SAND2010-0792C

CHERNOBYL UNIT 4

THE REACTOR

THE ACCIDENT

THE CONSEQUENCES

III
2/9/2010

OBJECTIVES

3. Explain the role in the reactor accident at Chernobyl, Unit 4 of each of the following:
   - Coolant flow rate and positive reactivity coefficient
   - Xenon initial level and burnout behavior
   - Control rod design, pre-accident position, and insertion characteristics

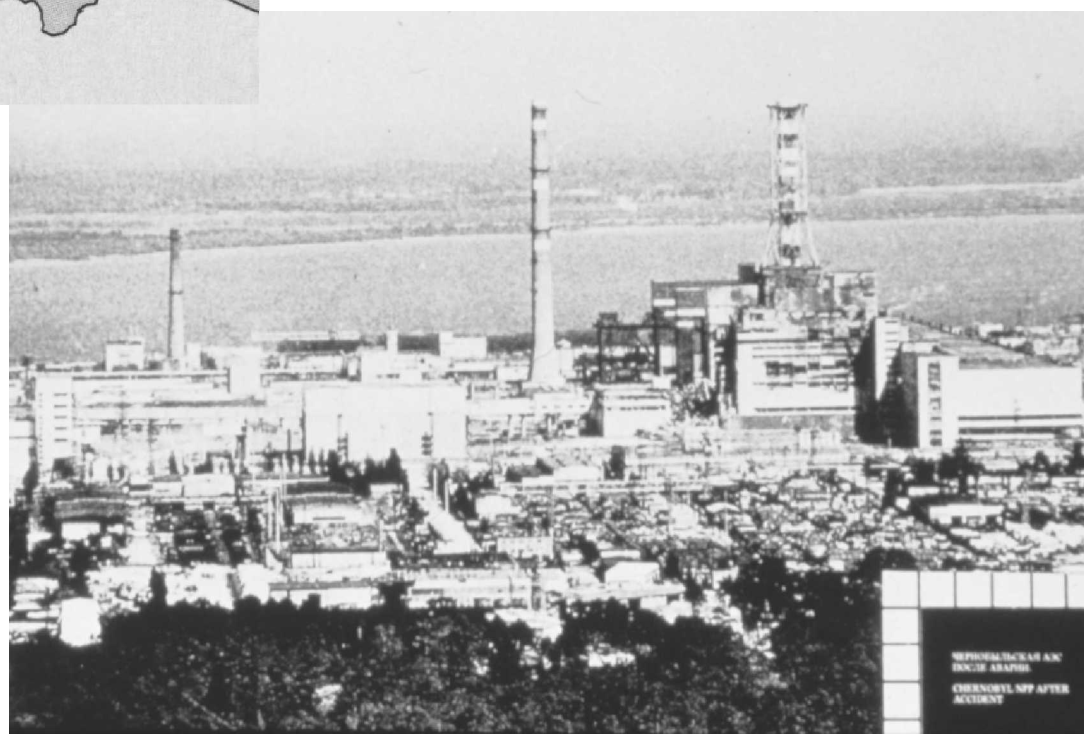
OBJECTIVES

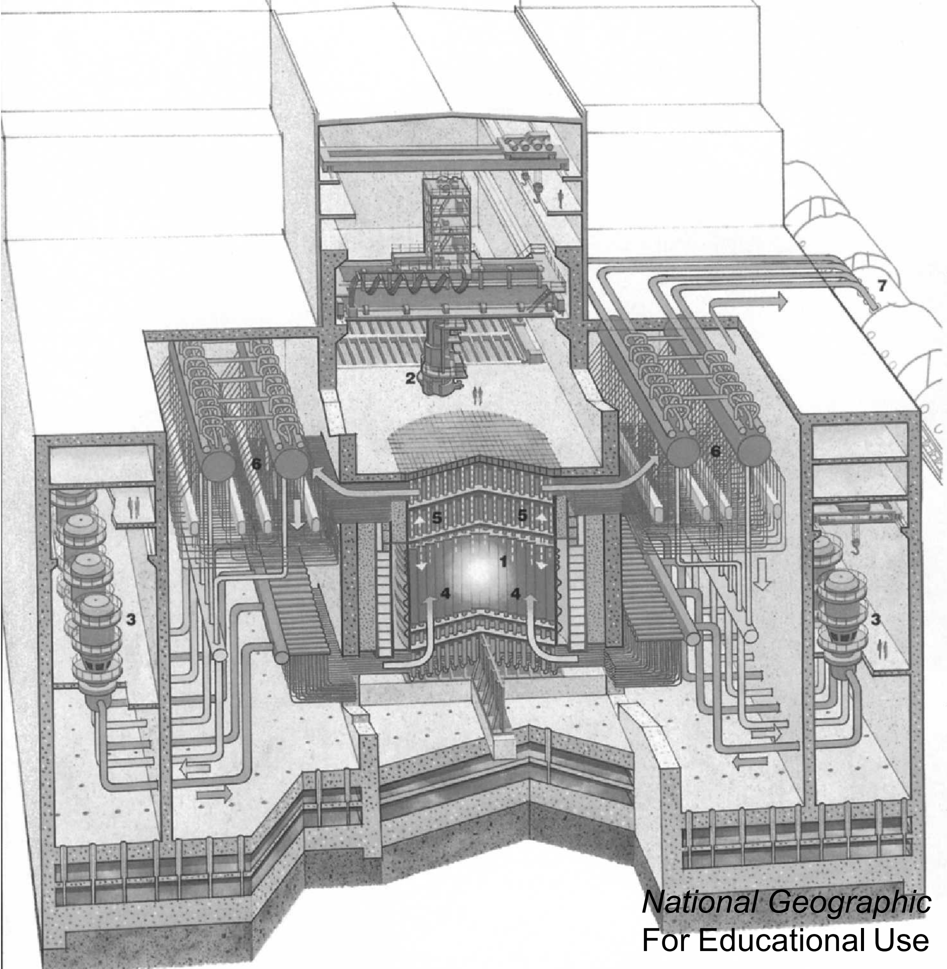
4. Compare the TMI-2 and Chernobyl-4 reactor accidents in terms of:
   - Nature and extent of core damage
   - Release of noble gases, iodine, cesium, and particulates
   - Final station configuration after recovery

