"Oh, by the way, there's been a slight nuclear plant mishap..."

SOURCES OF CONFUSION AND COMMUNICATION DEFICIENCES DURING THE TMI ACCIDENT AND CORRECTIVE ACTIONS

TMI DEFICIENCIES	CORRECTIVE ACTIONS
1. INADEQUATE FACILITIES ● NO SPECIAL TELEPHONE SERVICES ● NRC RESPONSE FACILITY OF LIMITED CAPABILITY ● NO OFFSITE (NEARBY) EMERGENCY OPERATIONS FACILITY OR PRESS CENTER ● LIMITED ASSEMBLY OF PLANT DRAWINGS, MAPS, OR EMERGENCY DOCUMENTS	-DEDICATED TELEPHONE LINES BETWEEN PLANTS & NRC/HQ -NRC OPERATIONS CENTER AT BETHESDA, MD; AUDIO/VIDEO DISPLAYS & DEDICATED COMPUTER SYSTEM -EACH PLANT HAS A DEDICATED EMERGENCY OPERATION FACILITY BASED ON NRC DESIGN CRITERIA; VARIABLE DESIGNS FOR PRESS CENTERS -IMPROVED ASSEMBLY FOR EACH PLANT AT NRC OPERATIONS CENTER AND EMERGENCY OPERATIONS FACILITIES
2. INSUFFICIENT EMERGENCY RESPONSE PLANNING; NO PLAN FOR FEDERAL STATE, LOCAL GOV'TS AND LICENSEE COOPERATION IN HANDLING AN EMERGENCY, INCLUDING PUBLIC INFORMATION ROLES	-NRC INCIDENT RESPONSE PLAN DEFINING ROLES, RESPONSE MODES, FUNCTIONS, AND MANAGEMENT -MANY ITEMS IN TMI ACTION PLAN (NUREG-0737) -DEVELOPING AN EMERGENCY RESPONSE DATA SYSTEM FOR AUTOMATIC COMPUTER-TO-COMPUTER TRANSMISSION OF PRE-SELECTED EMERGENCY PLANT OPERATING DATA TO NRC OPERATING CENTER
3. INADEQUATE EMERGENCY PREPAREDNESS PLANNING FOR PUBLIC PROTECTION	-IN COOPERATION WITH FEMA, DEVELOPED UPGRADED CRITERIA FOR EMERGENCY PLANNING BY LICENSEES & STATE AGENCIES (NUREG-0654) -DEVELOPMENT AND REVIEW OF EVACUATION PLANS AND PERIODIC EVACUATION EXERCISES -CONTRACTOR RESEARCH

SOURCES OF CONFUSION AND COMMUNICATION DEFICIENCES DURING THE TMI ACCIDENT AND CORRECTIVE ACTIONS

TMI DEFICIENCIES	CORRECTIVE ACTIONS
4. INADEQUATE COORDINATION OF ROLES AND EMERGENCY EFFORTS AMONG FEDERAL AGENCIES	-FEMA ESTABLISHED WITH COORDINATION ROLE(EO-12148) -ISSUANCE OF A FULLY OPERATIONAL FEDERAL EMERGENCY RESPONSE PLAN FOR OFFSITE RADIOLOGICAL EMERGENCIES WITH CONCURRENCE OF 12 FEDERAL AGENCIES (50 FR 46542, NOV. 8, 1985) -FEDERAL RADIOLOGICAL MONITORING & ASSESS'T PLAN -MOU'S WITH FBI (TERRORIST ACTIVITIES) AND DOT (TRANSPORTATION ACCIDENTS)
5. INCOMPLETE INFORMATION OF THE STATE OF THE REACTOR AND ACCIDENT PROGRESSION	-ADDITION OF MONITORS AND SENSORS -CONTROL ROOM MODIFICATION INCLUDING A SAFETY PARAMETER DISPLAY SYSTEM -COMPUTER-AIDED DIAGNOSTICS -OPERATOR TRAINING FOR MITIGATION OF CORE DAMAGE -OTHER TMI ACTION PLAN ITEMS (NUREG-0737) -SEVERE ACCIDENT RESEARCH PROGRAM (NUREG-0900) -SEVERE ACCIDENT POLICY REQUIREMENTS FOR PLANT-SPECIFIC PROBABILISTIC EVALUATION OF A PLANT FOR DOMINANT RISK CONTRIBUTORS (NUREG-1070) -SAFETY PROGRAMS OF THE INSTITUTE OF NUCLEAR POWER OPERATIONS (INPO) AND THE NUCLEAR SAFETY ANALYSIS CENTER (NSAC)
6. DEFICIENT GENERIC KNOWLEDGE OF ACCIDENT PRECURSOR SEQUENCES, ACCIDENT PROGRESSION PHENOMENOLOGY, THERMAL HYDRAULIC TRANSIENTS, COMPUTER CODE ASSESSMENTS, CONTAINMENT PERFORMANCE AND FAILURE MODES, HYDROGEN CONTROL, FRACTURE MECHANICS, FISSION PRODUCT RELEASE AND TRANSPORT, AND SEVERE ACCIDENT SEQUENCE ANALYSIS FOR DIFFERENT CLASSES OF PLANT DESIGN	-SEVERE ACCIDENT RESEARCH PROGRAM (NUREG-0900) -PROBABILISTIC RISK ASSESSMENT (NUREG-1050 & NUREG-1150) -SOURCE TERM REASSESSMENT (NUREG-0956) -PRECURSORS TO POTENTIAL SEVERE CORE DAMAGE ACCIDENTS (NUREG/CR-3591 & NUREG/CR-3762) -EVALUATION OF RELIABILITY TECHNOLOGY APPLICABLE TO LWR OPERATIONAL SAFETY (NUREG/CR-4618)

SOURCES OF CONFUSION AND COMMUNICATION DEFICIENCES DURING THE TMI ACCIDENT AND CORRECTIVE ACTIONS

TMI DEFICIENCIES	CORRECTIVE ACTIONS
7. NRC ORGANIZATIONAL DEFICIENCIES IMPAIRING SEVERE ACCIDENT ANALYSIS	-ESTABLISHMENT OF NEW DIVISIONS AND BRANCHES RELATING TO HUMAN FACTORS, SYSTEMS TECHNOLOGY REVIEW, SYSTEMS INTERACTION INCLUDING MAN-MACHINE INTERFACES, ETC.
8. INADEQUATE TRAINING OF THOSE INVOLVED IN COMMUNICATING THE COMPLEXITIES OF NUCLEAR TECHNOLOGIES, HEALTH PHYSICS, ETC. IN JARGON-FREE TERMS AND CONCEPTS THAT ARE UNDERSTANDABLE TO THE PUBLIC, INCLUDING MEDIA REPORTERS	-NRC TRAINING PROGRAMS ON NUCLEAR ACCIDENT COMMUNICATIONS FOR STAFF TECHNICAL ADVISORS/BRIEFERS; LICENSEE PR PERSONNEL, LOCAL, STATE & FEDERAL GOV'T PUBLIC INFORMATION OFFICERS; AND THE NEWS MEDIA -SINCE 1981 NRC HAS CONDUCTED 27 SEMINARS ON REACTORS AND RADIATION INVOLVING 450 MEDIA PARTICIPANTS
9. DIFFICULTIES IN DEALING WITH THE CREDIBILITY GAP AND THE PUBLIC RIGHT TO INFORMATION	-PROVISION OF A STRONGER SCIENTIFIC BASE FOR SEVERE ACCIDENT ANALYSIS THROUGH ABOVE PROGRAMS -OPEN AND CANDID RESPONSE TO QUERIES REGARDING WHAT IS KNOWN AND NOT KNOWN -QUALIFIED JUDGMENT AS TO WHETHER AND HOW TO RESPOND TO SPECULATIVE MATTERS, EXPECIALLY "WHAT-IF" QUESTIONS -IMPROVED UNDERSTANDING OF POSSIBLE MISUNDERSTANDINGS OF RAW DATA OR A TOO-LIMITED INTERPRETATION OF THE LARGER PERSPECTIVE OF SEVERE ACCIDENT CONSEQUENCES AND ISSUES -IMPROVED UNDERSTANDING OF THE FRAGILITY OF CREDIBILITY

BASIS FOR EMERGENCY ACTION LEVELS FOR NUCLEAR POWER FACILITIES

FOUR CLASSES OF EMERGENCY ACTION LEVELS ARE:

