QUESTIONS FROM STEPS 1, 3 AND 6: CONSOLIDATE, ATTEMPT TO ANSWER

- QUESTIONS OF "HOW TO"?

STEP 8 DEFINE THE INFORMATION NEEDED TO ANSWER QUESTIONS FROM STEP 7

- QUESTIONS OF HOW TO?

STEP 9 DOCUMENT RESULTS OF STEPS 1 TO 8 IN MANNER WHICH ALLOWS QA VERIFICATION, INTEGRITY OF INFORMATION, EXAMINATION OF INTERRELATIONSHIPS AND ARCHIVING

STEP 10 PROVIDE RESULTS OF STEPS 1 TO 8 TO DOE AS GUIDANCE FOR PREPARATION OF A LICENSE APPLICATION

STEP 11 PROVIDE RESULTS OF STEPS 1 TO 8 TO NRC STAFF TO GUIDE LICENSE APPLICATION REVIEW

STEP 12 REPEAT AS NECESSARY UNTIL YOU FEEL BETTER

- PUT IN FEEDBACK LINES WHEREVER YOU WANT THEM

RESULT

- A LOGICAL PATH TO REPOSITORY LICENSING
  - SIMILAR TO OTHER NRC LICENSING PROCEDURES
  - TIES TO REGULATORY STRATEGY, SITE CHARACTERIZATION PLAN, ETC.
- DOCUMENTED, CROSS-LINKED INFORMATION
- A METHOD DESIGNED FOR ITERATION AND FEEDBACK
- GUIDANCE TO DOE AND NRC STAFFS IS EASILY DERIVED FROM THIS PROCESS
- SYSTEM ENGINEERING APPLIED TO REPOSITORY LICENSING

DEFINING SRA

PURPOSE OF BRIEFING

- MATCH STEPS IN PREVIOUS BRIEF TO SRA
- DISCUSS HOW INDIVIDUALS' EFFORTS FIT INTO THE SRA PROCESS

STEP 1 IDENTIFY WHAT THE REGULATION REQUIRES

- QUESTIONS OF INTENT, COMPLETENESS OR JURISDICTION?

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STEP 7 UNCERTAINTIES (UN) AND THEIR METHODS OF REDUCTION (URM)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 8 INFORMATION REQUIREMENTS (IR)
- THE QUESTIONS OF "HOW TO" ARE TECHNICAL UNCERTAINTIES (UN)

STEP 9 PROGRAM ARCHITECTURE SUPPORT SYSTEM (PASS) AND PROGRAM ARCHITECTURE DATABASE (PADB)

STEP 10 FORMAT AND CONTENT REGULATORY GUIDE (F & CRG)

STEP 11 LICENSE APPLICATION REVIEW PLAN (LARP)

STEP 12 STEPS 1 THROUGH 15a OF THE TWENTY-TWO STEP PROGRAM ARCHITECTURE PROCESS

WHAT DO I NEED TO KNOW ABOUT THE TWENTY-TWO STEP PROCESS?

- IT EXISTS AS A REPRESENTATION OF THE COMPLETE HLW PROGRAM
- EACH STEP HAS DETAILED INSTRUCTIONS WHICH CAN BE REFERENCED AS NECESSARY (TOP-001-02)
- IF YOU ARE PUZZLING OVER THE TWENTY-TWO STEP PROCESS ON A DAILY BASIS, YOU'RE PROBABLY TRYING TO SOLVE THE WRONG PUZZLE

OPTIONS - A SENSITIVITY

- SRA HELPS DEFINE AREAS FOR STUDY
- INVESTIGATE USING STANDARD SCIENTIFIC AND ENGINEERING TECHNIQUES
- IDENTIFY, EVALUATE & SELECT TECHNICAL OPTIONS USING STANDARD PROCEDURES
- DOCUMENT RATIONALE AS IN OTHER NRC LICENSING ACTIONS
- PASS PROVIDES THE MEANS FOR DOCUMENTING THESE ACTIONS
- PA RELATIONAL DATABASE PROVIDES A PLACE FOR DOCUMENTING AND LINKING THESE ACTIONS

HOW DOES MY WORK FIT INTO THIS PROCESS?