CHERNOBYL NUCLEAR STATION

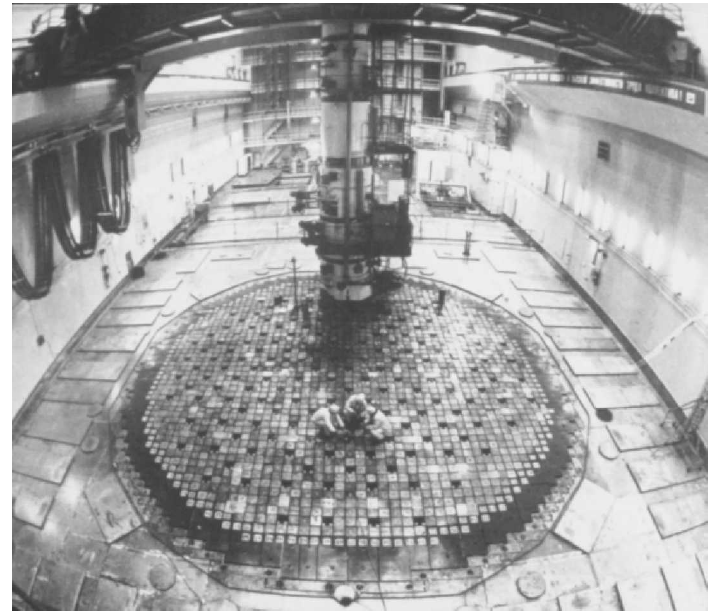
- FEATURES
  - Owned & Operated by the Soviet Ministry of Power and Electrification
  - Location: Ukraine
    - 3 km from Pripyat
    - 18 km from Chernobyl
    - 130 km North of Kiev
  - Four Operating RBMK-1000 Units
  - Two RBMK-1000 Units Under Construction

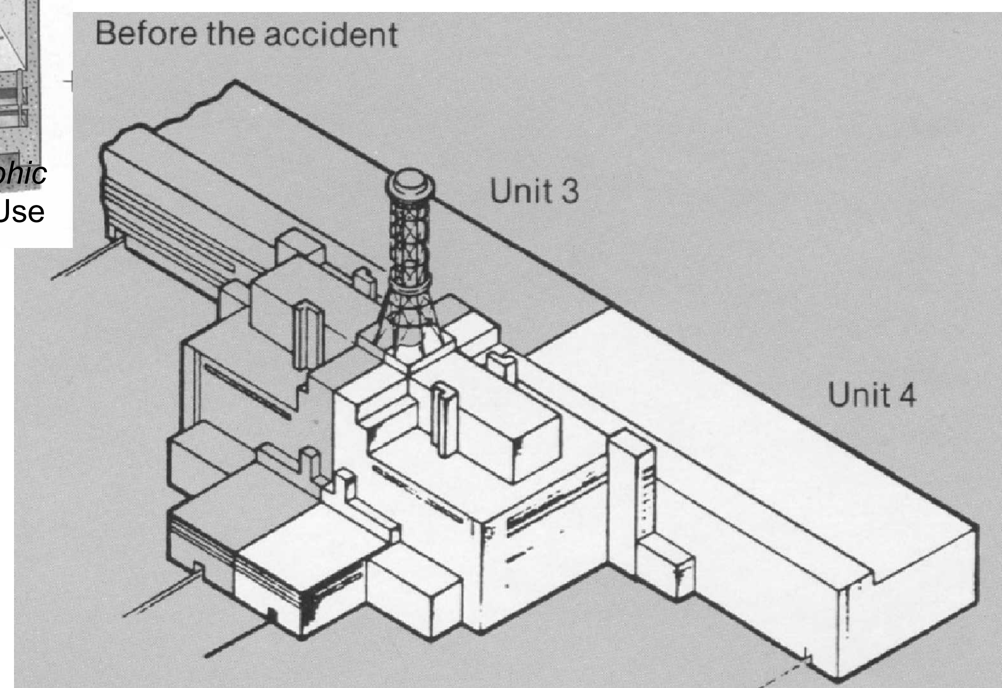

Moscow
250 km
RUSSIA
Minsk
BELARUS
Chernobyl
Kiev
UKRAINE





National Geographic
For Educational Use





CHERNOBYL UNIT 4

THE REACTOR

THE ACCIDENT

THE CONSEQUENCES

CHERNOBYL-4 ACCIDENT

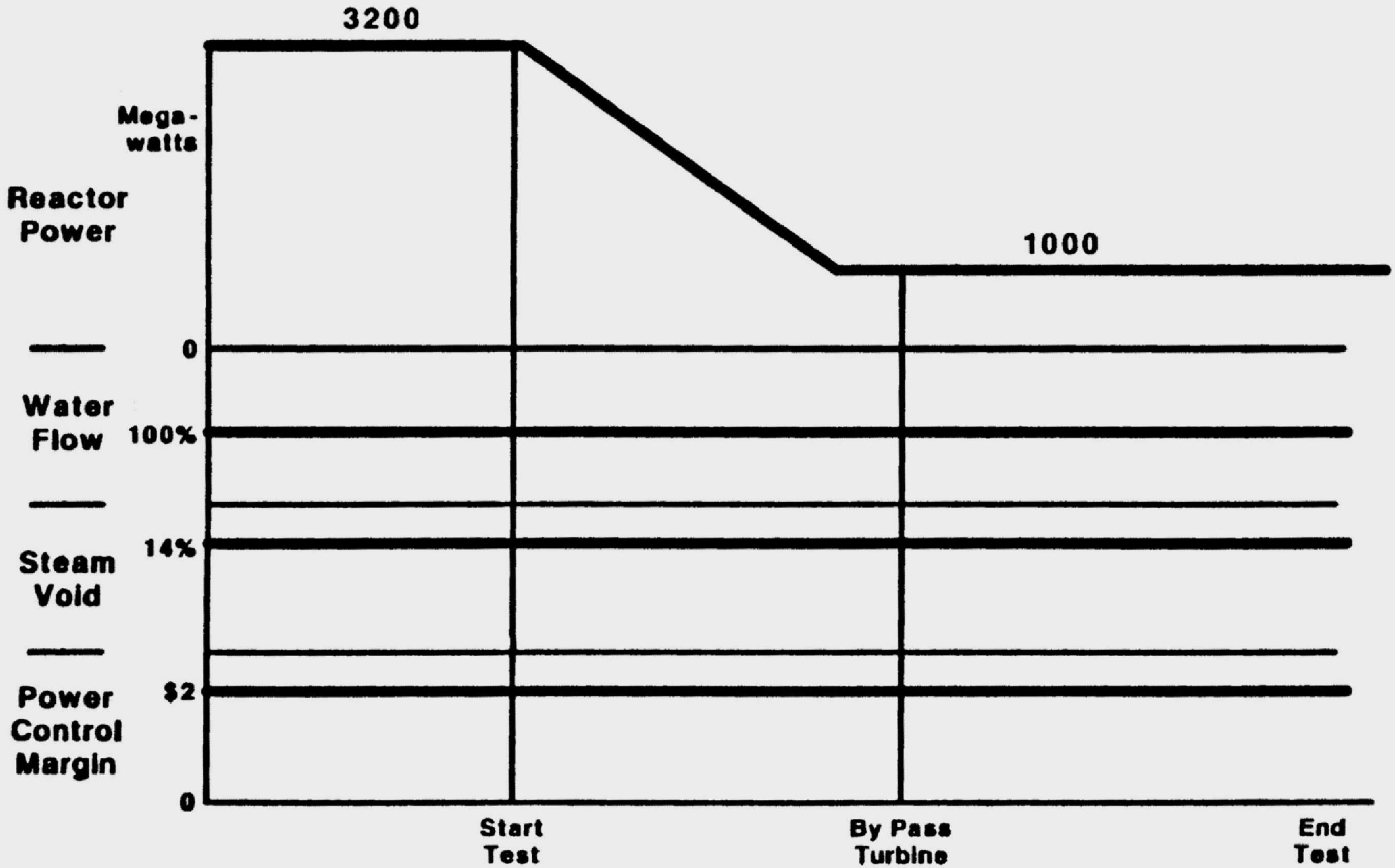
- BACKGROUND
  - Excellent Operating Record at Chernobyl-4
  - Test to Assess Use of Turbine Post-Trip
    - Provide Emergency Electrical Power
    - Eliminate Expensive Alternatives
      - Continuous Operation of (Slow-Starting) Diesels
      - Independent Auxiliary Cooling System
    - Known Difficult; Attempted Unsuccessfully Twice
    - If Test Not Completed Need to Wait a Year

