DISCUSSION TOPICS FOR THE TPA TECHNOLOGY STEERING COMMITTEE

MOHAMED ABDOU

TPA TECHNOLOGY STEERING COMMITTEE MEETING
SHERATON O'HARE
SEPTEMBER 4-6, 1985

TOPICS

- AGENDA (AND CHANGES)
- TPA MISSION STATEMENT HIGHLIGHTS
- DETAILED DEFINITON OF MFPP ISSUES
- ORGANIZATIONAL DETAIL
- TPA TECHNOLOGY PROCESS AND OVERALL SCHEDULE
- SETTING OBJECTIVES
- ATTRIBUTES (IMPORTANT FACTORS)
- CHARACTERIZATIONS OF TECHNICAL ISSUES (TECHNICAL CONTENT AND FORMAT)
- GENERIC DESIGNS/PARAMETERS ASSUMPTIONS
- INTERIM OCTOBER REPORT
  - OUTLINE
  - CONTENT
  - LEAD AUTHORS
  - SCHEDULE

AGENDA

TPA TECHNOLOGY STEERING COMMITTEE
Sheraton International Hotel - O'Hare Aiport
September 4-6, 1985

Wednesday, September 4

Morning (9:00-11:30)

Introduction	Abdou
TPA Mission Statement	
Detailed Definition of MFPP Issues	
Organizational Detail	
Interim (October) Report	

Afternoon (1:00-5:30) (Burn/Confinement Support Technologies)

1:00 - 2:15	Magnets	Henning
2:15 - 3:30	Heating/Fueling	Berry
3:30 - 5:00	PIC	Gauster/Schmidt

Thursday, September 5

Morning (9:00-12:00)

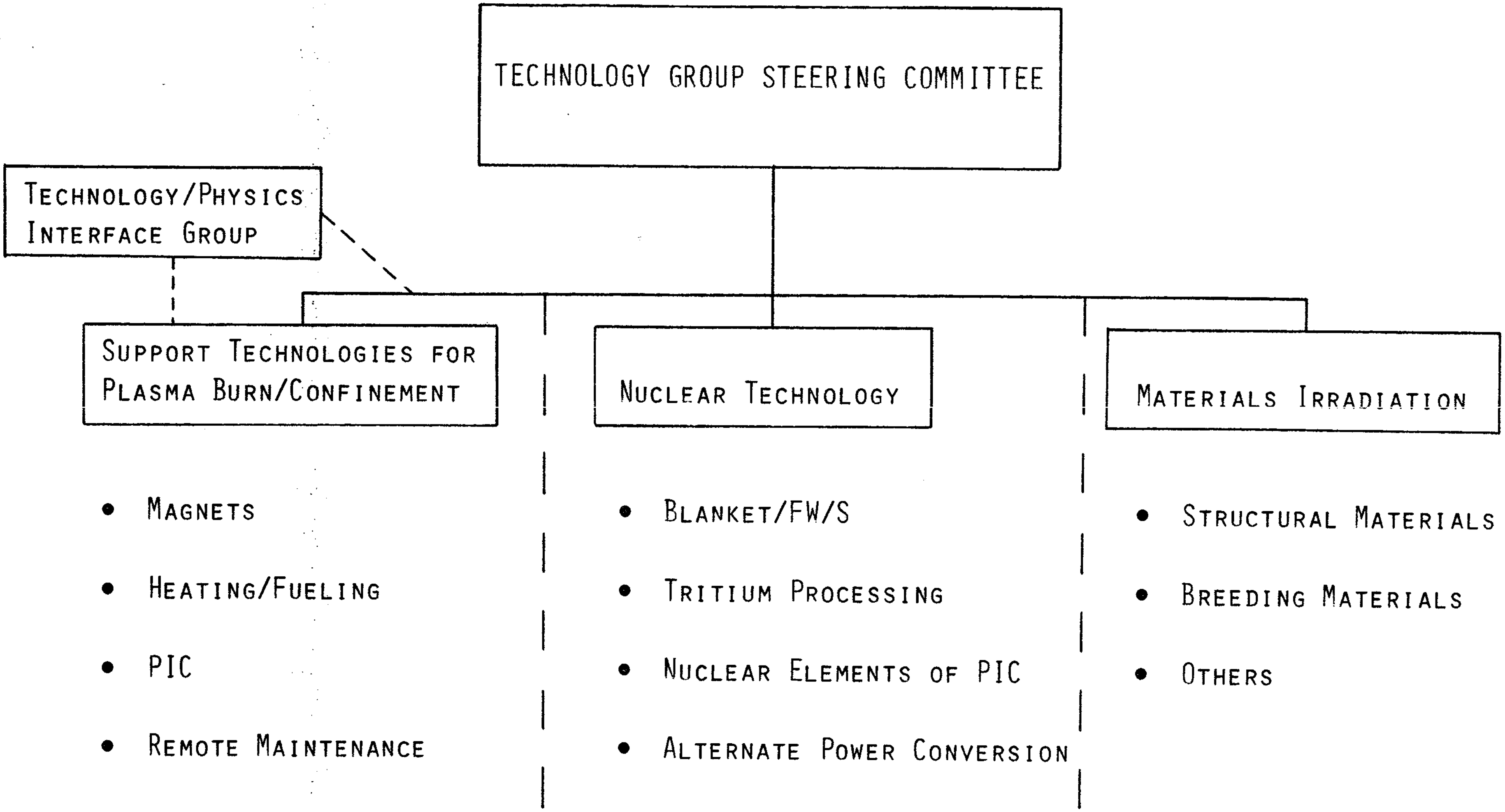
9:00 - 10:30	Materials Irradiation Issue	Smith
10:30 - 12:00	Nuclear Technology Issue and Blanket/FW/Shield	Berwald
12:00 - 1:30	Lunch	