1. NOTIFICATION OF UNUSUAL EVENT
2. ALERT
3. SITE AREA EMERGENCY
4. GENERAL EMERGENCY

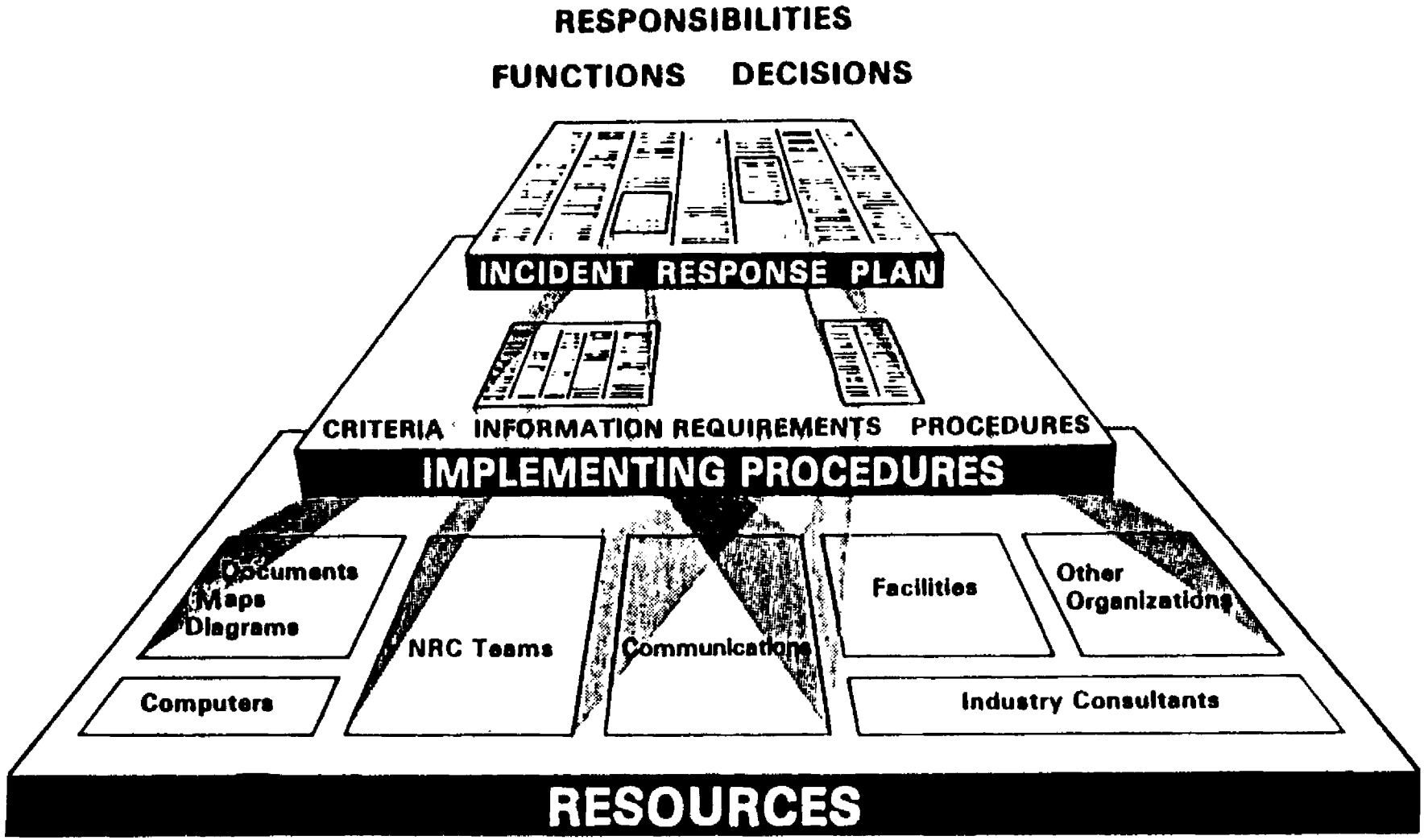
THE RATIONALE FOR THE NOTIFICATION AND ALERT CLASSES IS TO PROVIDE EARLY PROMPT NOTIFICATION OF MINOR EVENTS WHICH COULD LEAD TO MORE SERIOUS CONSEQUENCES GIVEN OPERATOR ERROR OR EQUIPMENT FAILURE OR WHICH MIGHT BE INDICATIVE OF MORE SERIOUS CONDITIONS WHICH ARE NOT YET FULLY REALIZED. A GRADATION IS PROVIDED TO ASSURE FULLER RESPONSE PREPARATIONS FOR MORE SERIOUS INDICATORS. THE SITE AREA EMERGENCY CLASS REFLECTS CONDITIONS WHERE SOME SIGNIFICANT RELEASES ARE LIKELY OR ARE OCCURRING BUT WHERE A CORE MELT SITUATION IS NOT INDICATED BASED ON CURRENT INFORMATION. IN THIS SITUATION FULL MOBILIZATION OF EMERGENCY PERSONNEL IN THE NEAR SITE ENVIRONS IS INDICATED AS WELL AS DISPATCHED OF MONITORING TEAMS AND ASSOCIATED COMMUNICATIONS. THE GENERAL EMERGENCY CLASS INVOLVES ACTUAL OR IMMINENT SUBSTANTIAL CORE DEGRADATION OR MELTING WITH THE POTENTIAL FOR LOSS CONTAINMENT. THE IMMEDIATE ACTION FOR THIS CLASS IS SHELTERING (STAYING INSIDE) RATHER THAN EVACUATION UNTIL AN ASSESSMENT CAN BE MADE THAT (1) AN EVACUATION IS INDICATED AND (2) AN EVACUATION, IF INDICATED, CAN BE COMPLETED PRIOR TO SIGNIFICANT RELEASE AND TRANSPORT OF RADIOACTIVE MATERIAL TO THE AFFECTED AREAS.

NRC INTERFACES WITH OTHER OGRANIZATIONS (EXCEPT LICENSEE)

ORGANIZATION	NRC OUTPUTS TO ORGANIZATION			EXPECTED INPUTS TO NRC	
	IMMEDIATE NOTIFICATION	PERIODIC STATUS REPORTS	TECHNICAL ASSISTANCE	PERIODIC STATUS REPORTS	TECHNICAL ASSISTANCE
DOE	S,I,E	S,I,E	S,I,E	S,I,E	S,I,E
DOT*	S,I,E	S,I,E	S,I,E	S,I,E	S,I,E
FEMA	S,I,E	S,I,E,	I,E	S,I,E,	I,E
EPA	S,I,E	S,I,E	I,E	I,E	I,E
HHS	S,I,E	S,I,E	I,E	I,E	I,E
FBI**	S,I,E	S,I,E	S,I,E	S,I,E	S,I,E
CONGRESS	I,E	I,E	--	--	--
WHITE HOUSE	S,I,E	I,E	--	--	--
STATE	S,I,E	S,I,E	S,I,E	I,E	I,E
CONSULTANTS***	--	--	S,I,E	--	S,I,E
PUBLIC, MEDIA	--	I,E	--	S,I,E	--

