CONTENTS

	EX	ECUTIVE SUMMARY	11
	1.	INTRODUCTION	11
	2.	MAJOR CONCLUSIONS	11
	3.	SAFETY APPROACH	12
	4.	PASSIVE SAFETY	16
	5.	TECHNICAL RESULTS	16
		5.1 Plasma physics	16
		5.2 Plasma facing components	17
		5.3 Tritium fuel cycle	17
		5.4 Nuclear engineering	18
		5.5 Radioactivity confinement	19
		5.6 Magnets	20
		5.7 ITER test program	20
	6.	SUMMARY OF ACCIDENT CONCERNS IN TERMS	
		OF DOSES	20
	7.	RECOMMENDATIONS FOR THE EDA	23
	8.	SAFETY CONSIDERATIONS FOR SITING ITER	26
	9.	RECOMMENDATIONS FOR SAFETY R&D FOR ITER	27
I.	IN	FRODUCTION	29
I. II.	IN7	FRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT	29 33
I. II.	INT NO 1.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION	29 33 33
I. II.	IN7 NO 1. 2.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS	29 33 33 33
I. II.	IN7 NO 1. 2.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation	29 33 33 33 33
I. II.	IN7 NO 1. 2.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations	29 33 33 33 33 33 35
п.	IN7 NO 1. 2.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents	29 33 33 33 33 33 35 36
Ι. П.	IN7 NO 1. 2. 3.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS	29 33 33 33 33 35 36 36
Π.	IN7 NO 1. 2. 3.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products	29 33 33 33 33 35 36 36 36 37
п.	IN7 NO 1. 2. 3.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas	29 33 33 33 33 35 36 36 37 38
I.	IN7 NO 1. 2. 3.	TRODUCTION ORMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas 3.3 Activated dust	29 33 33 33 33 35 36 36 37 38 38
Π.	IN7 NO 1. 2. 3.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas 3.3 Activated dust 3.4 Summary of atmospheric activation products effluents	29 33 33 33 33 35 36 37 38 38 39
п.	IN7 NO 1. 2. 3.	TRODUCTION ORMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents 3.1 Activated corrosion products 3.2 Activated corrosion products 3.3 Activated dust 3.4 Summary of atmospheric activation products effluents	29 33 33 33 33 35 36 37 38 38 39 39
I.	IN7 NO 1. 2. 3.	TRODUCTION ORMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas 3.3 Activated dust 3.4 Summary of atmospheric activation products effluents	29 33 33 33 33 35 36 36 37 38 38 39 39
I. II.	IN7 NO 1. 2. 3. 4.	TRODUCTION PRMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas 3.3 Activated dust 3.4 Summary of atmospheric activation products effluents	29 33 33 33 33 33 35 36 37 38 38 39 39
п.	IN7 NO 1. 2. 3. 4. AC	TRODUCTION ORMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents 3.1 Activated corrosion products 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas 3.3 Activated dust 3.4 Summary of atmospheric activation products effluents CONCLUSIONS CUDENT SCENARIOS	29 33 33 33 33 35 36 37 38 39 39 41
I. II. III.	IN7 NO 1. 2. 3. 4. AC 1.	TRODUCTION ORMAL OPERATION EFFLUENTS ASSESSMENT INTRODUCTION ATMOSPHERIC TRITIUM EFFLUENTS 2.1 Tritium effluents during normal operation 2.2 Tritium effluents during maintenance operations 2.3 Summary of atmospheric tritium effluents ATMOSPHERIC ACTIVATION PRODUCTS EFFLUENTS 3.1 Activated corrosion products 3.2 Activation of cooling water/inert gas/insulating gas 3.3 Activated dust 3.4 Summary of atmospheric activation products effluents CONCLUSIONS	29 33 33 33 33 35 36 37 38 39 39 41

	3. SCENARIOS	42	
	3.1 Accident groups	42	
	3.2 Ranking	45	
	4. CONCLUSIONS	45	
IV . 1	PLASMA CHAMBER SAFETY	47	
	1. INTRODUCTION	47	
1	2. CHARACTERIZATION OF VACUUM CHAMBER,		
	IN-CHAMBER COMPONENTS, SAFETY ISSUES		
	AND FEATURES	47	1
	2.1 Vacuum chamber and in-chamber components	47	
	2.2 Safety issues	48	
	2.3 Safety features	49	
	3. LOSS OF COOLANT ACCIDENT (LOCA) ANALYSES	50	
	3.1 Temperature transients	50	
	3.2 Pressurization	51	
	3.3 Chemical reactions (mainly carbon-steam)	52	
	4. LOSS OF VACUUM ACCIDENT (LOVA) ANALYSES	53	1
	4.1 Temperature transients	53	
	4.2 Pressurization	54	
	4.3 Chemical reactions (mainly carbon-air)	54	
	5. RADIOACTIVITY MOBILIZATION	55	
	5.1 Tritium	55	
	5.2 Activation products	56	i
	5.3 Doses	57	1
	6. CONCLUSIONS	57	
V. 1	TRITIUM SYSTEM SAFETY	61	