Control Room

CHERNOBYL-4 ACCIDENT

- BACKGROUND
  - Test Plan
    - Preparer Not Familiar w/ RBMK-1000
    - Not Sent to Moscow for Academy of Sciences Review
    - Requirements
      - Power Level in 700-1000 MWt Range
      - Bypassing Some Safety Systems
      - Reactor Trip w/ Turbine Shutdown

Turbine Coastdown Test
(Properly Executed)



CHERNOBYL-4 ACCIDENT

- BACKGROUND
  - Test Plan Requirements
    - Normal Plant Shutdown
    - Complete Test on a Single Daylight Shift
    - Complete by Friday Prior to “May Day” Holiday on the Following Thursday

CHERNOBYL-4 ACCIDENT

- ACCIDENT CHRONOLOGY

CAUTION!!

WHAT happened is generally well established.

Exactly *HOW* and *WHY* it happened will always be subject to uncertainty.

For example, operators have claimed that some procedures they were said to have violated *never existed*.

CHERNOBYL-4 ACCIDENT

- ACCIDENT CHRONOLOGY

  25 April

  0100 [-24 hr]

  – Electrical Engineers Given Control of Reactor Operation

  – Control Rods Lowered to Begin Reduction in Power from 3200 MWt (Full Power) to 1600 MWt (50% Power)

CHERNOBYL-4 ACCIDENT

25 April

1400 [-11 hr]

– Local Load Dispatcher Suspends Power Reduction
– Emergency Core Cooling Systems Shut Off to Avoid Drawing Power

2310 [-2 hr]

– Load Dispatcher Allows Resumption of Power Reduction

NOTE: Test is No Longer to be Run by Intended Shift

ACCIDENT CHRONOLOGY

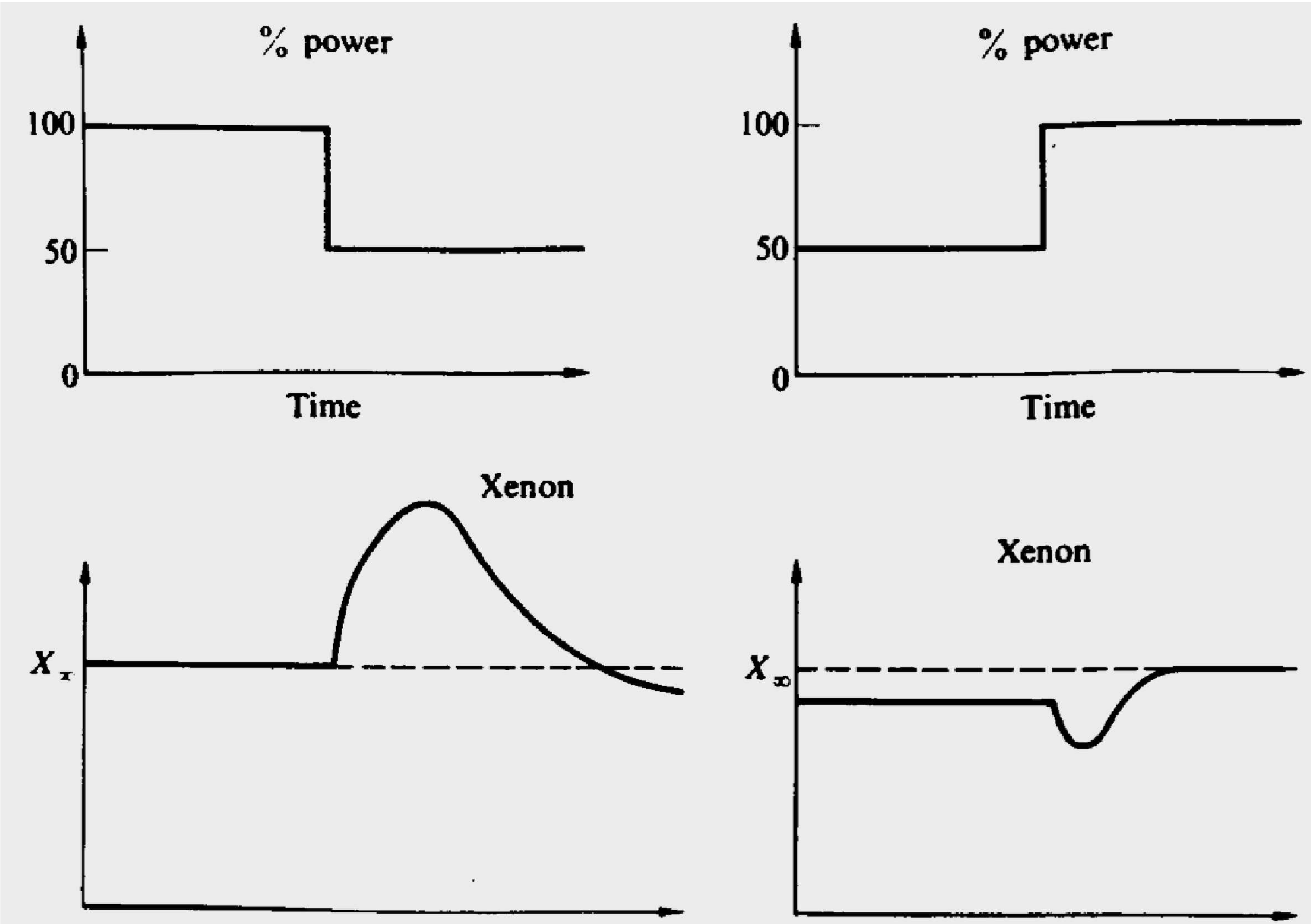
26 April

0028 [-1 hr]