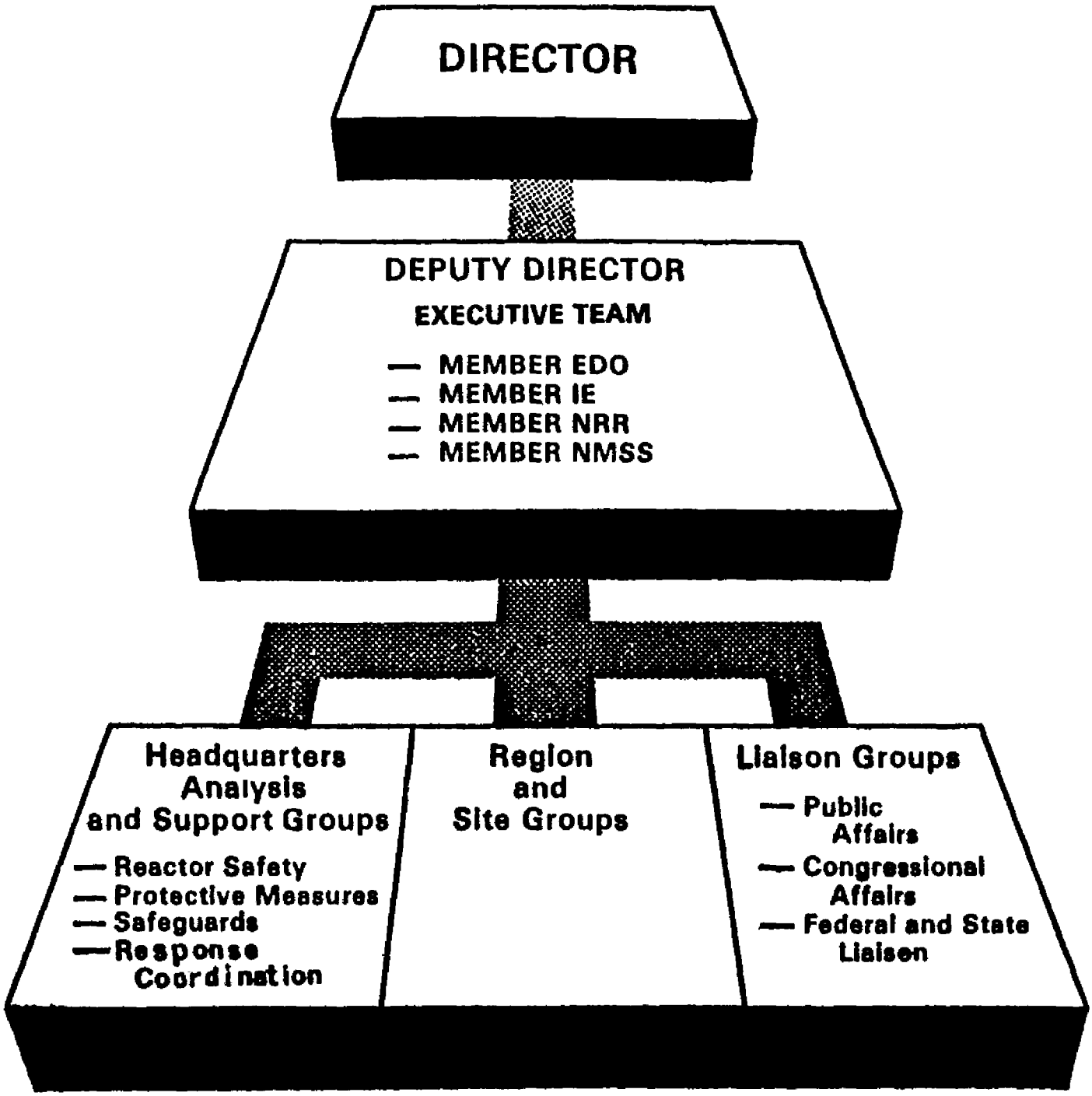
LEGEND: S - DURING STANDBY
I - DURING INITIAL ACTIVATION
E - DURING EXPANDED ACTIVIATION

