BRIEFING ON TPA TECHNOLOGY

MOHAMED ABDOU

TPA STEERING COMMITTEE MEETING
BOSTON, MASSACHUSETTS
AUGUST 15, 1985

OUTLINE

- ORGANIZATION
- METHODOLOGY
- OBJECTIVES
- SCHEDULE
- TOPICS REQUIRING DISCUSSION
  - DETAILED DEFINITION OF MFPP ISSUES
  - GROUNDRULES FOR PIC
  - INTERFACE BETWEEN PHYSICS AND TECHNOLOGY
  - RESOURCES FOR PERFORMING TPA
  - OTHERS

TECHNOLOGY STEERING COMMITTEE (TSC)

MOHAMED A. ABDOU (UCLA), CHAIRMAN

LEE A. BERRY (ORNL)

DAVID H. BERWALD (TRW)

JAMES CROCKER (EG&G)

WILHELM B. GAUSTER (SNL)

CARL D. HENNING (LLNL)

MICHAEL KORENKO (WHC/HEDL)

JOHN A. SCHMIDT (PPPL)

DALE L. SMITH (ANL)

HERBERT H. WOODSON (UT)

SUBSYSTEM	LEADERSHIP RESPONSIBILITY
• MAGNETS	HENNING/BERRY
• HEATING/FUELING	BERRY/SCHMIDT
• BLANKET/FIRST WALL	ABDOU/SMITH/KORENKO/BERWALD
• PLASMA INTERACTIVE COMPONENTS (PIC)	GAUSTER/SCHMIDT
• TRITIUM PROCESSING, VACUUM SYSTEMS	(BARTLIT)
• RADIATION SHIELD	(SCHULTZ)
• REMOTE MAINTENANCE EQUIPMENT	GAUSTER/KORENKO

SPECIAL TASK	
• NON-ELECTRIC APPLICATIONS	BERWALD/(MOIR)
• INNOVATIVE POWER CONVERSION	HENNING/BERWALD

SUBSYSTEMS AND MFPP ISSUES MATRIX

Subsystem	MFPP Issue			
	Magnetic Confinement Systems (Definition)	Properties of Burning Plasma (Definition)	Fusion Materials (Definition)	Fusion Nuclear Technology (Definition)
Magnets	X	X	X	
Heating/Fueling	X	X		X
PIC	X	X	X	X
Blanket			X	X
Tritium Processing	X	X		X
Radiation Shield				X
Remote Maintenance	X			X

- X's are for illustration only (ideally should have a number)
- Advantage of Matrix Approach:
  1) Detailed subissues of MFPP issues are derived from subsystem needs (not from abstract), allows focused planning; provides technical depth to MFPP issues
  2) Ensures that work on subsystems is driven by MFPP issues (rather than exhaustive R&D)

SUBSYSTEMS AND MFPP ISSUES MATRIX

- WORKABLE
- JUDGED BY TPA TECHNOLOGY GROUP TO BE THE BEST ORGANIZATIONAL APPROACH
- DOES NOT CONFLICT WITH ANY RULE
- OUTPUT CAN BE ORGANIZED BY ISSUES, SUBSYSTEMS, OR BOTH

MAIN CONCERN

(DEFINITELY NOT HOW SUBGROUPS ARE ORGANIZED)