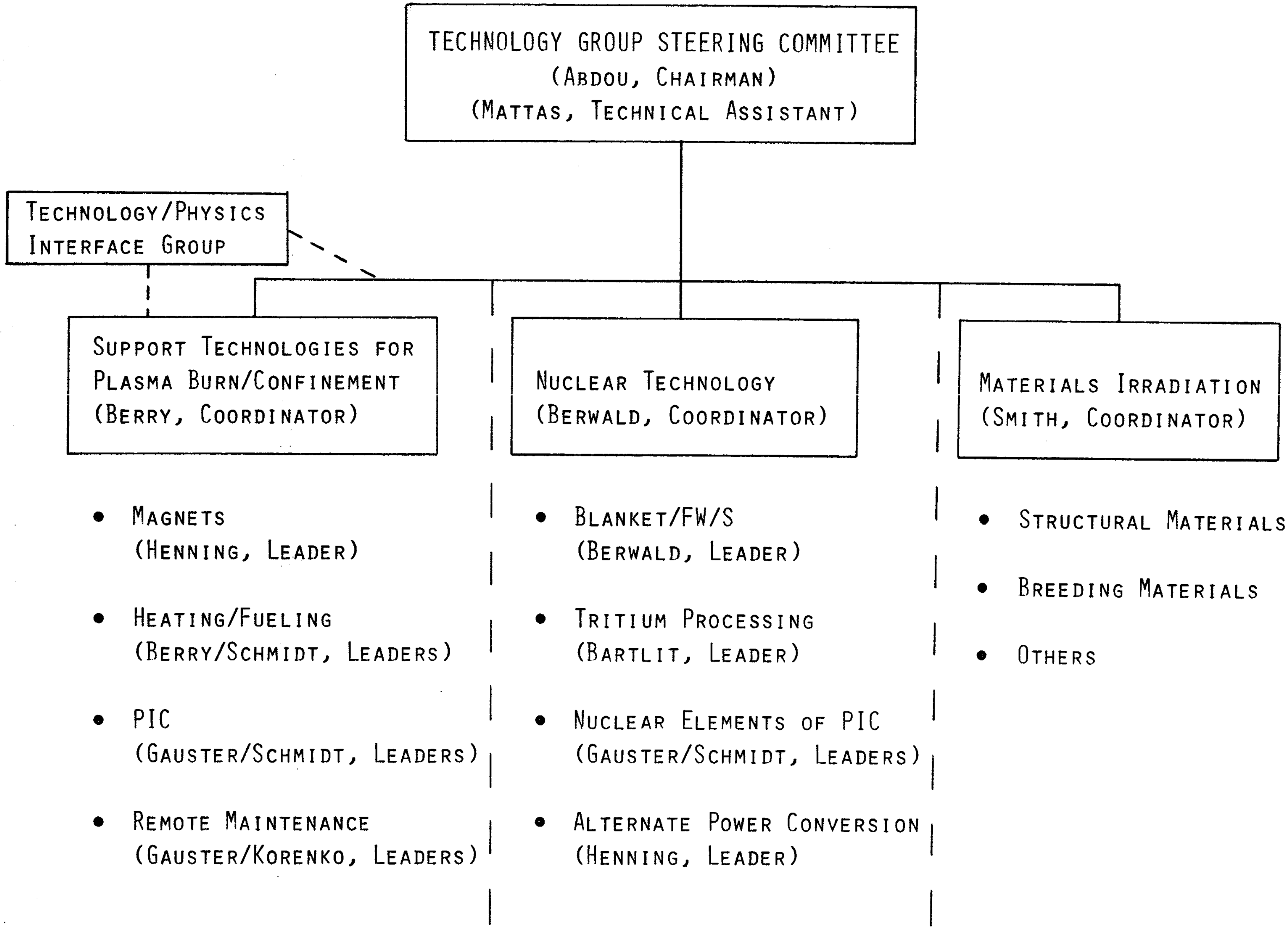
Afternoon (1:30-5:30)