*TRANSPORTATION ONLY
**SAFEGUARDS ONLY
***INDUSTRY, ADVISORS, PLANT VENDORS, CONTRACTORS

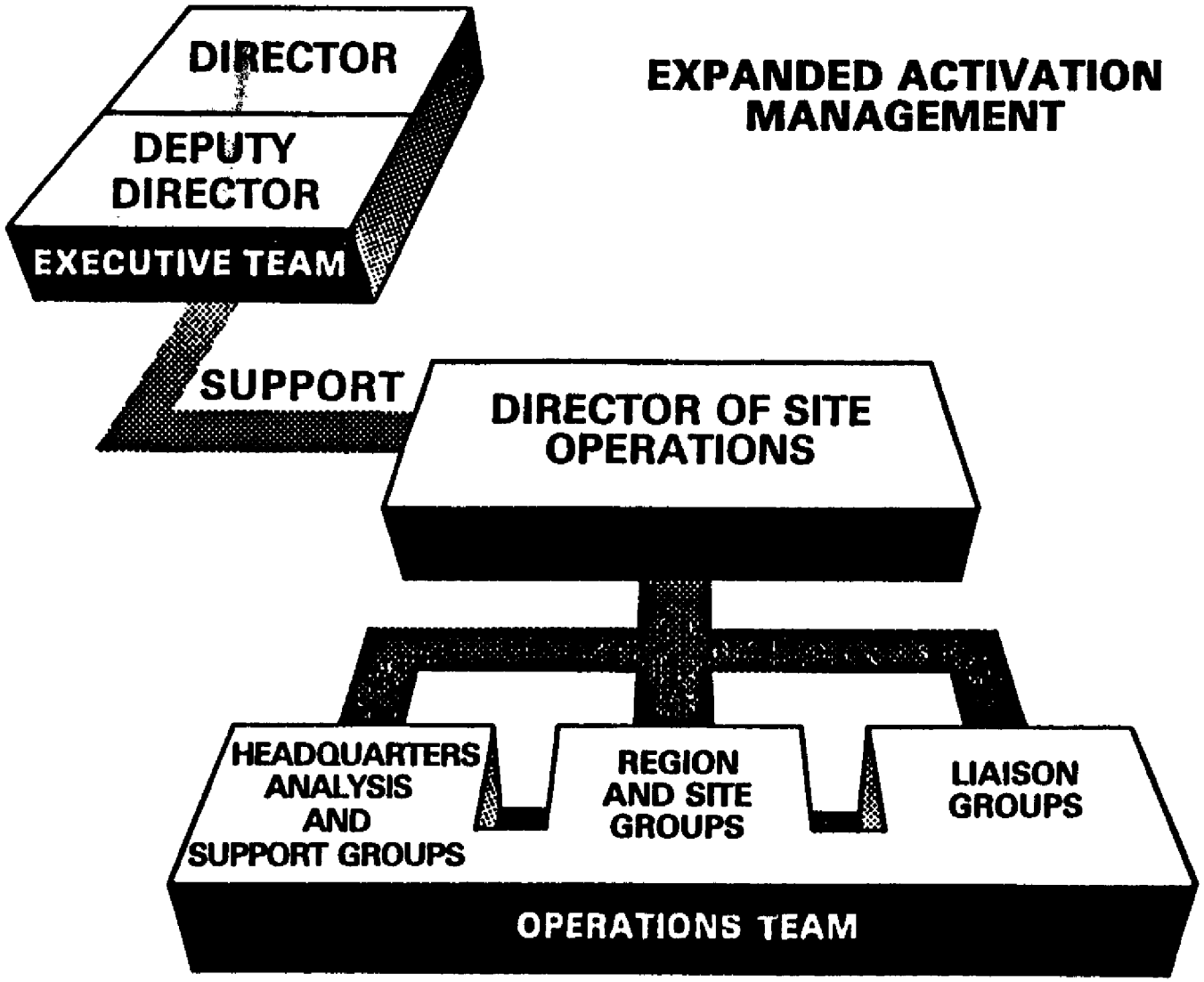


RELATIONSHIP OF PLAN, PROCEDURES, AND RESOURCES

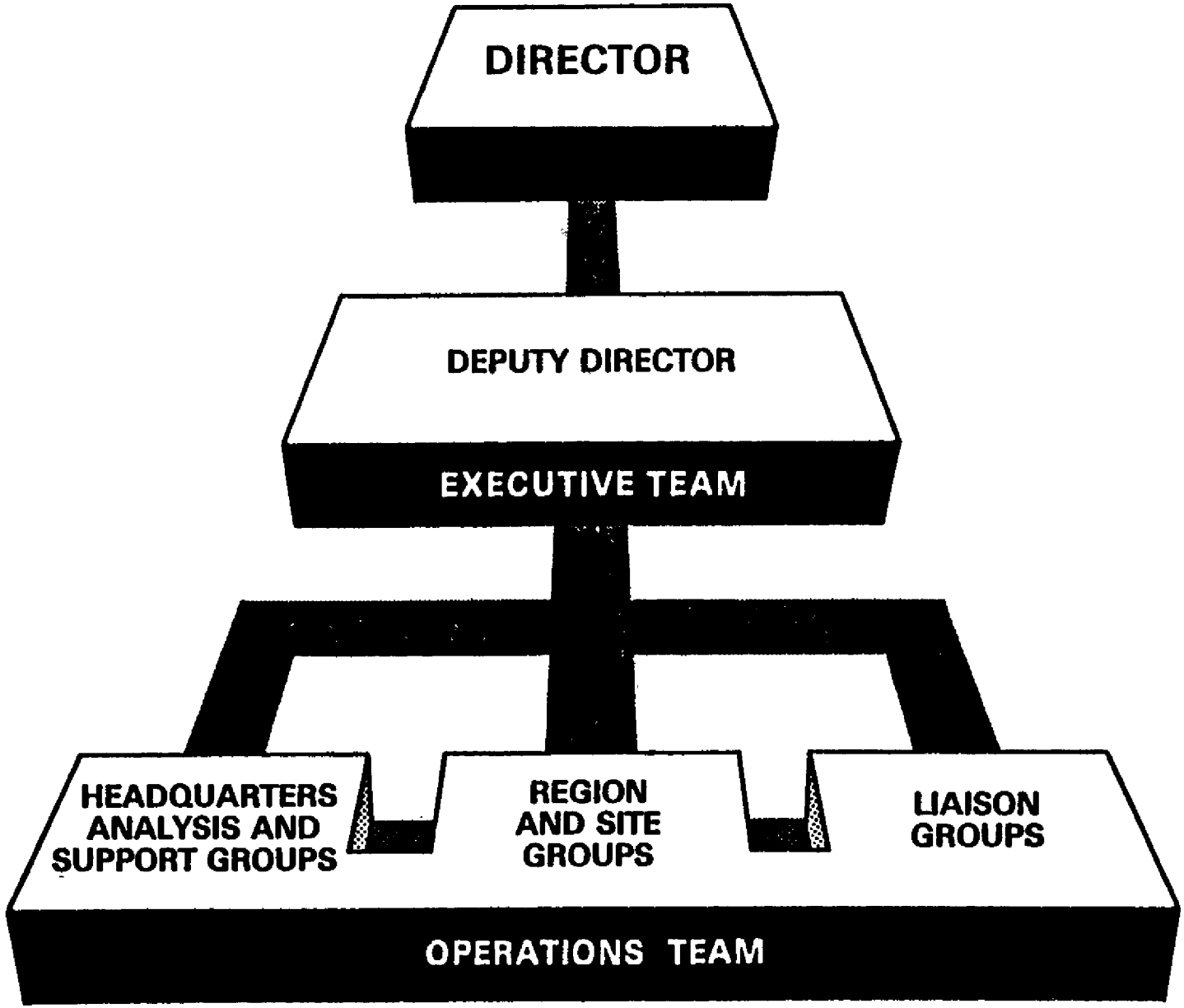
HEADQUARTERS INTERNAL ORGANIZATION
INITIAL ACTIVATION

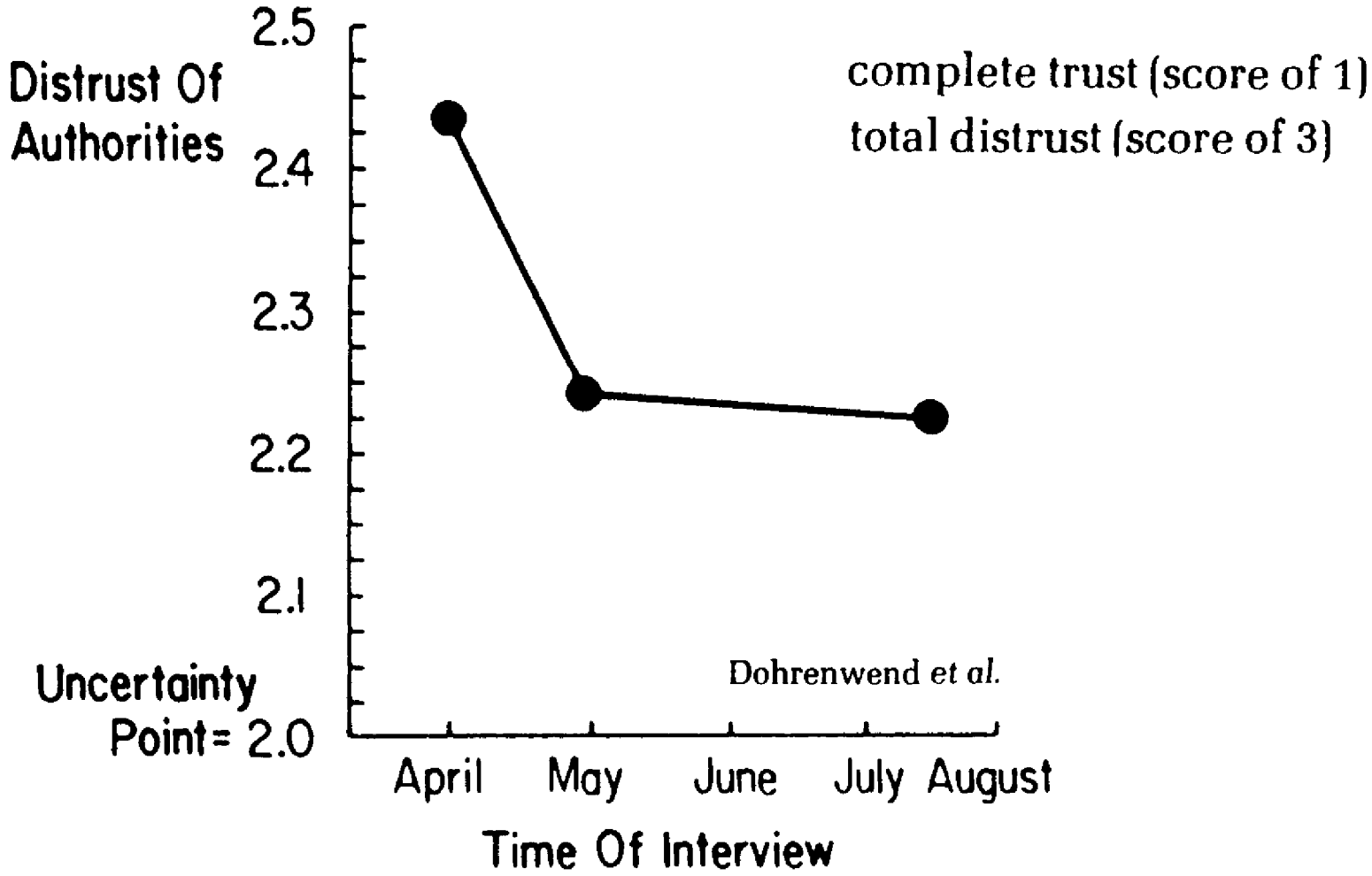


EXPANDED ACTIVATION MANAGEMENT



INITIAL ACTIVATION MANAGEMENT