- DETAILED AND CLEAR DEFINITION OF THE FOUR MFPP ISSUES AND THE GROUNDRULES FOR PLANNING ARE NOT YET COMPLETE

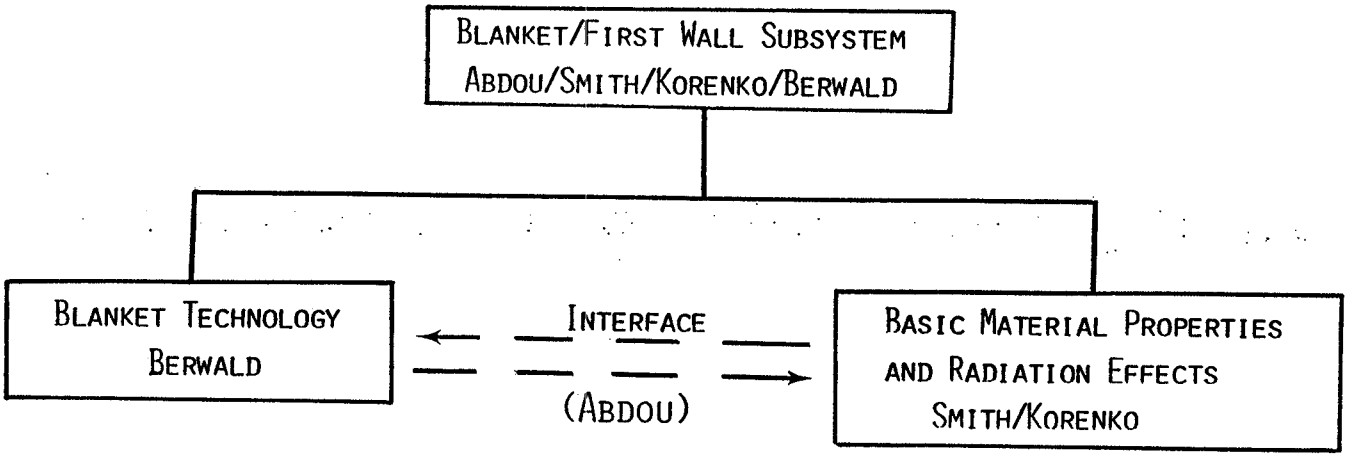
MFPP ISSUES

Suggested Actions

- Develop and agree on detailed definition of each of the four MFPP issues
- Develop and agree on a number of guidelines

Examples of Guidelines

- Framework for Development of Materials should be derived from sets of "compatible combinations of materials" acceptable for subsystem application
- Highest priority of (or the only) work on subsystem R&D is for areas that are related to the four MFPP issues



SCOPE

- ALL TECHNOLOGY ASPECTS
- PHENOMENA EXPLORATION
- MULTIPLE EFFECT TESTS
- INTEGRATED TESTS
- CONCEPT VERIFICATION
- ANALYTICAL MODELLING

SCOPE

- BASIC MATERIAL PROPERTIES (PHYSICAL, CHEMICAL, MECHANICAL AND NUCLEAR PROPERTIES) FOR ALL MATERIALS (STRUCTURE, MULTIPLIER, BREEDER, COOLANT, ETC.)
- "SINGLE EFFECT" MATERIAL IRRADIATION
  - SINGLE MATERIAL
  - SINGLE ENVIRONMENT
- RADIATION DAMAGE THEORY

INCENTIVES FOR A "STRUCTURED METHODOLOGY/APPROACH

- TO ENCOURAGE CREATIVE THINKING AROUT VARIOUS R&D PATHWAYS (ALTERNATIVES TO ACCOMPLISH OBJECTIVES)

- TO ENCOURAGE UNCOVERING AND UNDERSTANDING KEY ASSUMPTIONS, DECISION POINTS AND LIKELY OUTCOME (CONSEQUENCES) OF VARIOUS ALTERNATIVES

- TO PROVIDE A "COMMON SCALE" FOR COMPARING:

  - VARIOUS ALTERNATIVES

  - RELATIVE "WORTH" OF MAJOR FACILITIES, EXPERIMENTS, RESEARCH ACTIVITIES

TPA TECHNOLOGY METHODOLOGY

- AGREED: NEED STRUCTURED METHODOLOGY
- SEVERAL OPTIONS FOR METHODOLOGY WERE CONSIDERED
- PREFERRED METHODOLOGY

  FRAMEWORK COMBINES:

  1. FIVE-STEP PROCESS ADOPTED FROM AN ONGOING "TECHNOLOGY DEVELOPMENT STUDY"
  2. GUIDELINES FROM "ANALYTIC DECISION-MAKING APPROACH" IN STEP 5B TO COMPARE PATHWAYS