1:30 - 2:00	Tritium Processing	Bartlit
2:00 - 3:00	Nuclear Portion of PIC	Gauster/Schmidt
3:00 - 3:30	Alternate Power Conversion	Henning
3:30 - 4:00	Remote Maintenance	Korenko
4:00 - 5:30	Setting Objectives and Attributes	

Friday, September 6 (9:00-12:30)

Important session to discuss specifics of TPA Technology and October Interim Report.


TECHNOLOGY GROUP STEERING COMMITTEE
TECHNOLOGY/PHYSICS INTERFACE GROUP
SUPPORT TECHNOLOGIES FOR PLASMA BURN/CONFINEMENT
NUCLEAR TECHNOLOGY
MATERIALS IRRADIATION
• MAGNETS
• HEATING/FUELING
• PIC
• REMOTE MAINTENANCE
• BLANKET/FW/S
• TRITIUM PROCESSING
• NUCLEAR ELEMENTS OF PIC
• ALTERNATE POWER CONVERSION
• STRUCTURAL MATERIALS
• BREEDING MATERIALS
• OTHERS


TECHNOLOGY GROUP STEERING COMMITTEE
(ABDOU, CHAIRMAN)
(MATTAS, TECHNICAL ASSISTANT)
TECHNOLOGY/PHYSICS INTERFACE GROUP
SUPPORT TECHNOLOGIES FOR PLASMA BURN/CONFINEMENT
(BERRY, COORDINATOR)
NUCLEAR TECHNOLOGY
(BERWALD, COORDINATOR)
MATERIALS IRRADIATION
(SMITH, COORDINATOR)
• MAGNETS (HENNING, LEADER)
• HEATING/FUELING (BERRY/SCHMIDT, LEADERS)
• PIC (GAUSTER/SCHMIDT, LEADERS)
• REMOTE MAINTENANCE (GAUSTER/KORENKO, LEADERS)
• BLANKET/FW/S (BERWALD, LEADER)
• TRITIUM PROCESSING (BARTLIT, LEADER)
• NUCLEAR ELEMENTS OF PIC (GAUSTER/SCHMIDT, LEADERS)
• ALTERNATE POWER CONVERSION (HENNING, LEADER)
• STRUCTURAL MATERIALS
• BREEDING MATERIALS
• OTHERS

NUCLEAR TECHNOLOGY

- Nuclear Subsystems
- All Technology Aspects
- Phenomena Exploration
- Multiple Effect Tests
- Integrated Tests
- Concept Verification
- Analytical Modelling
- Experiments, Facilities for Nuclear Technology R&D

MATERIALS IRRADIATION

- Materials for Reactor Subsystem
- Single Material Irradiation
- Basic Material Properties (Physical, Chemical, Mechanical and Nuclear Properties) for all Materials (structure, multiplier, breeder, coolant, etc.)
- Radiation Damage Theory
- Facilities for Single Material Irradiation