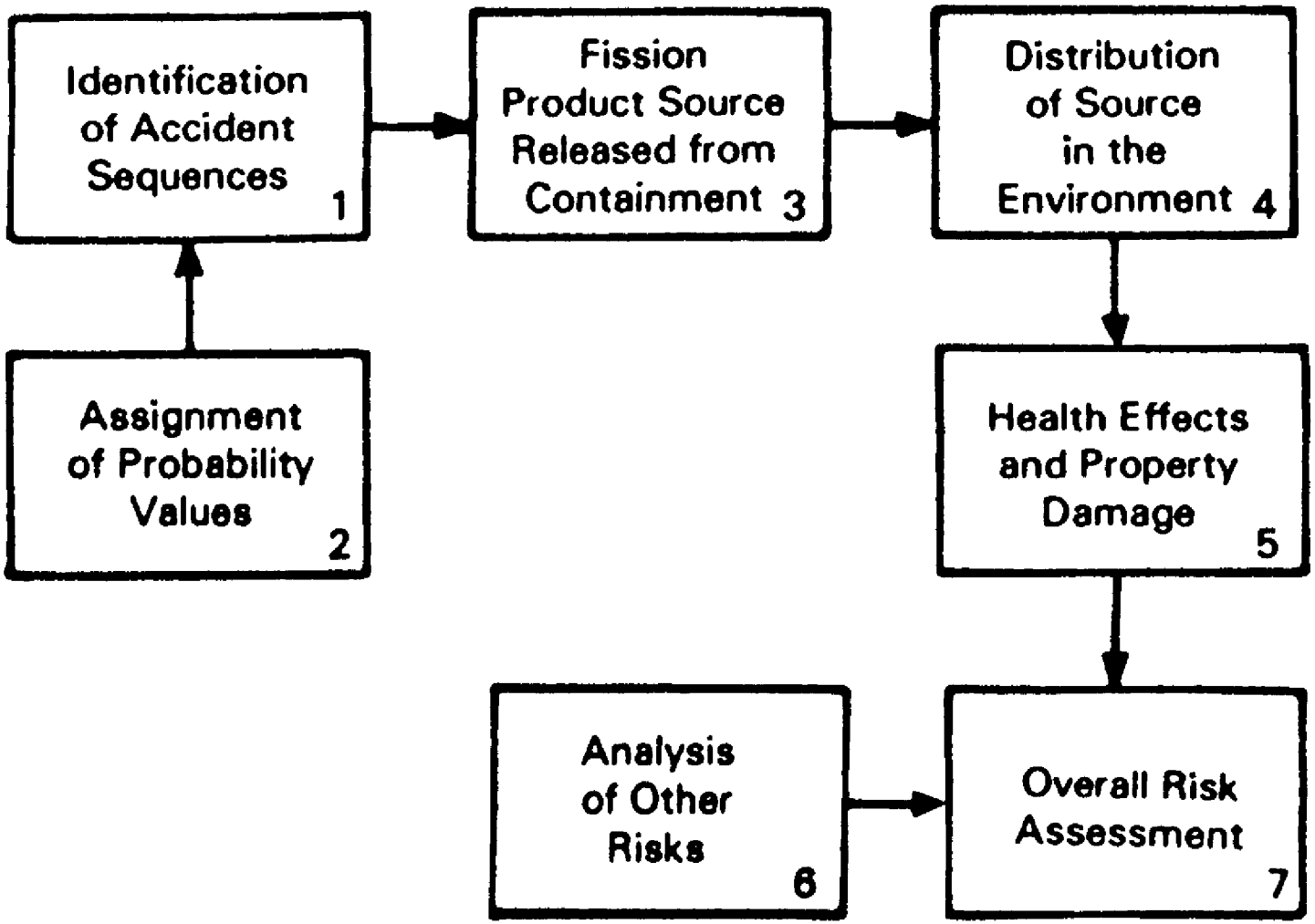




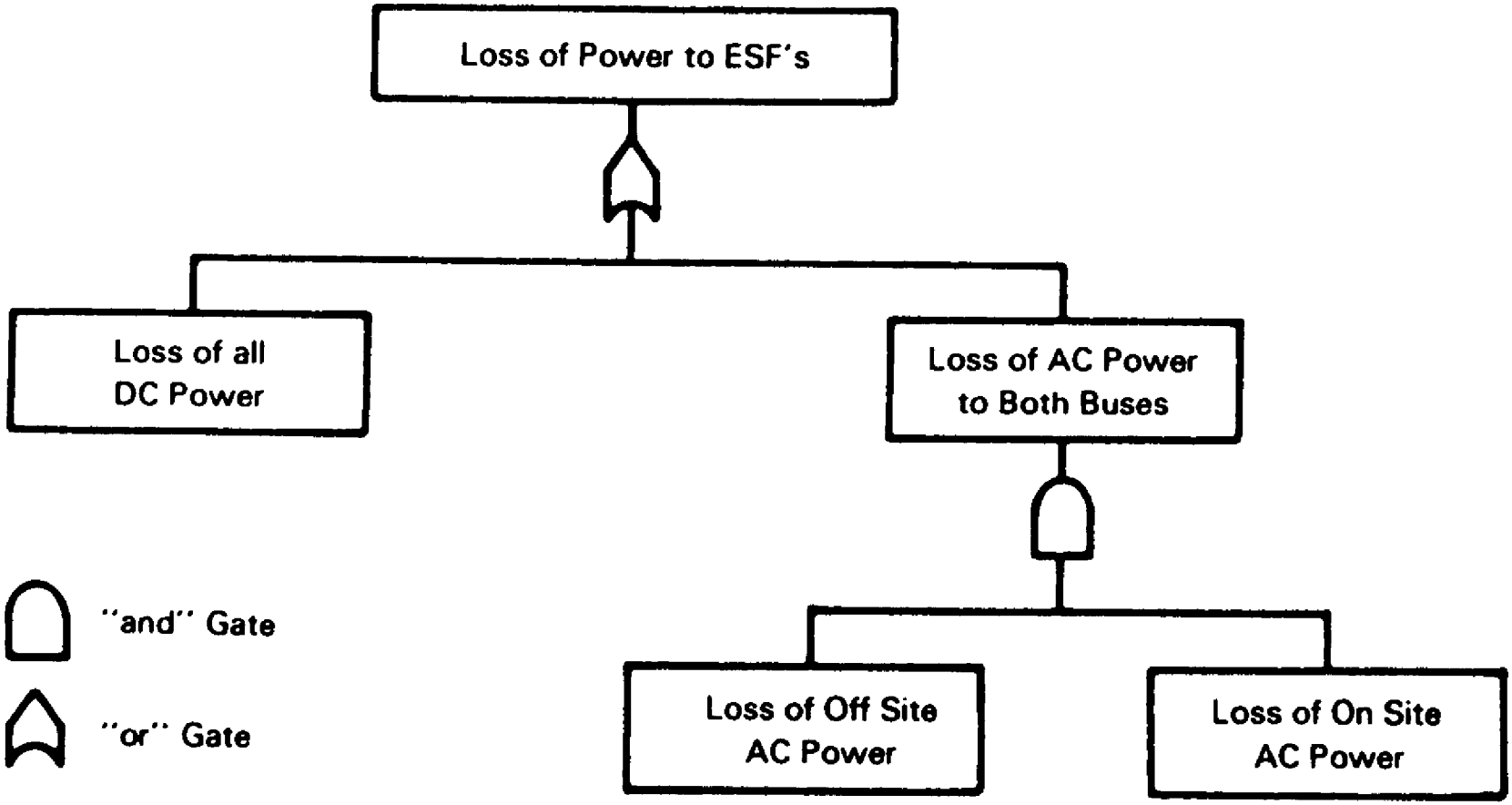
Change in distrust of authorities from April to August 1979 in area of Three Mile Island

APPENDIX A

PERSPECTIVES ON RADIATION AND CONSEQUENCES OF SEVERE NUCLEAR ACCIDENTS



SEVEN BASIC TASKS IN THE REACTOR SAFETY STUDY, WASH-1400



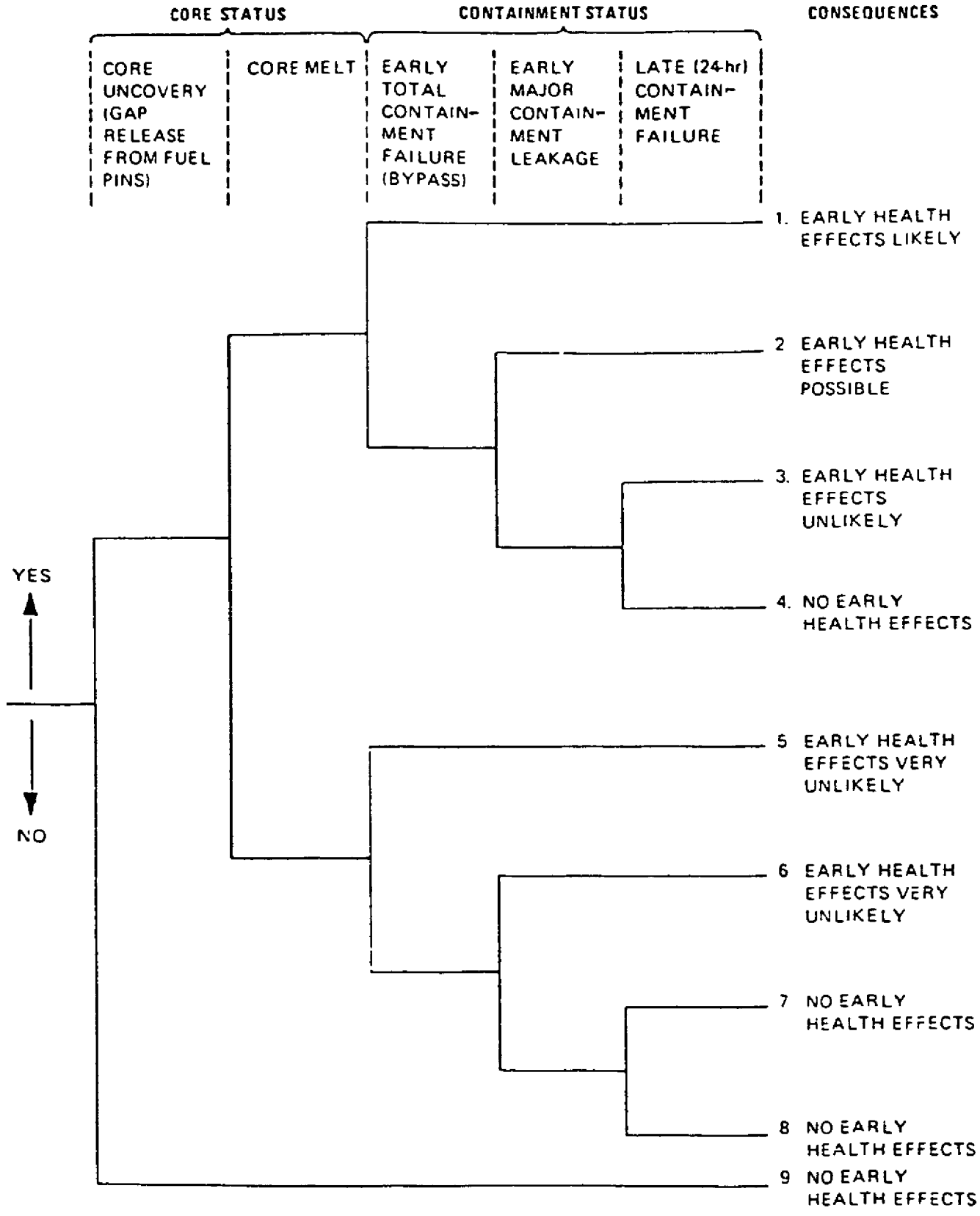
ESF- Engineered Safety Feature
(Important to Defense-in- Depth)