– Monitoring Systems Adjusted to Lower Power
  - Operator Fails to Reprogram Computer
  - Power
    - – Unstable
    - – Falls to 30 MWt (<1%)

– Control Rods Withdrawn to Counteract Xe Buildup (During 9-hr Load-Change Hiatus)

Xe-135 Operational Effect



Lamarsh (1975)

ACCIDENT CHRONOLOGY

26 April

0028 [-1 hr]

- Monitoring Systems Adjusted to Lower Power
  - Operator Fails to Reprogram Computer
  - Power Falls to 30 MWt (<1%)
- Control Rods Withdrawn to Counteract Xe Buildup (During 9-hr Load-Change Hiatus)
- Power Climbs & Stabilizes Briefly at 200 MWt

ACCIDENT CHRONOLOGY

0103 [-20 min]

- All Eight Pumps Activated
  - Violated Limits: High Flow Rate
    Pump Cavitation
  - Eliminated Essentially all Voids
  - Maximized Coolant Negative (Absorption) Reactivity
- More Control Rods Withdrawn
- Low Power & High Flow Increase Instability
- Many Manual Adjustments
- Operators Turn Off Other Shutdown Signals

ACCIDENT CHRONOLOGY

0122 [-1 min]

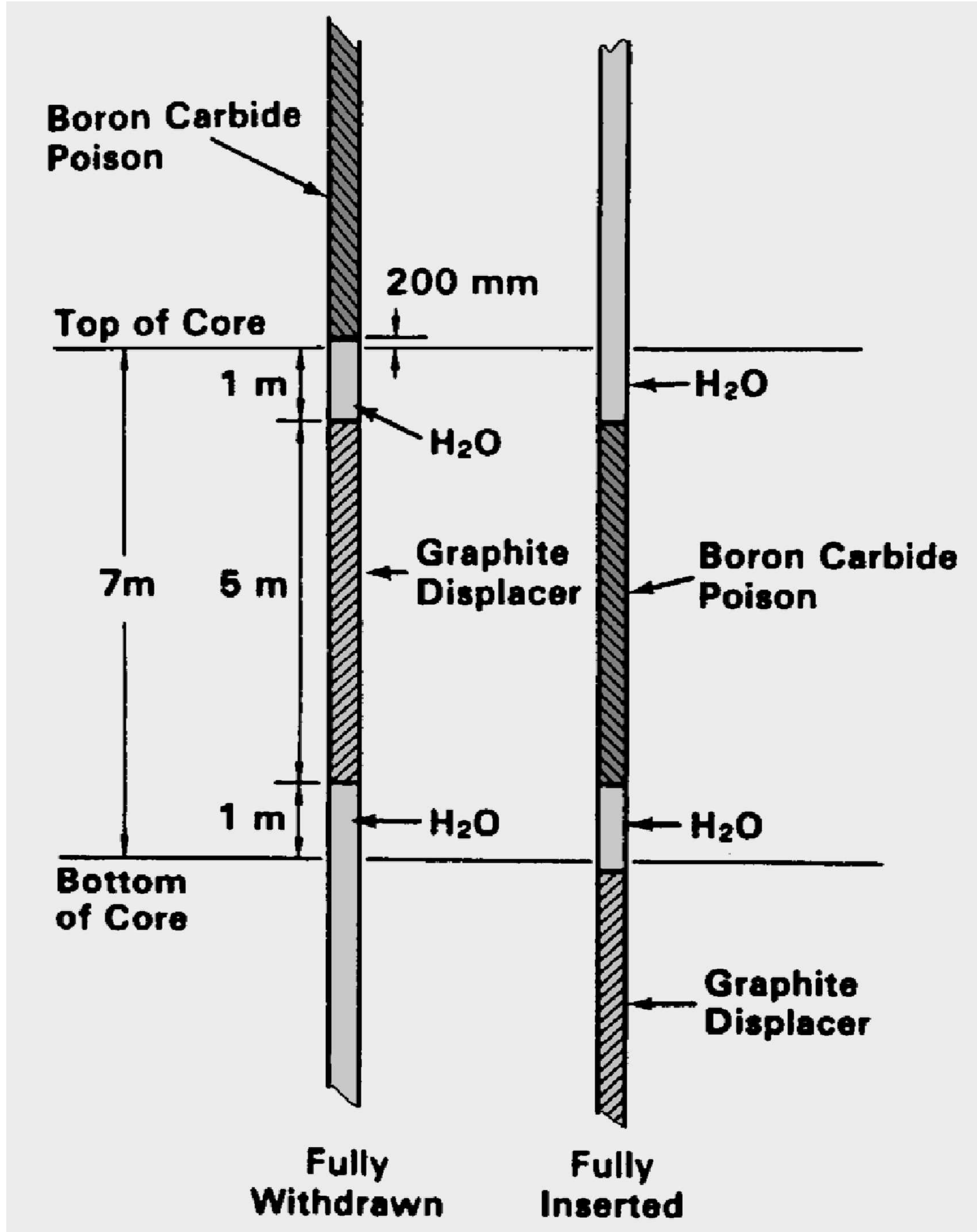
- Computer Indicates Excess Reactivity
- Last Remaining Scram Signal Disabled (To Allow Test to be Rerun, if Necessary)

ACCIDENT CHRONOLOGY

0123

- Test Begins
- Power Starts to Rise
- Coolant Voiding Increases
- Accelerated Power Increase
- Operators Scram Control Rods
  - Initial "Positive Scram"
    - Essentially <u>NO</u> "Bite"
    - "Poison"/Water/Graphite-Follower Configuration
  - Slow Insertion (20-s Insertion Time)