INTERFACE BETWEEN PLASMA-INTERACTIVE COMPONENTS AND PLASMA HEATING

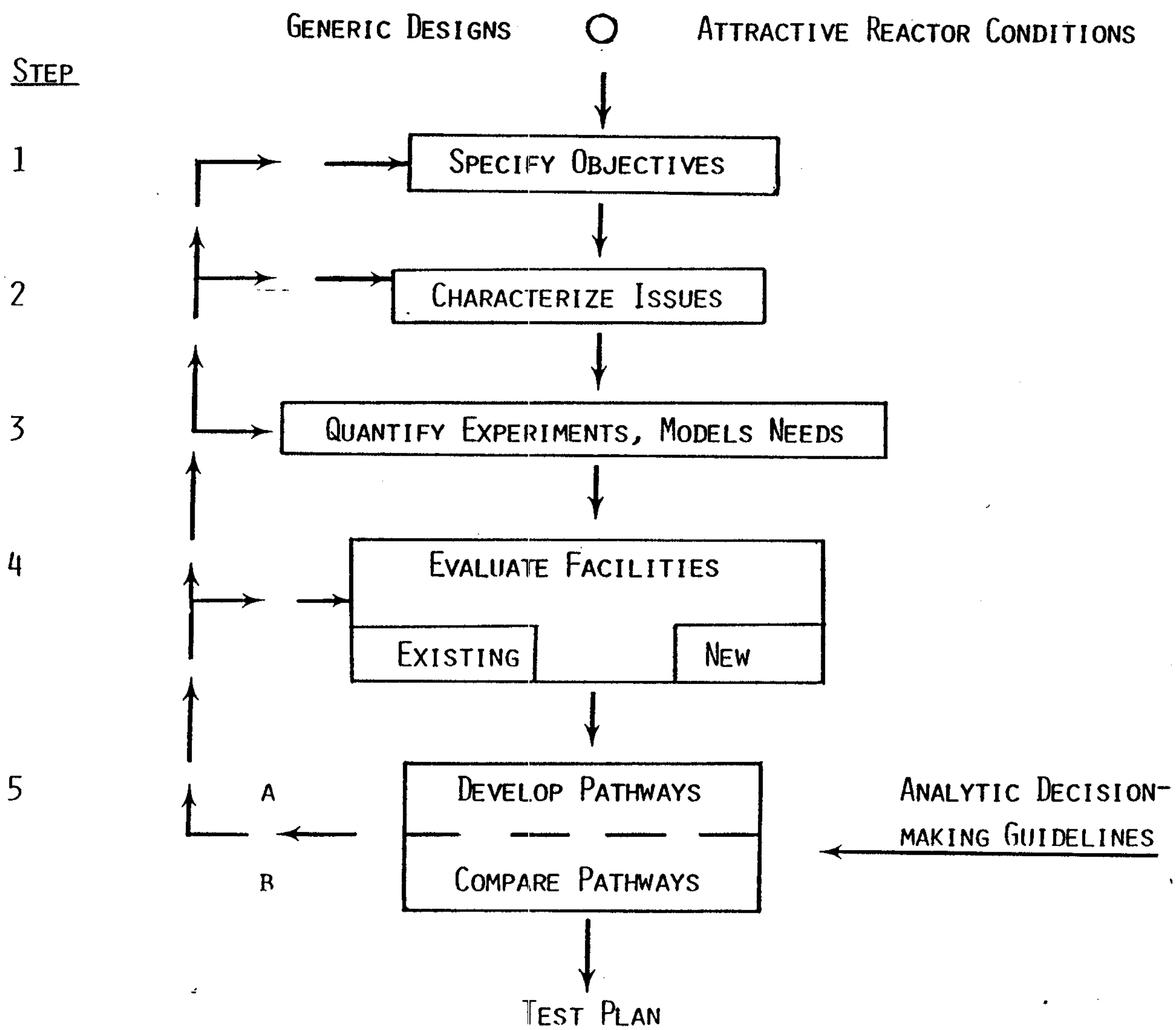
- PROBLEM:

  TECHNICAL AREAS OF EROSION, HEAT REMOVAL, ETC. FOR IN-VESSEL ELEMENTS OF HEATING NEED TO BE CONSISTENT WITH THOSE FOR LIMITER, DIVERTOR, ETC.