SIMPLIFIED FAULT TREE ON ELECTRIC POWER, WASH-1400

Estimated Consequences of an Extremely Serious Nuclear Power Plant Accident*

Prompt Fatalities		3,300
Early Radiation Sickness		45,000
Thyroid Nodules (within 30 years)	8,000/year	240,000
Cancer Fatalities (within 30 years)	1,500/year	45,000
Genetic Defects (within 150 years)	200/year	30,000
Economic Loss Due to Contamination	$14 billion	
Decontamination Area	3,200 square miles	

*From WASH-1400



EVENT TREE FOR SEVERE REACTOR ACCIDENT CONSEQUENCE ASSESSMENT

APPROXIMATE AVERAGE SOCIETAL AND INDIVIDUAL RISK PROBABILITIES PER YEAR FROM POTENTIAL NUCLEAR PLANT ACCIDENTS*

Consequence	Societal	Individual
Early fatalities†	3×10^{-3}	2×10^{-10}
Early illness†	2×10^{-1}	1×10^{-8}
Latent cancer fatalities‡	7×10^{-2}/yr	3×10^{-10}/yr
Thyroid nodules‡	7×10^{-1}/yr	3×10^{-9}/yr
Genetic effects§	1×10^{-2}/yr	7×10^{-11}/yr
Property damage ($)	2×10^{6}	—

*Based on 100 reactors at 68 current sites. WASH-1400

†The individual risk value is based on the 15 million people living in the general vicinity of the first 100 nuclear power plants.

‡This value is the rate of occurrence per year for about a 30-year period following a potential accident. The individual rate is based on the total U.S. population.

§This value is the rate of occurrence per year for the first generation born after a potential accident; subsequent generations would experience effects at a lower rate. The individual rate is based on the total U.S. population.

Situations Involving a One-in-a-Million Risk of Death*

Traveling 700 miles by air	(accident)
Traveling 60 miles by car	(accident)
Visiting 2 months in Denver	(cancer from cosmic rays)
Living 2 months in a stone building	(cancer from radioactivity)
Working 1½ weeks in a typical factory	(accident)
Working 3 hours in a coal mine	(accident)
Smoking 1-3 cigarettes	(cancer, heart disease)
Rock climbing 1½ minutes	(accident)
20 minutes being a man aged 60	(mortality from all causes)

* Pochin, E. E.(1978) & Wilson, R.(1978)

ESTIMATED ANNUAL WHOLE-BODY RADIATION DOSE RATES TO THE POPULATION OF THE U.S.*

Source of Radiation		Average Dose Rates (mrem/year)
Natural		
Environmental		
Cosmic Radiation		40 (30-130)†
Terrestrial Radiation		40 (30-115)‡
Internal Radioactive Isotopes		20
	Subtotal	100
Man-Made		
Environmental		
Global Fallout		4
Nuclear Power		0.023§
Medical		
Diagnostic		72
Radiopharmaceuticals		1
Occupational		0.8
Miscellaneous		2
	Subtotal	80
	TOTAL	180

*U.N. Scientific Committee on the Effects of Atomic Radiation & KEENY *et al.* (1977)

†Values in parentheses indicate range over which average levels for different states vary with elevation.

‡Range of variation (shown in parentheses) attributable largely to geographic differences in the content of potassium-40, radium, thorium, and uranium in the earth's crust.

§Value for 1975.

ESTIMATED LIFETIME CANCER RISKS OF LOW-LEVEL RADIATION*

Site	Risk per Million Person-Rem	
	Fatal Cancers	Incident Cancers
Bone Marrow (leukemia)	20-50	15-40
Thyroid	10	100
Breast (women only)	50	100
Lung	25-50	25-50
Stomach, Liver, Colon	10-15 (each)	15-25
Bone, Esophagus, Small Intestine, Urinary Bladder, Pancreas, Lymphatic Tissue	2-5 (each)	2-10
Skin	1	15-20
Total (both sexes)	100-250	300-500

*From References 3, 4, 8, 9, and 13.

SOURCE: A. C. UPTON, "HEALTH IMPACT OF THE TMI ACCIDENT", ANNALS OF THE N.Y. ACADEMY OF SCIENCES, VOL. 365 (1981)

VALUES ASSUMED IN ESTIMATING CANCER RISKS*

Age at Irradiation	Type of Cancer	Duration of Latent Period (years)	Duration of Plateau Region (years)†	Risk Estimate: Absolute Risk‡ (deaths/10^6/yr/rem)	Risk Estimate: Absolute Risk (% increase in deaths/rem)
In Utero	Leukemia	0	10	25	50
	All other cancer	0	10	25	50
0-9 Years	Leukemia	2	25	2.0	5.0
	All other cancer	15	30-Life	1.0	2.0
10 + Years	Leukemia	2	25	1.0	2.0
	All other cancer	15	30-Life	5.0	0.2

*From L. BATTIST ET AL., USNRC (1979)

†Plateau region = interval following latent period during which risk remains elevated.

‡The absolute risk for those aged 10 or more the time of irradiation for all cancer excluding leukemia can be broken down into the respective sites as follows:

Type of Cancer	Deaths/10^6/year/rem
Breast	1.5§
Lung	1.3
GI including stomach	1.0
Bone	0.2
All other cancer	1.0
Total	5.0

§This is derived from the value of 6.0 for women, corrected for a 50% cure rate and the inclusion of men as well as women in the population.

ESTIMATES OF PROPORTIONS OF GENERAL POPULATION SAMPLE AND OF SAMPLE OF MOTHERS OF PRESCHOOL CHILDREN LIVING WITHIN 20 MILES OF TMI WHO LEFT ON EACH DAY DURING THE ACCIDENT*

Day	Percent of Leavers	
	General Population Sample (13% have preschool children)	Sample of Mothers of Preschool Children
3/28	2.4	2.0
3/29	2.4	6.2
3/30	59.5	65.8
3/31	17.0	14.0
4/1	10.5	7.8
4/2	4.9	3.6
4/3	3.2	0.7
Percent who left	51.8	72.4
Percent who stayed	48.2	27.6

* Dohrenwend *et al.*

Radiation Doses Calculated for the Three Mile Island Vicinity*
(within three miles)

Intake Mode	Organ	Dose (mrem)
Cow's milk ingestion	newborn thyroid	6.9
	1-year-old thyroid	4.7
	adult thyroid	0.6
	ovaries	0.00002
	testes	0.00002
	red bone marrow	0.00009
	total body	0.0003
Inhalation (off site)	newborn thyroid	2.0
	1-year-old thyroid	6.5
	adult thyroid	5.4
	ovaries	0.0002
	testes	0.0001
	red bone marrow	0.0007
	total body	0.003

* President's Commission on the Accident at Three Mile Island. 1979. Report of the Task Force on Public Health and Safety. Washington, D.C.