- TECHNICAL EXPERTISE AND RESULTS OF SCIENTIFIC AND ENGINEERING INVESTIGATION ARE REQUIRED FOR TRC, CDS, CDM, UN AND IR DEVELOPMENT
- PASS IS ANOTHER MEANS OF DOCUMENTING THE RESULTS OF TECHNICAL WORK
- SOUNDLY DEVELOPED F & CRG, AND LARP ARE NECESSARY FOR A QUALITY AND TIMELY LICENSE APPLICATION AND REVIEW
  - SRA ALSO SUPPORTS RULEMAKING AND OTHER REGULATORY GUIDANCE
- THE PROCESS CAN HELP FOCUS THE HLW PROGRAM
- DON'T NEED TO BE A SYSTEMS ENGINEER TO WORK WITHIN FRAMEWORK PROVIDED BY SRA

THE BASIC STRUCTURE OF SYSTEMATIC REGULATORY ANALYSIS

CONTENT

- APPLICABLE PROCEDURES
- PROGRAM ARCHITECTURE STRUCTURE
- SYSTEMATIC REGULATORY ANALYSIS
- PROGRAM PLANNING
- PROGRAM MANAGEMENT
- PROGRAM ARCHITECTURE SUPPORT SYSTEM (PASS)

APPLICABLE PROCEDURES

APPLICABLE TECHNICAL OPERATING PROCEDURES (TOPs)

- TOP-001 PROGRAM ARCHITECTURE DEVELOPMENT AND MAINTENANCE
  - DEFINITION OF, AND BROAD GUIDELINES FOR PROGRAM ARCHITECTURE
- TOP-001-01 GUIDANCE TO THE PROGRAM ARCHITECTURE REVIEW COMMITTEE REVIEW AND REVISION OF WSE&I MAJOR MILESTONE NO. 12
  - PROCEDURE USED FOR IDENTIFYING STATUTES AND REGULATIONS APPLICABLE TO THE HLW MANAGEMENT PROGRAM -- COMPLETED IN 1988
- TOP-001-02 "PROGRAM ARCHITECTURE RELATIONAL DATABASE CONTENT AND DEVELOPMENT INSTRUCTIONS" [PROGRAM ARCHITECTURE PROCESS AND INSTRUCTIONS]
  - DRAFT OF SEP '89 APPROVED WITH MINOR REVISIONS
  - WILL BE UPDATED TO DEFINE "SRA" AND ADDED REFINEMENTS OF PROCESS

APPLICABLE TECHNICAL OPERATING PROCEDURES (TOPs) [Cont'd]

- TOP-001-03 SUBMISSION AND VERIFICATION OF PROGRAM ARCHITECTURE DATABASE (PADB) ENTRIES
  - INSTRUCTIONS FOR PROGRAM ARCHITECTURE REVIEW COMMITTEE (PARC) AND ASSOCIATED REVIEW ACTIVITIES
- TOP-001-04 SELECTION OF REGULATORY TOPICS FOR PROGRAM ARCHITECTURE ANALYSIS
  - COVERS SELECTION OF "TOPICS" AND INITIAL CONSTRUCTION OF "REGULATORY REQUIREMENTS"
- TOP-001-05 IMPLEMENTING THE SYSTEMATIC REGULATORY ANALYSIS PROCESS
  - INSTRUCTIONS FOR INTEGRATING THE VARIOUS ELEMENTS OF SRA
- TOP-001-06 PROCEDURE FOR REGULATORY REQUIREMENT CATEGORIZATION AND COMPLIANCE DETERMINATION STRATEGY DEVELOPMENT
  - PREPARED TO IMPLEMENT THE APPROACH GIVEN IN THE RECOMMENDATION REPORT; WILL BE REVISED TO FIT APPROACH THAT EVOLVES FROM CURRENT TESTING
- TOP-015 PROCEDURE FOR DECISION ANALYSIS
  - DESCRIBES AND PROVIDES DIRECTION FOR DECISIONS BY ATTRIBUTES

TOP-001-02 AS A REFERENCE DOCUMENT

CONTENTS

- BODY OF PROCEDURE -- PURPOSE AND SCOPE, DEFINITIONS, RESPONSIBILITIES, RECORDS, QUALITY ASSURANCE

- ATTACHMENTS

  A. PADB -- DEFINITIONS AND CONTENTS OF RECORDS
  B. TOPICS OF REGULATORY REQUIREMENTS
  C. BINARY LOGIC DIAGRAM INSTRUCTIONS
  D. LISTING OF COGNIZANT ELEMENT CODES
  E. LISTING OF EXPERTISE CODES
  F. DETAILED PA PROCESS ACTIVITIES (GUIDANCE ONLY)
  G. DW4 DATA INPUT FORMS [REPLACE WITH "SRA OUTPUT FORMATS AND REPORTS"]
  H. UNCERTAINTY EXCLUSION FOLLOWING DATABASE ENTRY
  I. GLOSSARY OF COMMON SRA TERMS, ABBREVIATIONS, AND ACRONYMS
  J. PROCEDURAL REGULATORY REQUIREMENTS
  K. BASIC STRUCTURE AND OPERATION OF THE PROGRAM ARCHITECTURE RELATIONAL DATABASE [REPLACE WITH "SRA PRODUCT EXAMPLES"]
  L. CHECKLIST FOR TOP-001-02, ATTACHMENT A