- SUGGESTED RESOLUTION:

  - PIC GROUP INCLUDES ALL IN-VESSEL ELEMENTS (I.E., LIMITER, DIVERTOR, RF ANTENNA, ETC.)
  - HEATING GROUP WILL DEAL WITH POWER INPUT AND HEATING TECHNOLOGY

TPA TECHNOLOGY METHODOLOGY STEPS



FUSION TECHNOLOGY GROUP ACTIVITIES/SCHEDULE

SUMMER 1985

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

FALL 1985

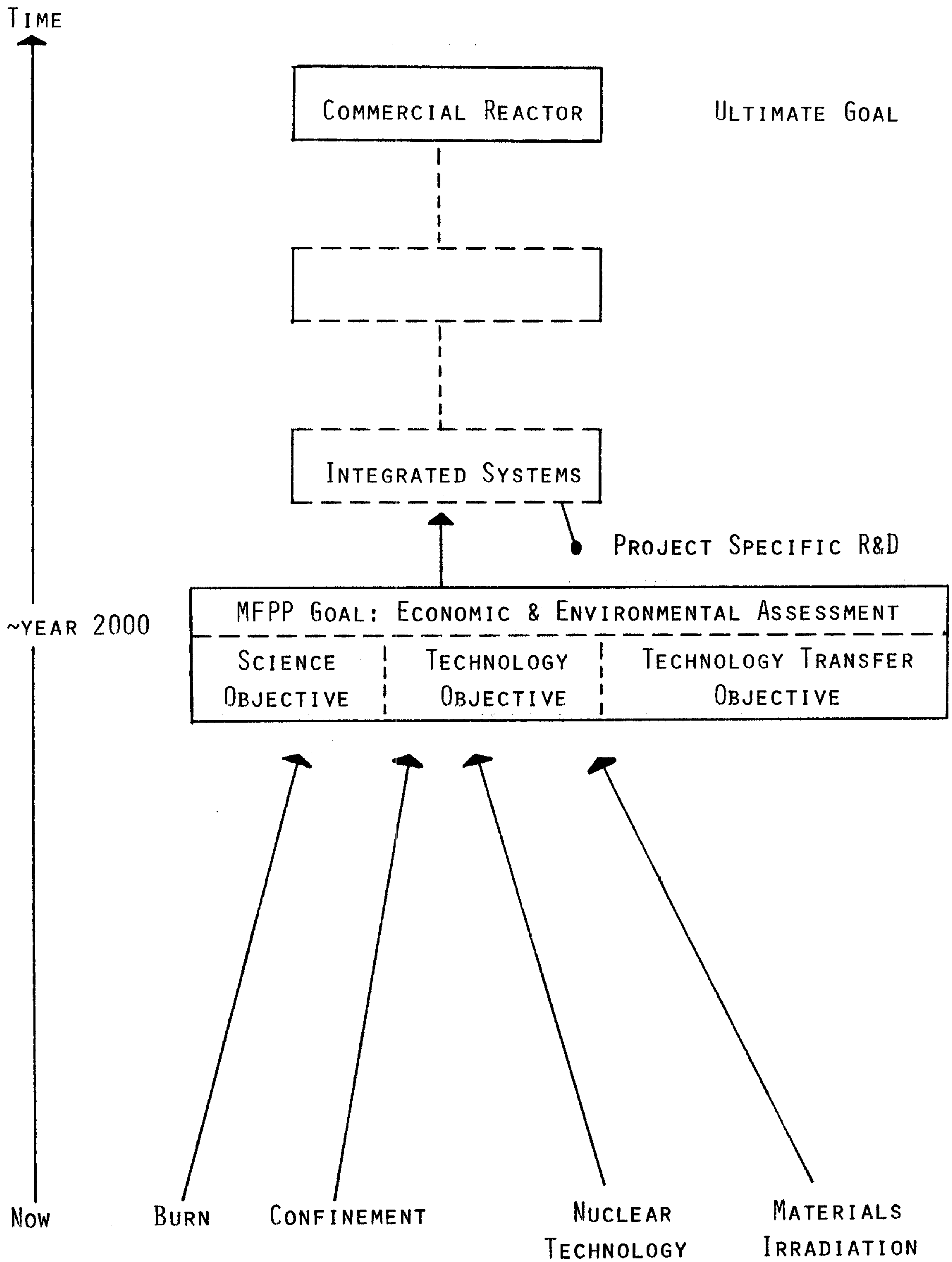
- EVALUATE EXISTING FACILITIES' CAPABILITIES AND LIMITATIONS
- CHARACTERIZE, SELECT NEW FACILITIES
- DEVELOP ALTERNATIVE PATHWAYS

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



Time
Commercial Reactor
Ultimate Goal
Integrated Systems
Project Specific R&D
~Year 2000
MFPP Goal: Economic & Environmental Assessment
Science Objective
Technology Objective
Technology Transfer Objective
Now
Burn
Confinement
Nuclear Technology
Materials Irradiation

MFPP Goal

Establish the Scientific and Technological Base Required for Fusion Energy

TPA plans should support goal and three strategic objectives.