PROJECTED IMPACT OF THREE MILE ISLAND ACCIDENT ON LIFETIME INCIDENCE OF CANCER IN OFF-SITE POPULATION WITHIN 50 MILES*

	Estimated Numbers of Cancers Attributable to Radiation from the Accident†	Estimated Numbers of Cancers Occurring Naturally‡
Fatal Cancers	0.7 (0.15–2.4)	325,000
Nonfatal Cancers	0.7 (0.15–2.4)	216,000

*From Reference 5.

†Values cover extreme ranges of estimates presented in References 3, 4, and 9, with their geometric means (see Reference 5).

‡Based on the natural incidence for the U.S. as a whole.

PROJECTED IMPACT OF THREE MILE ISLAND ACCIDENT ON INCIDENCE OF HEREDITARY DISEASE IN OFFSPRING OF POPULATION WITHIN 50 MILES

Disease Category	Natural Incidence (per million live births)	Incidence per Million Live Births per Rem to Both Parents*		Incidence per Generation Attributable to TMI Accident	
		First Generation	At Equilibrium	First Generation	150 Years
Dominant Diseases	10,000	10-100	50-500	0.01-0.1	0.05-0.5
Chromosomal and Recessive Diseases	10,000	slight	very slow increase	slight	very slow increase
Congenital Anomalies	15,000	1-100	10-1000	0.001-0.1	0.005-0.5
Anomalies Expressed Later	10,000				
Constitutional and Degenerative Disease	15,000				
Total	60,000	12-200	60-1500	0.01-0.2	0.06-1.0

*From References 3, 4, and 9.

SOURCE: A. C. UPTON, "HEALTH IMPACT OF THE TMI ACCIDENT", ANNALS OF THE N.Y. ACADEMY OF SCIENCES, VOL. 365 (1981)

CLINICAL DATA OF CANCER FATALITIES AND GENETIC EFFECTS OF NAGASAKI AND HIROSHIMA A-BOMB SURVIVORS, 1950-1978

- OUT OF 283,498 A-BOMB SURVIVORS MONITORED THERE WERE 527 ESTIMATED EXCESS CANCER DEATHS OF WHICH 191 WERE DUE TO LEUKEMIA. THE EXCESS CANCER DEATHS DUE TO NUCLEAR RADIATION WERE 4.9% OF CANCER DEATHS IN THIS GROUP FROM ALL CAUSES AND 0.78% OF TOTAL DEATHS FROM CANCER AND OTHER CAUSES

- THE A-BOMB SURVIVORS AT NAGASAKI AND HIROSHIMA RECEIVED AN AVERAGE RADIATION DOSE OF 16 RADS (A RAD IS ROUGHLY EQUIVALENT TO A REM ESPECIALLY FOR NUCLEAR POWER PLANT ACCIDENT WHOLE BODY DOSE)

- OUT OF AN EXTENDED SAMPLE OF 79,856 A-BOMB SURVIVORS 87% HAD A DOSE LESS THAN 50 RADS AND 92% LESS THAN 100 RADS: THE AVERAGE DOSE FOR THE EXTENDED SAMPLE WAS 27 RADS

- IT TOOK A PERIOD OF 30 TO 33 YEARS AFTER THE A-BOMB EXPLOSION OVER NAGASAKI BEFORE A STATICALLY SIGNIFICANT EXCESS OF CANCER DEATHS OCCURRED. SINCE (EXCEPT FOR LEUKEMIA) MOST TYPES OF CANCERS OCCUR IN THE OLDER AGE BRACKETS. THE ABOVE ESTIMATES OF EXCESS CANCER FATALITIES CAN BE EXPECTED TO INCREASE SOMEWHAT AS THE REMAINING SURVIVORS REACH AGES ABOVE 60 YEARS

- BETWEEN 1946 AND 1980 ABOUT 105,000 CHILDREN WERE BORN TO ADULTS EXPOSED TO A-BOMB RADIATION AT NAGASKAI AND HIROSHIMA. NO STATISTICALLY SIGNIFICANT INCREASE IN HARMFUL GENETIC EFFECTS WERE OBSERVED FOR THESE CHILDREN, ALTHOUGH ON THEORETICAL GROUNDS OF ASSUMED DOSE-RESPONSE RELATIONSHIPS, AN EXCESS OF GENETIC EFFECTS OF 5 TO 7% AT NAGASAKI AND 11 TO 16% AT HIROSHIMA MIGHT HAVE BEEN EXPECTED DUE TO RADIATION DOSES OF PARENTS

APPENDIX B

INFORMATION REGARDING THE CHERNOBYL NUCLEAR ACCIDENT SUPPLIED BY BY SOVIET SOURCES AT THE IAEA MEETING IN VIENNA, AUSTRIA

AUGUST 25 -29, 1986


500 BUCKS, TAKE IT—OR LEAVE IT! THESE "RED CARDS" DON'T GROW ON TREES, Y'KNOW!
CHERNOBYL POST-ACCIDENT ASSESSMENT MEETING

WHAT WENT WRONG AT CHERNOBYL?

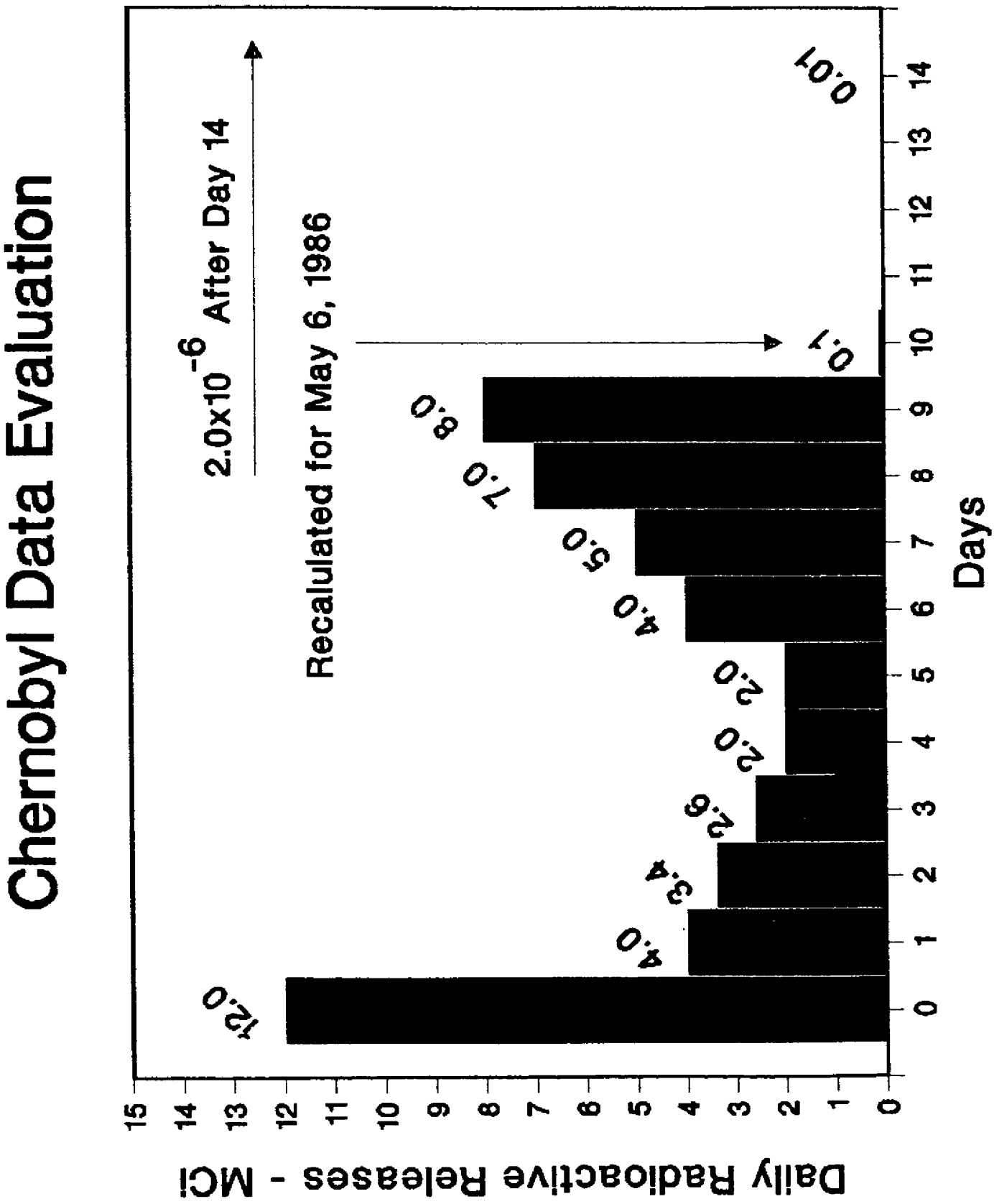
- ACCIDENT SEVERITY LINKED TO KEY DESIGN AND HUMAN FACTOR ASPECTS

HUMAN FACTOR ASPECTS

- TEST PROCEDURES VIOLATED CERTAIN SOVIET SAFETY REGULATIONS
- OPERATORS VIOLATED CERTAIN PARTS OF TEST PROCEDURE
- SOVIETS BELIEVE OPERATORS LOST SENSE OF VIGILANCE TOWARDS SAFETY