TOP-001-02, ATTACHMENT A, AS A REFERENCE DOCUMENT

- ORGANIZED INTO 26 SECTIONS PLUS TWO ANNEXES (PASS ID CODES AND DETAILED TABLE OF CONTENTS)
- MOST SECTIONS CORRESPOND TO A SINGLE PROGRAM ARCHITECTURE PROCESS STEP; I.E., THE DEVELOPMENT OF A SINGLE PROGRAM ARCHITECTURE ELEMENT SUCH AS UNCERTAINTIES OR COMPLIANCE DETERMINATION METHOD
- EACH SECTION PROVIDES:
  - DEFINITION — OF THE PROGRAM ARCHITECTURE ELEMENT THAT IS THE SUBJECT OF THE ANALYSIS PERFORMED IN THAT STEP
  - BACKGROUND — RATIONALE FOR DEVELOPMENT, EXPLANATION OF THE STRUCTURE OF PROGRAM ARCHITECTURE ELEMENT, AND INTERACTION WITH OTHER PROGRAM ARCHITECTURE ELEMENTS
  - CONTENT — RECORD-BY-RECORD DESCRIPTION OF THE INFORMATION THAT IS TO BE PRODUCED IN THE ANALYSIS AND ENTERED IN THE PROGRAM ARCHITECTURE DATABASE (PADB)
    - AS APPROPRIATE, INSTRUCTIONS SPECIFIC TO THE INDIVIDUAL OUTPUT, DESCRIPTIONS OF SPECIAL CONDITIONS, EXPLANATION OF EXCEPTIONS, ETC.

TOP-001-02, ATTACHMENT F, AS A GUIDANCE DOCUMENT

- STEP-BY-STEP GUIDANCE FOR THE ANALYSIS PROCESS
- IDENTIFICATION AND SEQUENCE OF INDIVIDUAL ACTIONS
- FOR EACH STEP OF THE PROCESS, REFERENCE TO THE ATTACHMENT A DESCRIPTION OF THE PRODUCT(S) AND IDENTIFICATION OF THE PADB RECORD NUMBER(S)

PROGRAM ARCHITECTURE

STRUCTURE

DEFINITION

PROGRAM ARCHITECTURE

A SYSTEMATIC COMPUTER-ASSISTED APPROACH TO ANALYSIS OF PROGRAM REQUIREMENTS, PROGRAM PLANNING AND EVALUATION, AND MANAGEMENT.

TAKEN IN TOTAL, IT IS THE DESCRIPTION OF THE NRC HIGH-LEVEL NUCLEAR WASTE REGULATORY PROGRAM. IT IS MISSION-ORIENTED, REQUIREMENTS-BASED, AND PROACTIVE; AND IT PROVIDES THE BASIS FOR INTEGRATION OF ALL ASPECTS OF THE NRC REGULATORY PROGRAM UNDER THE NWPAA.

PROGRAM ARCHITECTURE

CONSISTS OF:

(a) SYSTEMATIC REGULATORY ANALYSIS,

(b) PROGRAM PLANNING, AND

(c) PROGRAM MANAGEMENT.

THESE ACTIVITIES ARE SUPPORTED, AND THEIR PRODUCTS ARE RECORDED, BY THE PROGRAM ARCHITECTURE SUPPORT SYSTEM (PASS)

SYSTEMATIC

REGULATORY ANALYSIS

DEFINITION

SYSTEMATIC REGULATORY ANALYSIS (SRA)

"THAT PORTION OF THE PROGRAM ARCHITECTURE WHICH ASSESSES THE STATUTORY AND REGULATORY RESPONSIBILITIES OF THE NRC IN A COMPREHENSIVE, STRUCTURED MANNER. THIS ASSESSMENT IS CONTROLLED BY APPROPRIATE TECHNICAL OPERATING PROCEDURES.