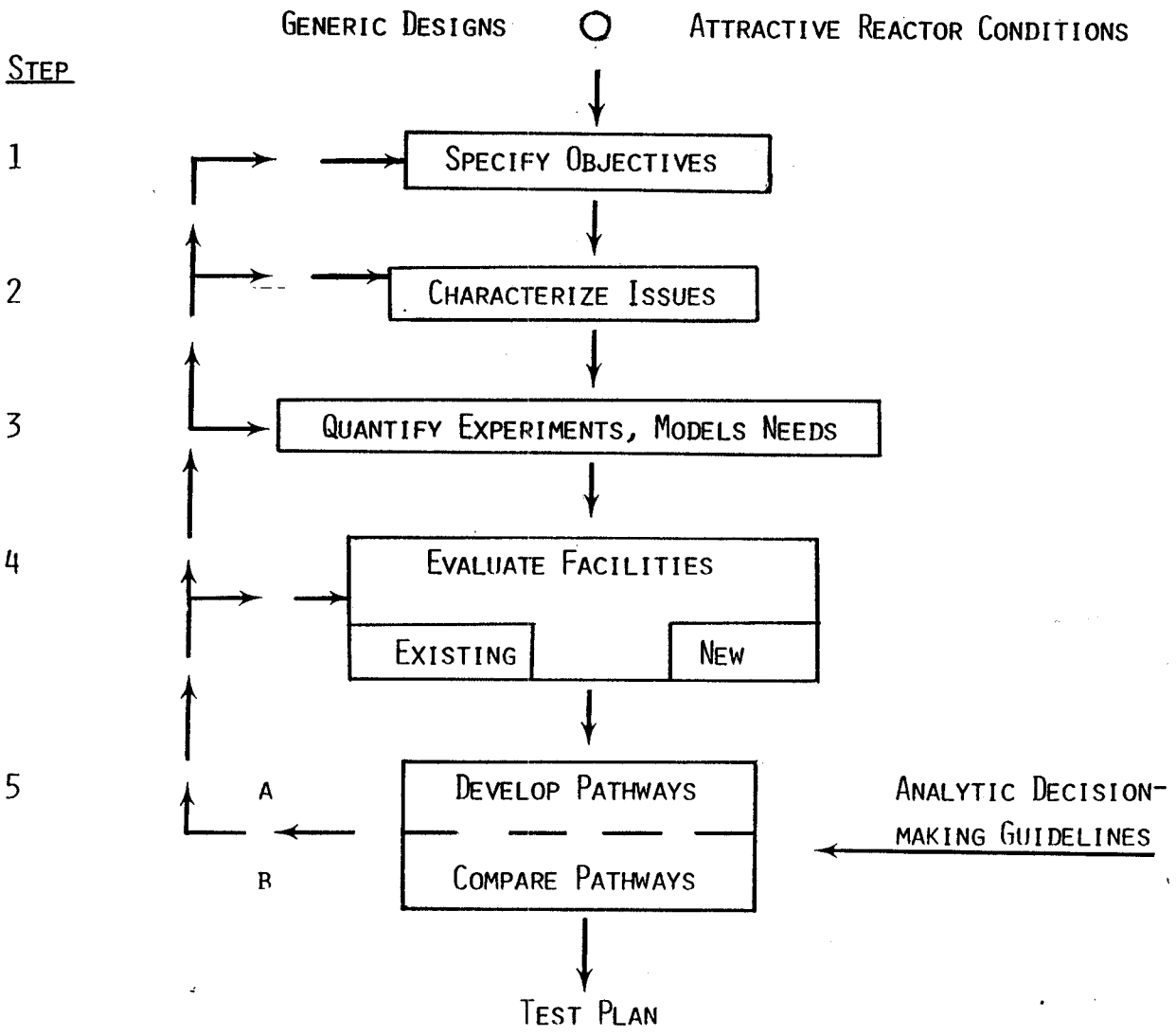
- CONCERN

  MANPOWER RESOURCES AND TIME REQUIRED MAY NOT BE AVAILABLE FOR TPA

- RESOLUTION

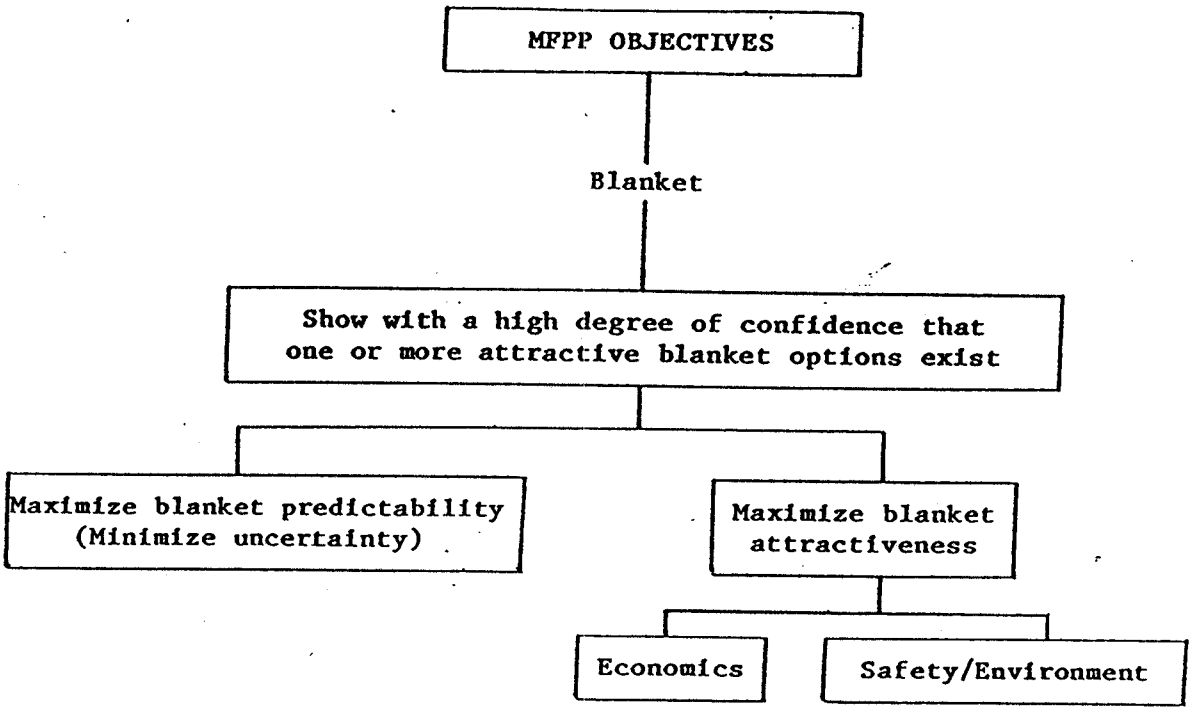
  1. APPLY PREFERRED METHODOLOGY FOR COMPLEX COMPONENTS (E.G. BLANKET) FOR WHICH INFORMATION AND RESOURCES FROM PREVIOUS OR ONGOING STUDIES ARE AVAILABLE
  2. SIMPLIFY METHODOLOGY FOR COMPLEX COMPONENTS FOR WHICH INFORMATION OR RESOURCES ARE LIMITED (E.G. PLASMA-INTERACTIVE COMPONENTS)