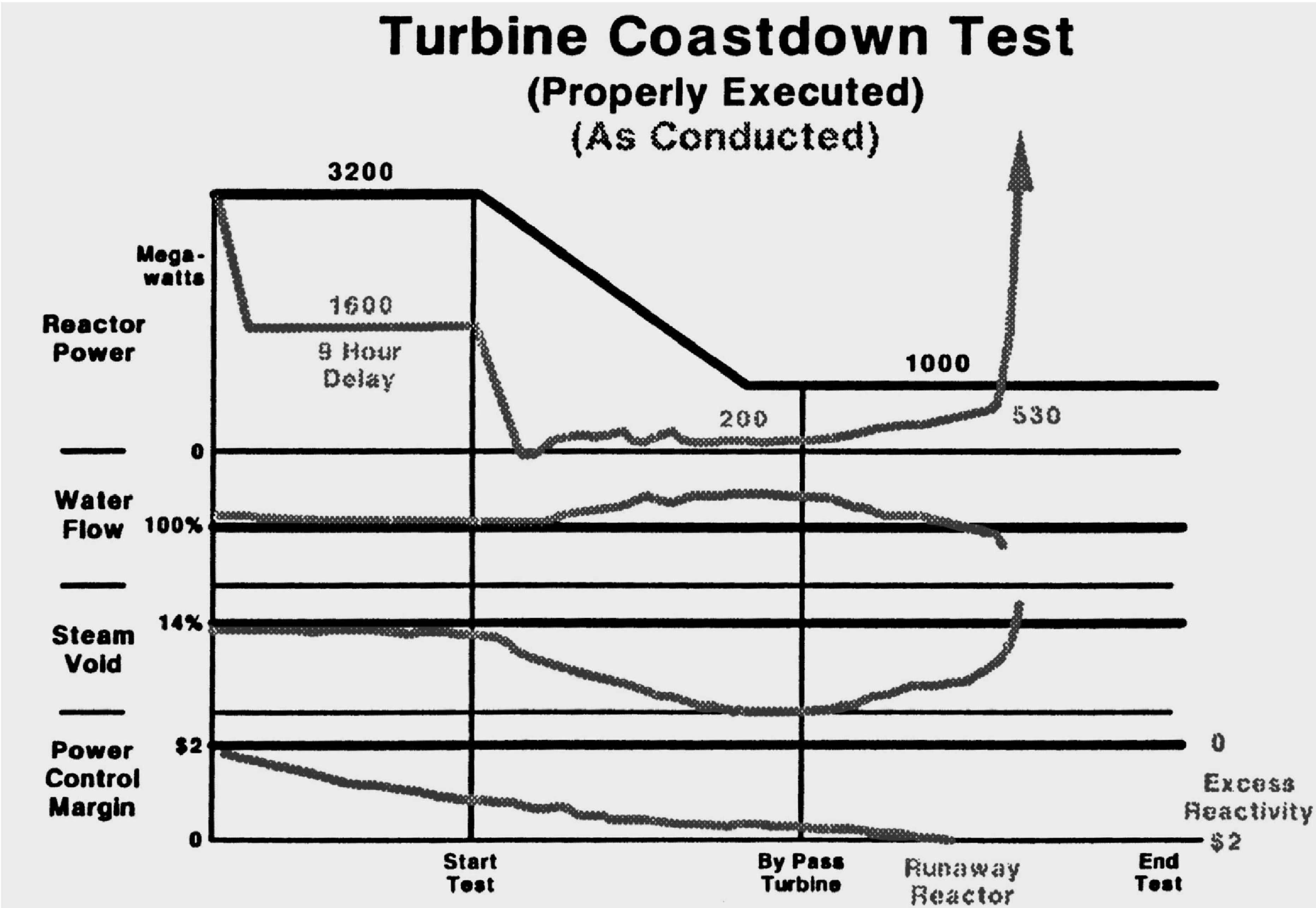
Fig: Control Rod Schematic



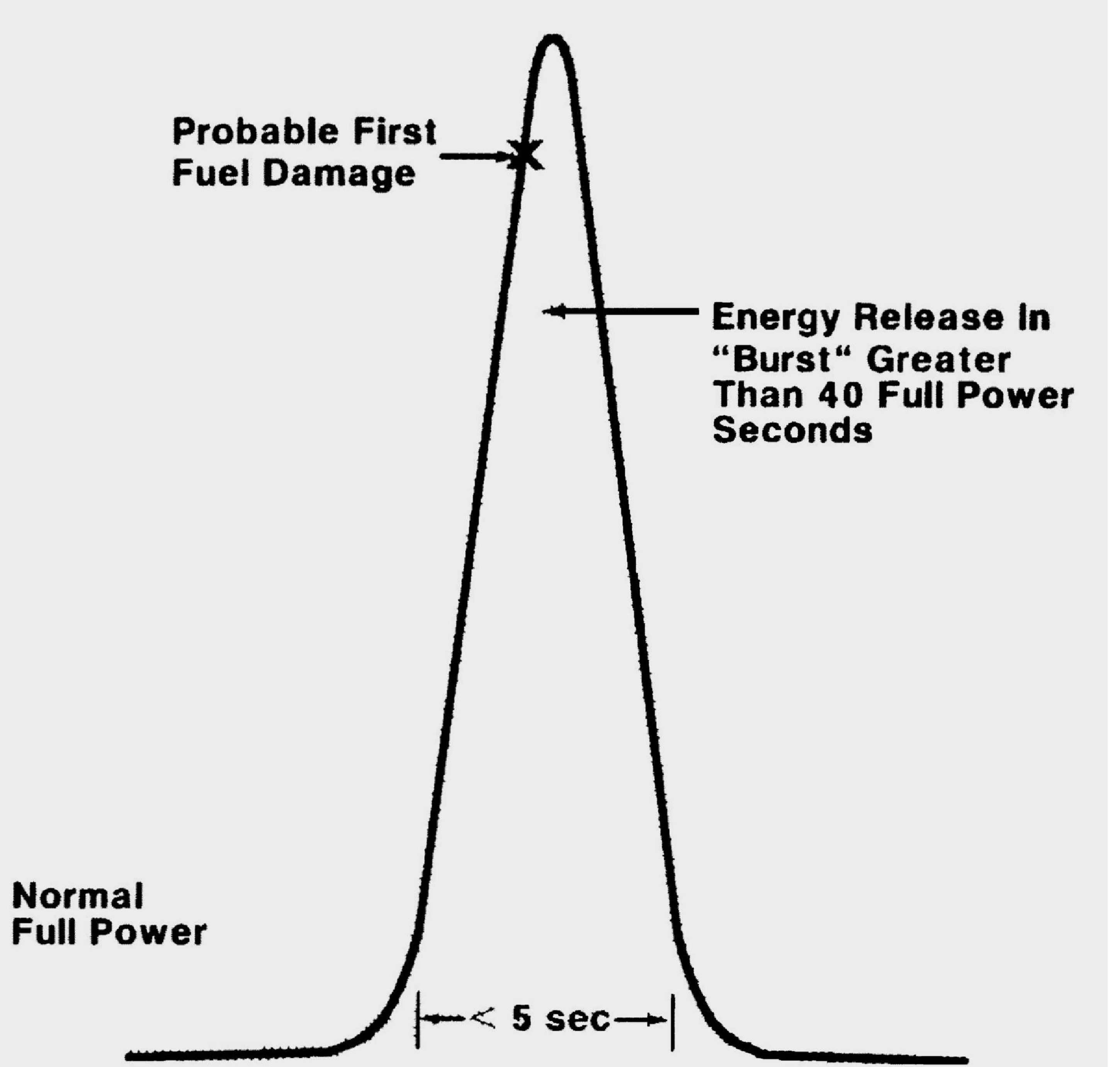
ACCIDENT CHRONOLOGY

0123

- Power Surges to 100 Times Maximum in 4 seconds
- Second Pulse Reaches Nearly 500 Times Maximum