DESIGN ASPECTS

- APPARENT SIMPLICITY WITH WHICH SAFETY AND PROTECTION SYSTEMS COULD BE OVERRIDDEN
- SLOW CONTROL ROD INSERTION RATE
- POSITIVE VOID REACTIVITY FEEDBACK


Chernobyl Data Evaluation
Daily Radioactive Releases - MCi
Days
Recalculated for May 6, 1986
2.0×10^{-6} After Day 14
12.0
4.0
3.4
2.6
2.0
2.0
4.0
6.0
7.0
8.0
0.1
0.01

RADIATION DOSES TO INDIVIDUAL WORKERS AT THE CHERNOBYL NUCLEAR PLANT

- WORKERS - PRIMARILY FIREFIGHTERS

  1ST VICTIMS - ONE DIED AT 6:00 AM FROM BURNS; ANOTHER WAS APPARENTLY BURIED IN COLLAPSED SECTIONS OF BUILDING

- 12 HOURS INTO ACCIDENT - 350 WORKERS CLOSELY EXAMINED FOR BLOOD CHANGES AND OTHER PHYSICAL SYMPTOMS OF HIGH RADIATION EXPOSURE
- 129 PEOPLE HOSPITALIZED IN SPECIAL CENTER IN MOSCOW
- 84 DIAGNOSED AS EXPERIENCING ACUTE RADIATION ILLNESS - IMMEDIATE SYMPTOMS
- 45 HAD LOWER EXPOSURES AND WERE OBSERVED FOR 1 TO 1.5 MONTHS
- TOTAL OF 203 PERSONS HOSPITALIZED WITH ACUTE RADIATION SICKNESS - NO MEMBERS OF THE GENERAL PUBLIC WERE INCLUDED IN THIS GROUP
- NO EVIDENCE OF NEUTRON EXPOSURE BASED ON ANALYSIS FOR NA-22
- SUBSTANTIAL AMOUNTS OF CS AND PU FOUND IN VICTIMS
- DOSE DISTRIBUTION - ALL 203 HOSPITALIZED VICTIMS RECEIVED > 100 REM. OF THAT GROUP, 35 PEOPLE EXCEEDED 400 REM UP TO A MAXIMUM OF 1200-1600 REM

EMERGENCY RESPONSE MEASURES TAKEN AT THE CHERNOBYL NUCLEAR PLANT

- IMMEDIATELY AFTER ACCIDENT PRIPYAT POPULATION (45,000) ADVISED TO REMAIN INDOOR AND CLOSE WINDOWS

- ON APRIL 26 OPEN-AIR ACTIVITIES BANNED AT ALL KINDERGARDENS, AND SCHOOLS; IODINE PROPHYLATIC TREATMENT GIVEN THERE

- EVACUATION OF PRIPYAT BEGAN AT 2 PM ON APRIL 27 AS DOSE RATE WORSENED; COMPLETED BY 5 PM THE SAME DAY

- REMAINING POPULATION (90,000) FROM 30-KM ZONE EVACUATED IN NEXT FEW DAYS BECAUSE OF CONTINUING CONTAMINATION DUE TO CHANGING PLUME DIRECTION

- CONSUMPTION OF MILK CONTAINING 1×10^{-7} CI/L OR MORE OF I-131 WAS BANNED

- ALL CHILDREN FROM 30-KM ZONE WERE SENT TO SUMMER SANITORIUM IN THE COUNTRY

EMERGENCY REPONSE MEASURES TAKEN (CONT.)

- STANDARDS FOR PERMISSIBLE LEVELS OF CONTAMINATION IN FOOD PRODUCTS ISSUED BEGINNING EARLY IN MAY 1986

- 1240 DOCTORS, 920 NURSES AND SEVERAL THOUSAND SUPPORTING ASSISTANTS MOBILIZED TO PROVIDE MEDICAL CARE OF EVACUEES

- EACH EVACUEE EXAMINED; BLOOD TESTS CARRIED OUT; IN SOME CASES EXAMINATION AND TESTS REPEATED

- EVACUEES WHO SHOWED IRREGULARITIES WERE HOSPITALIZED IN SPECIAL SECTIONS SET-UP AT CENTRAL REGIONAL HOSPITALS

- LONG-TERM PROGRAMS ARE BEING ESTABLISHED FOR MEDICAL AND BILOGICAL MONITORING OF POPULATION AND PERSONNEL


AND NOW I'D LIKE TO LIST ALL THE RADIO-NUCLIDES FOUND IN THE REGION OF VILNIUS...
ZZZZZZZZZZZZ

Soviets' Estimate of Doses of Public Exposure in Some Populated Areas in the 30 km - Zone Around Chernobyl

Settlement	Distance from Chernobyl (km)	Dose from Cloud, R	Dose on Child's Thyroid, Rem	Dose from Radio-active Fallout in 7 Days, R (Ground Deposition)
Chistowka	5.5	10	120	3.2
Levlev	9	7	250	10
Chernobyl	16	1.2	80	3.0
Rudki	22	0.6	80	2.2
Crevichi	29	0,2	25	4.4

NRC Note: Several other communities could have experienced doses (individual) of 30-40 Rem.

ESTIMATED VALUES OF COLLECTIVE DOSAGES OF EXTERNAL RADIATION OF THE EVACUATED POPULATION FROM THE CHERNOBYL REGION

REGION AROUND CHERNOBYL AES	POPULATION (THDS. OF PERSONS)	COLLECTIVE DOSAGE (MILLIONS OF PERSON-REMS)
PRIPYAT	45.	0,15
3 – 7 KM	7.0	0.38
7 – 10 KM	9.0	0.41
10 – 15 KM	8.2	0.29
15 – 20 KM	11.6	0.06
20 – 25 KM	14.9	0.09
25 – 30 KM	39.2	0.18
TOTAL	135.	1.6

CHERNOBYL NUCLEAR ACCIDENT

SUMMARY OF GENERAL POPULATION COLLECTIVE DOSES & ASSOCIATED ESTIMATED HEALTH EFFECTS

PATHWAY	NO. OF EXPOSED PERSONS	COLLECTIVE DOSE (PERSON-REMS)	AVG. DOSE PER PERSON (REMS)
EXTERNAL DOSE	135,000	1.6×10^6	12.
EXTERNAL DOSE	74,500,000	29×10^6	0.4
FOOD PATHWAY - Cs	UNSPECIFIED	$210 \times 10^{6*}$	— —

*SOVIETS STATED THIS NUMBER IS CONSERVATIVE BY AS MUCH AS A FACTOR OF 10

DECONTAMINATION--OFFSITE
AT THE CHERNOBYL NUCLEAR PLANT

- BUILDING AND HOUSES ARE BEING DECONTAMINATED BY SPRAYING DECONTAMINATION SOLUTION
- AFTER WASHING, CONTAMINATED SOIL AROUND THE BUILDINGS TURNED OVER OR REMOVED WITH BULL-DOZERS AND TAKEN AWAY
- TRANSPORT VEHICLES DECONTAMINATED USING SOLUTIONS BY SPRAYING AND STEAM JETS.
- LONG TERM DECONTAMINATION PROCEDURES OF THE ENVIRONMENT ARE BEING RESEARCHED