Strategic Objectives

Science Objective

Be able to predict, control and optimize the behavior of plasma confined in fusion relevant magnetic configurations

Technology Objective

Show that it is possible to create the unique fusion components and subsystems under conditions relevant to fusion energy sources

Technology Transfer Objective

Provide a range of options for private sector investment and commercial development of fusion

Plasma Science will be planned with an issue orientation.

Fusion Technology will be planned with a component orientation.

Characterize Issues

- Assess Accuracy and Completeness of Existing Data and Models
- Analyze Scientific/Engineering Phenomena to Determine (Anticipate) Behavior, Interactions and Governing Parameters in Fusion Reactor Environment
- Evaluate Effect of Uncertainties on Design Performance
- Compare Tolerable and Estimated Uncertainties

△ Quantified Understanding of Important Issues, Interactions, Parameters . . .

FINESSE

ITEMS TO BE INCLUDED IN CHARACTERIZATION OF ISSUES

1. DESCRIPTION

   TEXT TO DESCRIBE PROBLEM

2. POTENTIAL IMPACT

   ONE (OR TWO) ENTRIES FROM ATTACHED TABLE

3. DESIGN SPECIFITY

   ENTRIES CAN BE

   - GENERIC
   - TOKAMAK
   - GENERIC/SOLID BREEDERS

4. LEVEL OF CONCERN

   - CRITICAL
   - HIGH
   - MEDIUM
   - LOW

5. OPERATING ENVIRONMENT/PARAMETERS

   SYMBOLS FROM ATTACHED TABLE TO INDICATE ENVIRONMENTAL CONDITIONS RELEVANT TO ISSUE

Table 3.2-1 Fusion Nuclear Testing Issues

Issue/Technical Area	Potential Impact	Design Specificity	Level of Concern	Operating Environment	
				Neutron	Parameters
I. **BLANKET/FIRST WALL ISSUES**					
A. **STRUCTURE**					
1. Changes in Properties and Behavior of Materials	US,UL	generic	critical	D,R	ϕ,S,F,T,σ,H,N
a. Prediction of Radiation Damage Indicators	US,UL	generic	high	D	S
2. Deformation and/or Breach of Components					
a. Effect of First Wall Heat Flux and Cycling on Fatigue or Crack Growth Related Failure	DW,RS,UL	tokamak	critical	H,D	Q,T,t,G,σ,N
b. Magnetic Field Interactions within the Structure					
1) Magnetic Forces due to Disruptions and Magnetic Transients	DW	tokamak	high	—	B,$\dot{B}$,G,σ,T,v,C
2) Magnetically Induced Stresses in Ferritic Steels	RL,IC	ferritic steels	low	R,D	B,$\dot{B}$,S,F,ϕ, T,G,N
c. Failures at Welds and Discontinuities	RS,UL	generic	high	R,D	A,ϕ,S,F,T,σ,N
d. Failures due to Hot Spots	RS,UL,DW	generic	high	H,D,R	B,G,T,ϕ, S,F,v,q
e. Interaction of Primary and Secondary Stresses and Deformation	UL,IC	generic	high	H,D,R	S,F,ϕ,q, T,σ,G
f. Failure due to Shutdown Residual Stress Effects	UL,IC	generic	high	D,R	S,F,ϕ,q,T,σ,G
g. Effect of Swelling, Creep, and Thermal Gradients on Stress Concentrations	UL,IC	generic	medium	D,R	S,F,q,T,σ,G
1) Response of Grooved Surface Concepts	RP,IC,UL	design	medium	H,D	t,q,T,σ,S,F
h. Interaction between Surface Effects and First Wall Failures	UL,RL	generic	medium	D	PMI,q,t,T, I,σ,B,F
i. Self-Welding of Similar and Dissimilar Metals	UL	generic	low	H,D,R	ϕ,S,F,T,σ,G
3. Tritium Permeation through the Structure					
a. Effectiveness of Tritium Permeation Barriers	US	generic	critical	D	T,I,C,γ,P_t, S,F,σ
b. Effect of Radiation on Tritium Permeation	RC,RS	generic	medium	D	T,ϕ,S,P_t,F,γ
4. Structural Activation Product Inventory	RC,RS	generic	low	R	S,F,I