Turbine Coastdown Test
(Properly Executed)
(As Conducted)
3200
Mega-
watts
1600
9 Hour
Delay
1000
200
530
Reactor
Power
0
Water
Flow
100%
Steam
Void
14%
Power
Control
Margin
$2
0
0
Excess
Reactivity
$2
Start
Test
By Pass
Turbine
Runaway
Reactor
End
Test

Power Surge



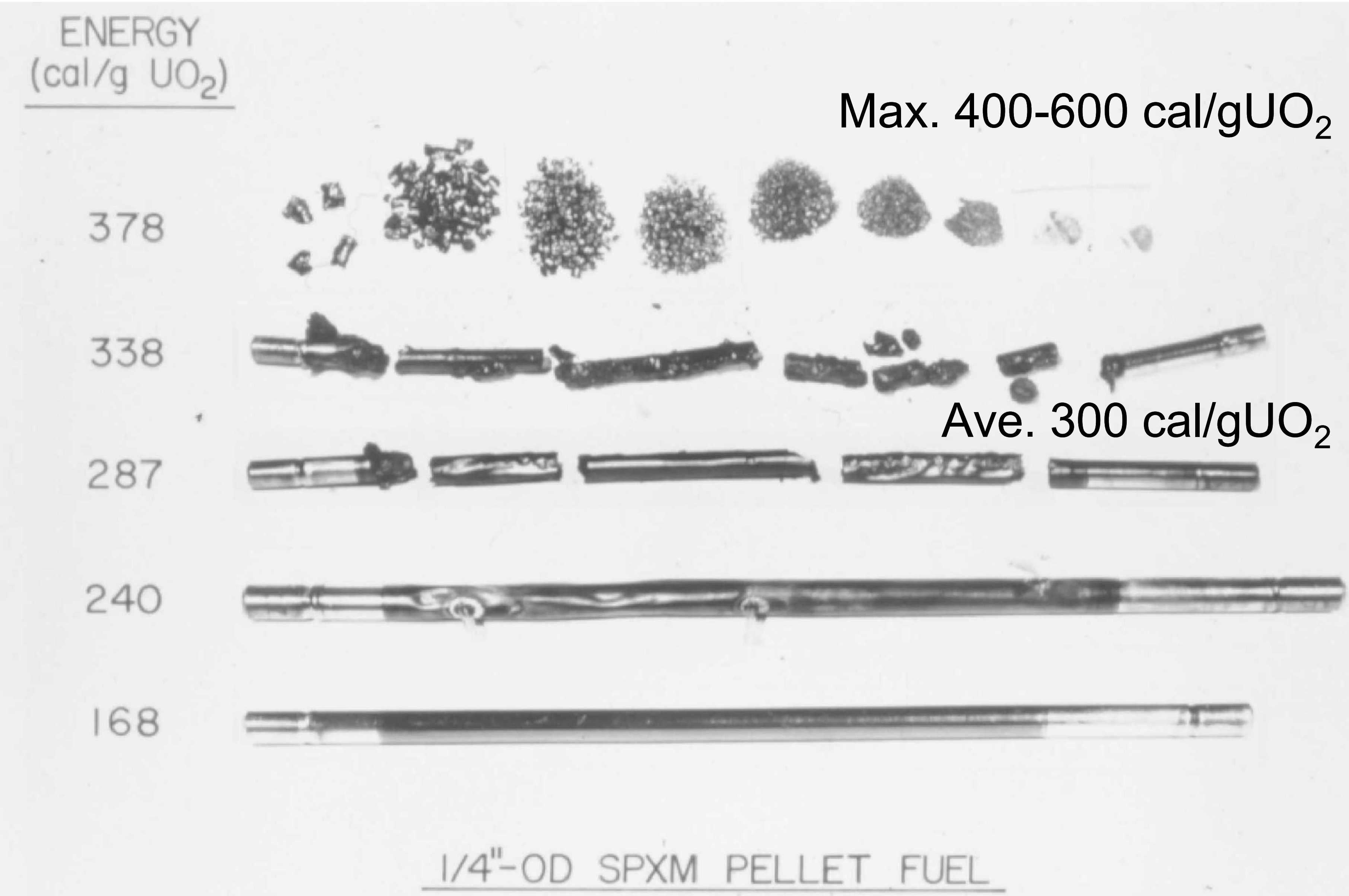
Probable First Fuel Damage
Energy Release In "Burst" Greater Than 40 Full Power Seconds
Normal Full Power
< 5 sec

ACCIDENT CHRONOLOGY

0123

– Average Energy Deposition 300 cal/gUO_2 (Maximum 400-600 cal/g)
  - Fuel Disintegrates
  - Cladding Breaches
  - Steam Explosion

Fuel Damage


ENERGY (cal/g UO_2)
Max. 400-600 cal/gUO_2
378
338
Ave. 300 cal/gUO_2
287
240
168
1/4"-OD SPXM PELLET FUEL