  3. USE ONLY "EXPERT JUDGEMENT" FOR SIMPLER COMPONENTS (E.G. SHIELD)

TPA TECHNOLOGY METHODOLOGY STEPS



OBJECTIVES

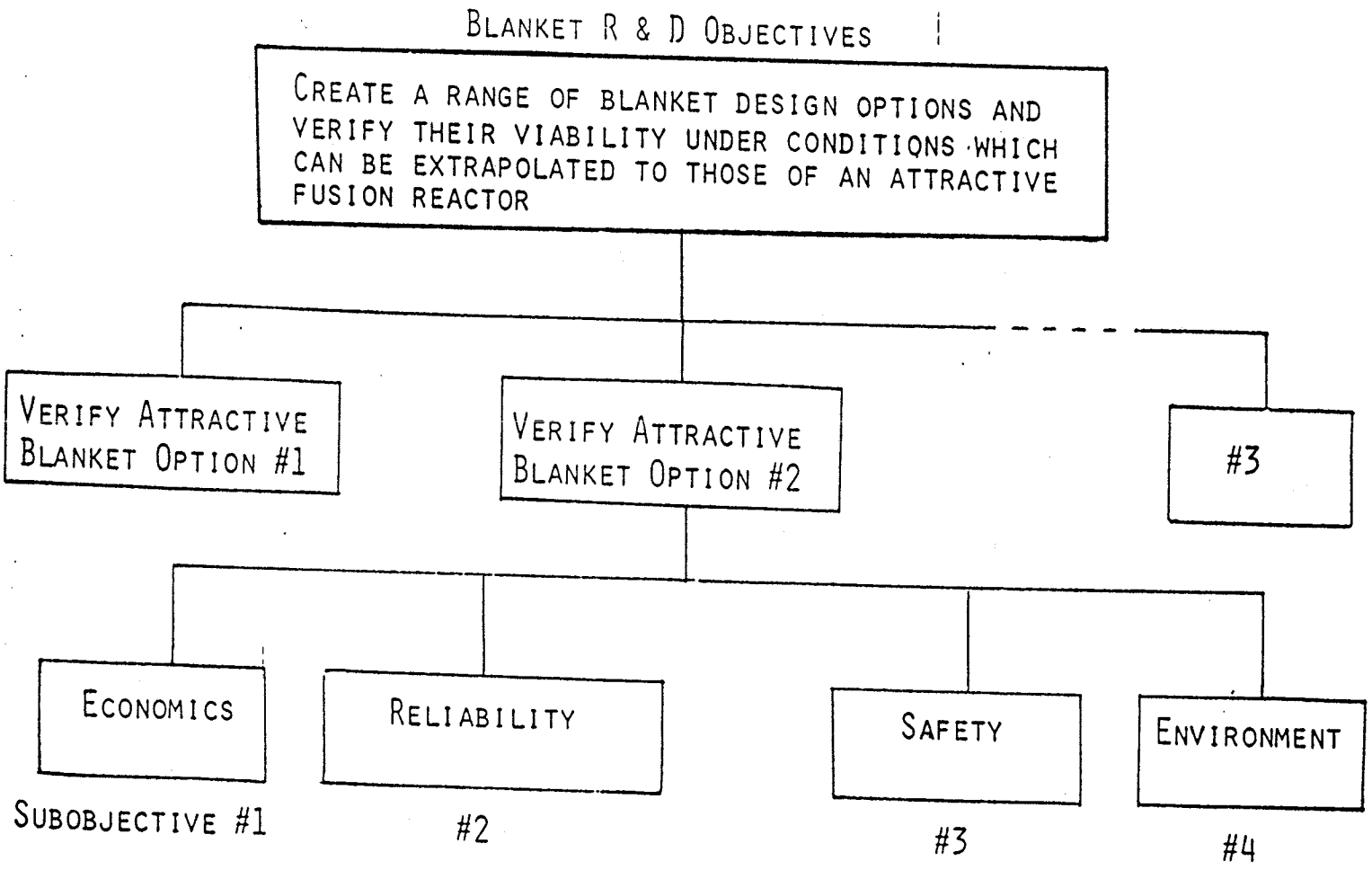
- MEASURABLE OBJECTIVES AND SUBOBJECTIVES ARE BEING DEVELOPED FOR SUBSYSTEMS REPORTS, PLANNED IN SEPTEMBER 4-6 MEETING IN CHICAGO
- IMPORTANT AND DIFFICULT TASK
- EXAMPLES FOR BLANKET FOLLOW (DISCUSSED BUT NOT AGREED TO YET)