"SRA BEGINS WITH THE IDENTIFICATION OF STATUTORY AND REGULATORY REQUIREMENTS RELEVANT TO THE HIGH-LEVEL NUCLEAR WASTE MANAGEMENT SYSTEM. THIS SYSTEM INCLUDES ONE OR MORE MINED GEOLOGIC REPOSITORIES, INTERIM STORAGE FACILITIES, AND NUCLEAR WASTE TRANSPORTATION CASKS."

SYSTEMATIC REGULATORY ANALYSIS

THE SRA PROCEEDS THROUGH

- DEVELOPMENT OF STRATEGIES AND METHODS FOR ASSESSING COMPLIANCE WITH THE REQUIREMENTS
- IDENTIFICATION OF LICENSE APPLICATION
  - INFORMATION NECESSARY TO DETERMINE COMPLIANCE AND
  - SUPPORTING MATERIAL NECESSARY TO VERIFY THAT INFORMATION
- IDENTIFICATION AND EVALUATION OF UNCERTAINTIES
- DEVELOPMENT OF METHODS FOR REDUCING REGULATORY AND INSTITUTIONAL UNCERTAINTIES AND TECHNICAL UNCERTAINTIES WITH REGULATORY IMPACT
- IDENTIFICATION OF INFORMATION REQUIREMENTS
  - FOR COMPLIANCE DETERMINATION IF REQUIRED BY SELECTED STRATEGY
  - FOR UNCERTAINTY REDUCTION

BASIC SYSTEMATIC REGULATORY ANALYSIS PRODUCTS -- REQUIREMENTS ON THE APPLICANT

STATUTORY AND REGULATORY PERFORMANCE REQUIREMENTS
AND DESIGN CRITERIA

⇓

REQUIREMENTS AND/OR CRITERIA FOR A SINGLE TOPIC
[REGULATORY REQUIREMENT]

⇓

WHAT MUST BE DEMONSTRATED TO SHOW COMPLIANCE WITH EACH
REQUIREMENT AND CRITERIA OF THE RR
[REGULATORY ELEMENTS OF PROOF]

⇓

LOGICAL INTERRELATIONSHIPS OF THE REQUIREMENTS
AND CRITERIA OF THE RR
[REGULATORY ELEMENTS OF PROOF SET]

REGULATORY DOCUMENTATION

- NUCLEAR WASTE POLICY AMENDMENT ACT (NWPAA)
- CODE OF FEDERAL REGULATIONS (CFR), TITLES 10 AND 40
- SUPPORTING DOCUMENTATION [10 CFR PART 60 EXAMPLES]
  - NUREG'S

    0804 STAFF ANALYSIS OF PUBLIC COMMENTS ON PROPOSED RULE

    1046 DISPOSAL IN UNSATURATED ZONE: TECHNICAL CONSIDERATIONS AND RESPONSE TO COMMENTS

  - FEDERAL REGISTER

    PROPOSED RULE MAKING -- 49 FR 5934, 2/16/84

    AMENDMENTS TO LICENSING PROCEDURE -- 50 FR 2579, 1/17/85

    "STATEMENTS OF CONSIDERATION" (FINAL RULE, SUPPLEMENTARY INFORMATION) -- 50 FR 29641, 7/22/85

    CURRENTLY APPLICABLE "SOURCES"

BASIC DEFINITIONS

PASS IDENTIFICATION NUMBER (PASS ID)

TWO CODES AND NUMBERS THAT UNIQUELY IDENTIFY PROGRAM ARCHITECTURE PRODUCTS, USED TO RELATE AND RETRIEVE PROGRAM ARCHITECTURE DATABASE (PADB) RECORDS. THE GENERAL FORM IS RRxxxx/AAyyyy

REGULATORY TEXT

AN ELEMENT OF A STATUTE, REGULATION OR OTHER SOURCE THAT HAS THE FORCE OF LAW AT OR ABOVE THE LOWEST LEVEL TO WHICH AN ALPHANUMERIC IDENTIFIER HAS BEEN ASSIGNED.

REGULATORY REQUIREMENT

PASS ID CODE: RR

PASS ID NUMBER: RRxxxx

DEFINITION: A STATEMENT OF A REQUIREMENT . . . COMPOSED OF ONE OR MORE <u>COMPLETE</u> AND CLOSELY RELATED REGULATORY TEXTS.