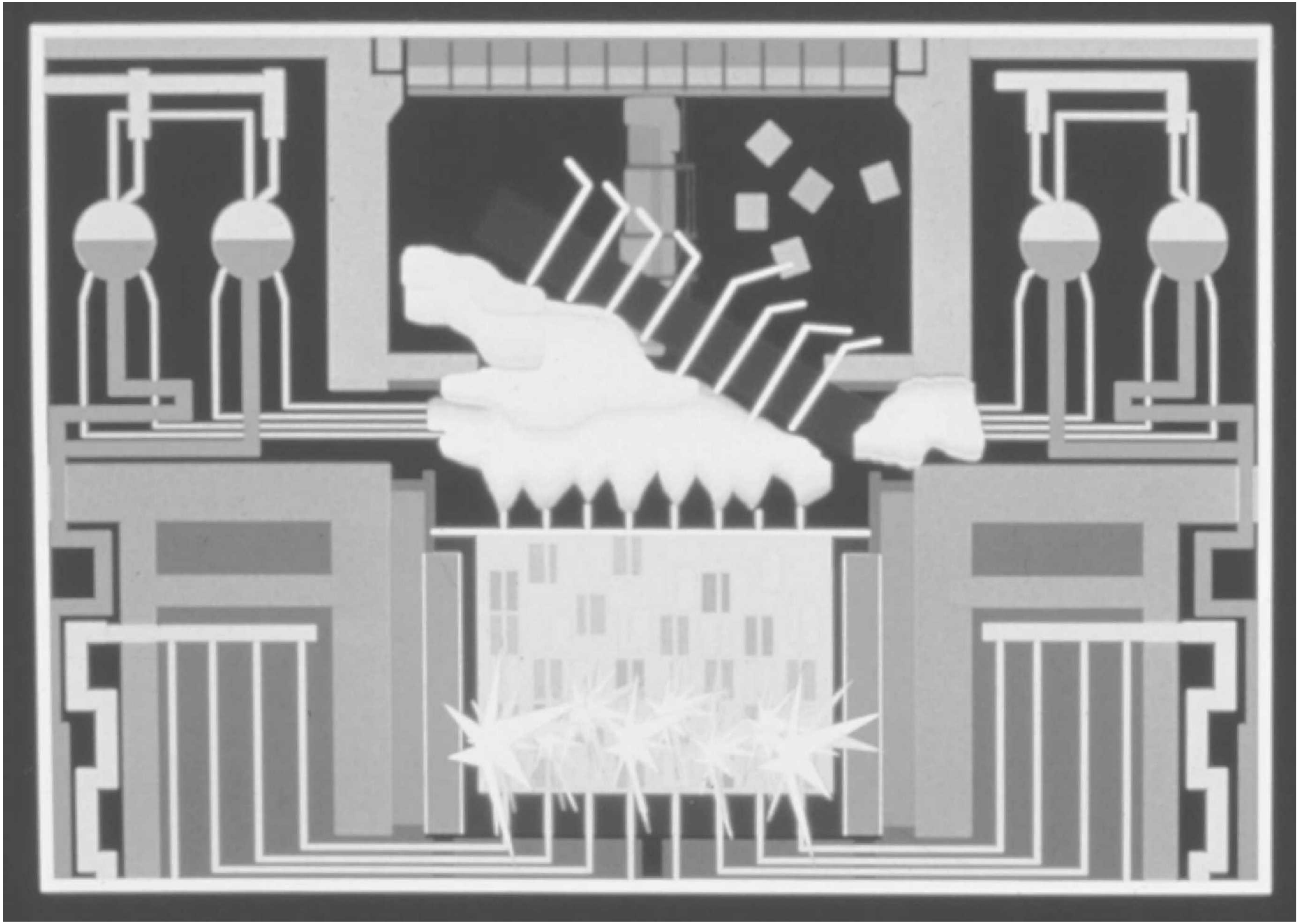
ACCIDENT CHRONOLOGY

0123

– Average Energy Deposition 300 cal/gUO_2 (Maximum 400-600 cal/g)
  - Fuel Disintegrates
  - Cladding Breaches
  - Steam Explosion

– Steam Explosion Energy
  - Lifts Top Shield $\rightarrow$ Pulls Out Pipes & Control Rods
  - Shrapnel Penetrates Concrete Walls
  - Disperses Burning Graphite & Fuel