Determine MHD pressure drop and pressure stresses (uncertainty in Δp)	Maximize lifetime (fluence)	Minimize chemical reactivity ($E_{reaction}$)
Determine heat transfer/fluid flow characteristics (uncertainty in h)	Maximize thermal efficiency ($\eta_{thermal}$)	Minimize tritium inventory (T inventory)
Determine tritium transport rates	Minimize blanket thickness	Minimize tritium loss
Determine compatible materials and ranges of compatibility	Maximize energy multiplication	Minimize activation (BHP @ 10 years)
Determine materials properties under irradiation (at shutdown)	Maximize prob. of self-sufficiency	Minimize afterheat (5 full power)
Determine structural response	Maximize reliability	Minimize internal pressure (p)
Determine characteristics of breeder/struct./mult. interaction		

Figure indicates Decision Analysis framework and sub-objectives hierarchy for Blanket (attributes in parantheses)

A KEY TO FORMULATING THE STRUCTURE OF THE DECISION ANALYSIS PROBLEM IS THE SELECTION OF SUBOBJECTIVES



PLASMA-INTERACTIVE COMPONENTS (PIC)

INCLUDES:

LIMITERS, DIVERTORS, ETC.

IN-VESSEL ELEMENTS OF PLASMA HEATING (E.G. RF ANTENNA)

QUESTION

TPA GROUND RULE CONCERNING NEAR-TERM AND LONG-TERM R&D?

OPTION A

PIC WILL BE DEVELOPED ONLY AS REQUIRED FOR PLASMA EXPERIMENTS (I.E. ONLY NEAR-TERM, ROLL-FORWARD APPROACH)

OPTION B

PIC WILL HAVE TWO R&D ELEMENTS:

1) SUPPORT PLASMA-EXPERIMENTS

2) ADDRESS SELECTED KEY LONG-TERM ISSUES WHERE RESOLUTION IS CRITICAL FOR ECONOMIC AND ENVIRONMENTAL ASSESSMENT

EXAMPLES OF DIFFERENCES BETWEEN NEAR AND LONG-TERM PIC ISSUES

Near Term	Long Term
Passive Cooling Short Pulse Erosion not life-limiting Disruption a driving factor Heat Transfer primary factor Tritium permeation not a key issue In-vessel RF antenna acceptable	Active Cooling Long Pulse Erosion is critical Disruption should not be a driver Thermomechanical Response main factor Tritium Permeation a key issue In-vessel RF antenna may not be acceptable
Graphite Surface acceptable Water cooling acceptable	Graphite Tiles not acceptable Need to explore liquid metals