TR	ITIUN	I SYSTEM SAFETY 61
1.	INTE	RODUCTION
2.	BRI	EF DESCRIPTION OF THE TRITIUM SYSTEM 61
3.	FAIL	URE MODE AND EFFECTS ANALYSIS 65
4.	GUI	DELINES FOR TRITIUM SYSTEM DESIGN
	4.1	Multiple barrier containment
	4.2	Fail safe design 67
	4.3	Redundancy and spares 67
	4.4	Isolation from torus
	4.5	Detector performance and reliability
	4.6	Consideration of neutron induced activity
5.	CON	CLUSIONS
	TR 1. 2. 3. 4.	TRITIUM 1. INTH 2. BRIH 3. FAIL 4. GUII 4.1 4.2 4.3 4.4 4.5 4.6 5. CON

VI.	MAGNET SYSTEM SAFETY 73
	1. INTRODUCTION
	2. DEFINITION OF MAGNET SYSTEM OPERATING LEVELS 73
	3. DEFINITION OF FAULTS FOR ANALYSIS
	4. RESULTS 76
	5. CONCLUSIONS 81
VII.	EXTERNAL LOSS OF COOLANT AND COOLANT FLOW 83
	1. INTRODUCTION
	2. CHARACTERIZATION OF THE COOLING SYSTEMS,
	SAFETY ISSUES AND FEATURES
	2.1 Vacuum vessel and in-vessel components
	cooling systems
	2.2 Safety issues
	3. EXTERNAL LOSS OF COOLANT ACCIDENT (LOCA)
	ANALYSES
	3.1 Temperature transients in components
	3.2 Radioactivity mobilization and release from
	the cooling systems
	3.3 Pressurization of volumes
	4. LOSS OF COOLANT FLOW ACCIDENT (LOFA)
	ANALYSES
	4.1 LOFA without plasma shutdown
	4.2 LOFA with subsequent plasma shutdown
	5. CONCLUSIONS
VIII.	WASTE MANAGEMENT ASSESSMENT
	1. INTRODUCTION
	2. INVENTORY OF RADIOACTIVE WASTE
	2.1 Activation products waste
	2.2 Tritiated waste
	3. WASTE MANAGEMENT REGULATIONS
	4. WASTE MANAGEMENT PRELIMINARY SCENARIO 98
	5. CONCLUSIONS 101
IX.	IMPLEMENTATION OF THE ITER SAFETY APPROACH 103
	1. SAFETY APPROACH
	2. PASSIVE SAFETY 103
	2.1 Passive features for loss of flow and/or coolant 104
	2.2 Passive features to prevent chemical combustion
	2.3 Passive electromagnetic features
	2.4 Passive features to control activation products 107

		2.5 Passive features to control tritium	108	
		2.6 Passive confinement features 108	108	
		2.7 Degree of passive safety in the conceptual design 108	108	
	3.	RADIOACTIVITY CONFINEMENT	118	
	4.	ACTIVE SAFETY SYSTEMS 121	121	
	5.	SUMMARY OF ACCIDENT CONCERNS IN TERMS		
		OF DOSES 122	122	
X.	CO	CLUSIONS AND RECOMMENDATIONS 123	123	
	1.	MAJOR CONCLUSIONS 123	123	
	2.	TECHNICAL RESULTS 124	124	
		2.1 Regulations 124	124	
		2.2 Passive safety assessment 124	124	
		2.3 Plasma physics 125	125	
		2.4 Plasma Facing Components (PFC) 125	125	
		2.5 Tritium Fuel Cycle 126	126	
		2.6 Nuclear Engineering 126	126	
		2.7 Radioactivity confinement 127	127	
		2.8 Magnets 128	128	
		2.9 ITER test program 129	129	
	3.	RECOMMENDATIONS FOR ENGINEERING		
		DESIGN ACTIVITY (EDA) 129	129	
	4.	SAFETY CONSIDERATIONS FOR SITING ITER 130	130	
	5.	RECOMMENDATIONS FOR SAFETY R&D FOR ITER . 131	131	
		5.1 Safety issues in the Physics R&D Plan 131	131	
		5.2 Safety issues for the Technology R&D Plan 132	132	