REGULATORY REQUIREMENT CONSTRUCTION

- REGULATORY TEXT SELECTION

  (1) IDENTIFY UNIQUE SUBJECTS OF CRITERIA AND REQUIREMENTS (TOPICS) IN AN APPLICABLE STATUTE OR REG (SOURCE)

  (2) IDENTIFY THE TOP-LEVEL REG TEXT OF THAT SOURCE THAT PROVIDES THE PRIMARY DEFINITION OF THE TOPIC — THE "PRIMARY REG TEXT"

  (3) IDENTIFY THE "ASSOCIATED REG TEXT"

  - CONTAINED IN THE SAME SOURCE OR THE AUTHORIZING STATUTE
  - DETAILS, EXPLAINS, OR QUALIFIES THE PRIMARY REG TEXT OR THE MEANS OF DEMONSTRATING COMPLIANCE
  - LOGICALLY RELATED TO THE PRIMARY TEXT

  (4) IDENTIFY THE "REFERENCED REG TEXT"

  (5) REFINE, REVISE, ADD, OR DELETE AS A RESULT OF PROGRAM CHANGES, RULEMAKING, OR SIMILAR FACTORS

REGULATORY REQUIREMENT CONSTRUCTION (Cont'd)

- RELATED REGULATORY TEXT
  - REG TEXT FROM

    (1) OTHER AGENCIES THAT IS APPLICABLE TO HLW,
    (2) ANALOGOUS NRC REGS NOT APPLICABLE TO NWPA HLW, AND
    (3) STATUTES NOT REFERENCED IN THE SOURCE.

  - THESE ARE IDENTIFIED FOR INFORMATION ONLY.

- REG TEXT NOT INCLUDED IN RR OR IN RELATED REG TEXT --
  - GENERAL PROCEDURAL GUIDANCE
  - GENERAL CONCEPTS (E.G., 10 CFR 60.102)
  - DISCUSSIONS OF REGULATORY PURPOSE OR INTENT THAT HAVE NO TECHNICAL IMPACT
  - DEFINITIONS

REGULATORY REQUIREMENT

- RR IS A POTENTIAL SOURCE OF REGULATORY AND/OR INSTITUTIONAL UNCERTAINTIES

- LICENSING PROCEDURAL REQUIREMENTS APPLICABLE TO DOE AND "NRC SELF-REGULATION REQUIREMENTS" TO BE ANALYZED AS "PROCEDURAL REGULATORY REQUIREMENTS" (PROCEDURE TO BE DEVELOPED)

PRODUCTS OF REGULATORY REQUIREMENT ANALYSIS
(PAPD STEP 2)

3.1. Topic of the Regulatory Requirement
3.2. Regulatory Requirement Applicable Period
3.3. Regulatory Agency
3.4. Included Regulatory Text
  a. Citation and Revision Date
  b. Statutory Basis
  c. Rationale for Inclusion of Regulatory Text
  d. Candidate Regulatory/Institutional Uncertainty Identifiers
  e. References for Rationale (Inclusion and Statutory Basis)
3.5. Excluded Regulatory Text
  a. Citation and Revision Date
  b. Rationale for Exclusion
  c. References for Exclusion Rationale
3.6. Related Regulatory Text
  3.6.1. Included Related Regulatory Text
    a. Citation and Revision Date
    b. Rationale for Inclusion
    c. References for Inclusion Rationale
    d. Related Regulatory Elements of Proof
  3.6.2. Excluded Related Regulatory Text
    a. Citation and Revision Date
    b. Rationale for Exclusion
    c. References for Exclusion Rationale
3.7. Overall Comments/Observations
3.8. References for Comments/Observations

PADB Ver. 2.1

REGULATORY ANALYSIS SYNOPSIS

- DEVELOPED BASED ON DISCUSSIONS WITH NRC TECHNICAL STAFF
- REFLECTS FORMAT AND CONTENT OF PROGRAMMED DATABASE PRINTOUT
- THE MOST EFFICIENT TOOL FOR NRC AND CENTER TECHNICAL STAFF TO RECORD SRA RESULTS FOR ENTRY IN DATABASE
- ANNOTATED SYNOPSIS OUTLINE FOR EACH SRA ELEMENT SERVES AS CHECKLIST
- DOCUMENTS KEY PRODUCTS OF THE REGULATORY ANALYSIS IN READER-FRIENDLY FORMAT -- SEE CNWRA 90-003, APPENDIX B, AND RR-REOP REPORT
- EASILY REVIEWED BY COGNIZANT MANAGERS AND REVIEW COMMITTEE
- INFORMATION TRANSFERRED TO COMPUTER INPUT FORMS BY CLERK-TYPIST (PASS VERSION 2.0)
- BASIS FOR "PROMPTS" IN PC-BASED, INTERACTIVE PASS (VERSION 2.1)