PIC PLANNING GROUNDRULE (NEAR- VS. LONG-TERM)

OPTION A (ONLY NEAR TERM)	OPTION B (NEAR AND LONG TERM)
ADVANTAGES - WORK COUPLED DIRECTLY TO PROJECTS - ENSURES NEAR-TERM NEEDS ARE MET - ELIMINATES THE NEED FOR A BROAD-BASED PROGRAM BASED ON UNCERTAIN PLASMA CONDITIONS - LOWEST NEAR-TERM COST	ADVANTAGES • PERMITS TIMELY FEEDBACK ON INTER-RELATIONS BETWEEN PIC, CONFINE-MENT CONCEPT AND PIC, OTHER TECH-NOLOGIES. • REDUCES LONG-TERM RISK • CAN POTENTIALLY SAVE TIME AND MONEY IF WORK ON LONG-TERM ISSUES HELPS WITH CHOICES IN NEAR-TERM
DISADVANTAGES - NEAR-TERM SOLUTIONS MAY NOT EXTRA-POLATE TO ATTRACTIVE CONDITIONS - HIGHEST RISK (MAY SERIOUSLY AFFECT THE OUTCOME OF FUSION ECONOMIC AND ENVIRONMENTAL ASSESSMENT)	DISADVANTAGES • REQUIRES LARGER FUNDING OR MORE BUDGET CONSTRAINTS ON NEAR-TERM EXPERIMENTS • MORE COMPLEX ORGANIZATIONAL PRO-BLEMS (IN THE FIELD, IN OFE)

INTERFACE BETWEEN PLASMA AND TECHNOLOGY GROUPS

NEEDED MOST FOR:

PLANNING PLASMA-RELATED TECHNOLOGIES (REQUIRE CONSISTENCY ON GROUNDRULES, ASSUMPTIONS, PLANNING STRATEGY, ETC.)

SUGGESTED ACTIONS

ONE MEMBER FROM TECHNOLOGY GROUP PARTICIPATES IN PLASMA SCIENCE GROUP (J. SCHMIDT IS SUGGESTED)

OR

FORM AN INTERFACE GROUP THAT MEETS OFTEN ENOUGH AND DEVELOP GUIDELINES ON INTERFACE ISSUES.

SUGGESTED MEMBERS:

J. SCHMIDT, W. GAUSTER

D. POST, J. RAWLS

PLUS ONE OR TWO FROM OUTSIDE TPA

FUSION TECHNOLOGY GROUP ACTIVITIES/SCHEDULE

SUMMER 1985

- ORGANIZE SUBGROUPS
- CHARACTERIZE ISSUES
- IDENTIFY, QUANTIFY EXPERIMENTS NEEDED (NOT FACILITIES, BUT MAJOR FEATURES OF EXPERIMENTS, EXPERIMENTAL CONDITIONS) TO RESOLVE ISSUES
- EVOLVE METHODOLOGY FOR PLANNING

FALL 1985

- EVALUATE EXISTING FACILITIES CAPABILITIES AND LIMITATIONS
- CHARACTERIZE, SELECT NEW FACILITIES
- DEVELOP ALTERNATIVE PATHWAYS

WINTER 1986

- COMPARE ALTERNATIVES FOR EACH COMPONENT
- COMPARE "RELATIVE WORTH" AMONG COMPONENTS?
- DEVELOP BASIC ELEMENTS/FEATURES OF TECHNOLOGY TECHNICAL PLAN

SPRING 1986

- FOCUS ON SPECIFIC PLANS FOR NEXT FIVE YEARS WITH MFPP ISSUES ORIENTATION
- REFINEMENT
- WRITING

VERY NEAR-TERM MILESTONES FOR TECHNOLOGY

SEPTEMBER 4-6

- MEETING IN CHICAGO
- FOCUS OF MEETING
  - OBJECTIVES AND SUBOBJECTIVES FOR SUBSYSTEMS
  - IMPORTANT FACTORS TO ACHIEVE OBJECTIVES
  - DETAILED DEFINITION OF MFPP ISSUES
  - TECHNICAL ISSUES
  - HIGHLIGHTS OF MAJOR FACILITIES, EXPERIMENTS AND RESEARCH ACTIVITIES

INTERIM REPORT

- OUTLINE DEVELOPED JULY 19
- FIRST DRAFT DUE: OCTOBER 5
- FINAL MANUSCRIPT DUE: OCTOBER 20
- ISSUE: OCTOBER 31