Table 3.1-4 Key to Parameters

F	Fluence	PMI	Plasma-Materials Interactions
ϕ	Flux	G	Geometry
S	Spectrum	Q	Power Density
T	Temperature	t	Time
σ	Stress State	q	Surface Heat Flux
C	Chemical Environment	P	Pressure
I	Impurities	P_t	Tritium Pressure
H	Tritium	v	Velocity
A	Dimensions (Area)	N	Cyclic Operation
B	Magnetic Field Strength	s	Surface Condition
B,b	Transient Magnetic Field	γ	Gamma Radiation

Other Abbreviations

TC	Ternary Ceramic
SB	Solid Breeder
LB	Liquid Breeder
LM	Liquid Metal
DS	Draw Salt

POTENTIAL IMPACT

Feasibility Issues

- May Close the Design Window
- May Result in Unacceptable Safety Risk
- May Result in Unacceptable Reliability, Availability or Lifetime

Attractiveness Issues

- Reduced System Performance
- Reduced Component Lifetime
- Increased System Cost
- Less Desirable Safety or Environmental Impact

FINESSE

From S. Dean
8/13/85

SYSTEMS PARAMETER GOALS FOR COMMERICAL AND INTEGRATED TEST FUSION REACTORS FOR ELECTRICITY

PARAMETER		COMMERICAL GOAL	INTEGRATED FACILITY GOAL
Net Electric Power,	MWe	$\lesssim$ 1200	
Fusion Power,	MW_2	$\lesssim$ 3500	$\lesssim$ 600
Weight of Fusion Island,	Tonnes	$\lesssim$ 10,000	
Neutron Flux to First Wall,	MWm^{-2}	4-6	$\lesssim$ 3
Wall Lifetime Fluence,	$MW \cdot y \cdot m^{-2}$	$\gtrsim$ 15	
Blanket & Shield Thickness,	m	$\lesssim$ 1.5	$\lesssim$ 1
Availability,	%	$\gtrsim$ 70	
Duty Factor,	%		~ 25
Toroidal Device Avg Beta,	%	~ 10	~ 10
Tokamak Thermal Diffusivity,	m^2g^{-1}	~ 1.5	~ 0.3
Stellarator RFP Therm Diff,	m^2g^{-1}	~ 0.7	~ 0.15
Stell or Tok Max Field,	T	9-12	9-12
RFP Max Field,	T	3	3
Mirror Avg Beta,	%	25	25-50
Mirror Thermal Diffusivity,	m^2s^{-1}	~ 0.12	~ 0.06
FRC Avg Beta,	%	~ 85	12-23
FRC Thermal Diffusivity,	m^2s^{-1}	3.5	~ 0.75
Peak Surface Heat Load,	MWm^{-2}		
Avg Surface Head Load,	MWm^{-2}		

TPA TECHNOLOGY INTERIM REPORT OUTLINE

	Lead Author	Pages
1. Introduction	Abdou	10
1.1 Scope		
1.2 Need for Technology	Woodson	
1.3 Assumptions	Henning	
1.4 Key Technologies and MFPP Issues		
1.5 TPA Technology Organization		
2. Summary		10
2.1 Fusion Nuclear Technology	Berwald	
2.2 Fusion Material Irradiation	Smith	
2.3 Support Technologies for Plasma Burn and Confinement Issues	Berry	
3. Fusion Nuclear Technology	Berwald	30
3.1 Introduction	Berwald	
3.2 Blanket/First Wall/Shield	Berwald	
3.3 Tritium Processing	Bartlit	
3.4 Nuclear Aspects of In-vessel Components	Gauster/Schmidt	
3.5 Alternate Power Conversion	Henning	
4. Materials Irradiation Issue	Smith/Yoshikawa	15
5. Support Technologies for Plasma Burn and Confinement Issues	Berry	30
5.1 Introduction	Berry	
5.2 Magnets	Henning	
5.3 Heating and Fueling	Berry	
5.4 Impurity Control and Exhaust	Gauster/Schmidt	
5.5 Remote Maintenance	Gauster/Yoshikawa	