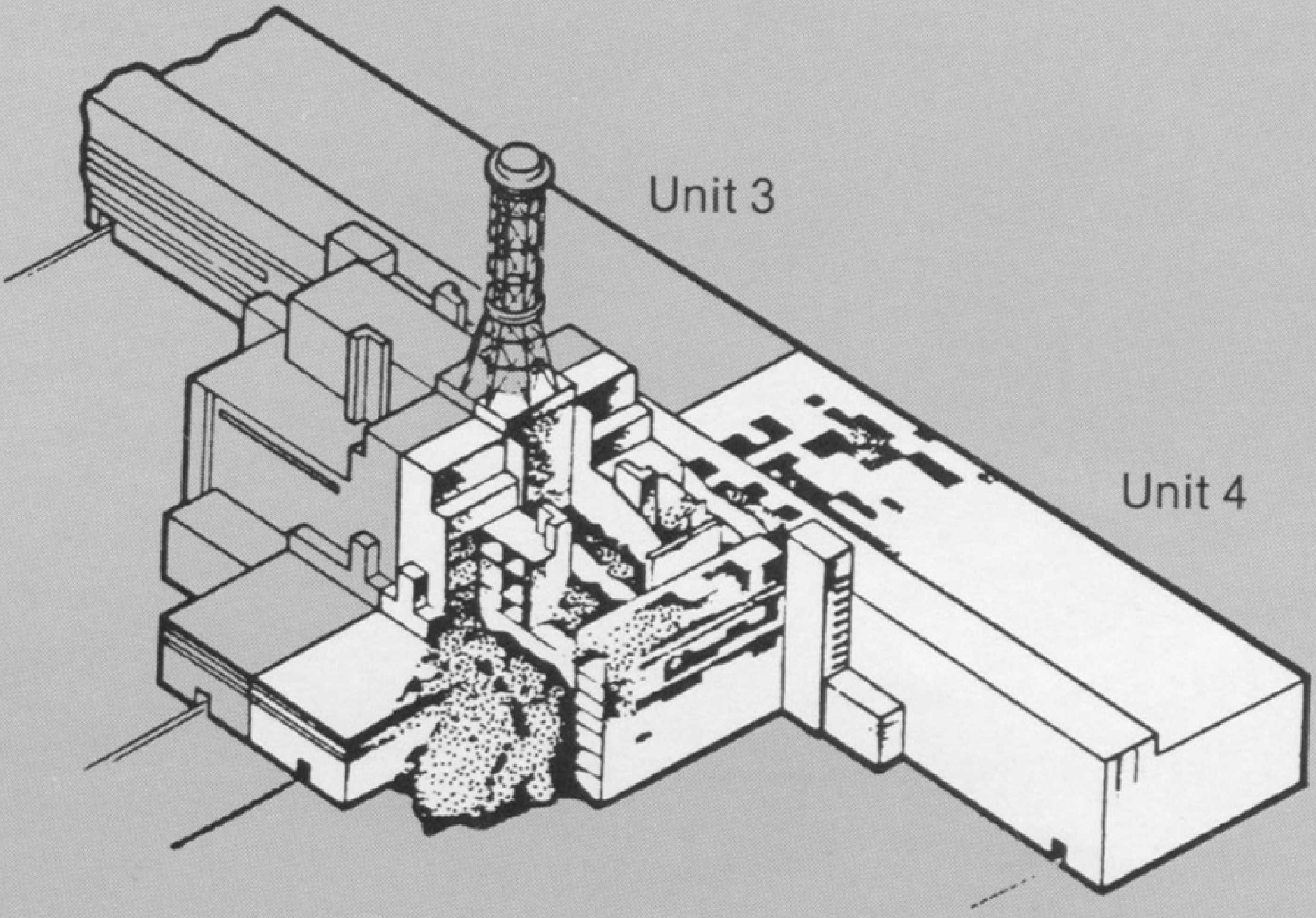
Reactor Damage



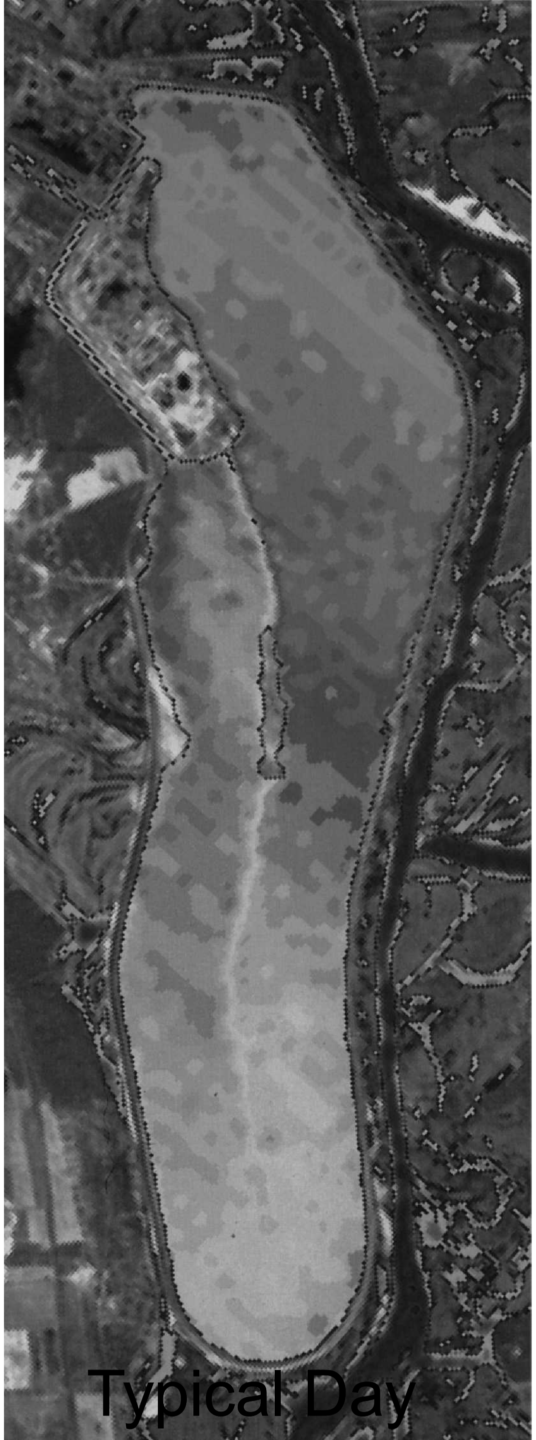
ACCIDENT CHRONOLOGY

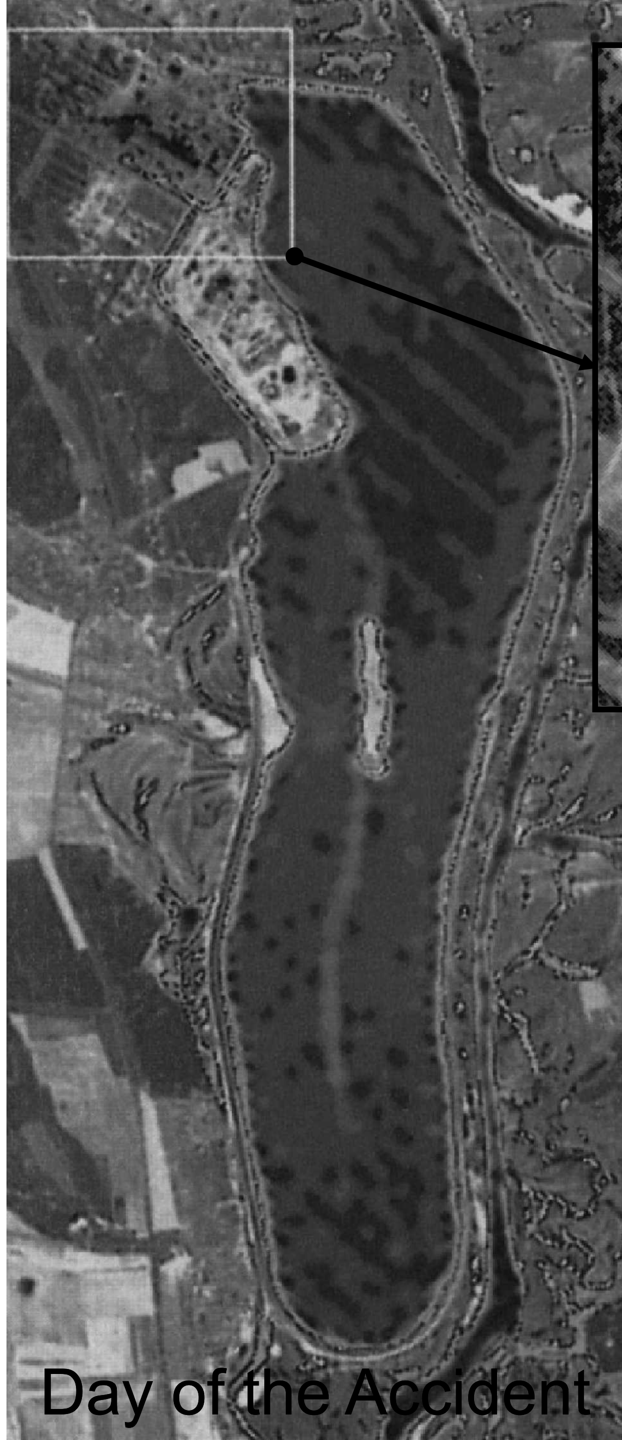
- **0123**
  - Oxidation of Zr & Graphite Produces Explosive H_2 & CO
    - Blows Off Building Roof
    - Causes Plume of Radioactive Gas & Particulates to Rise into Atmosphere
  - Burning Core Visible from Satellite
  - Explosions Reportedly Seen As Far Away As Kiev

After the accident



Destroyed !



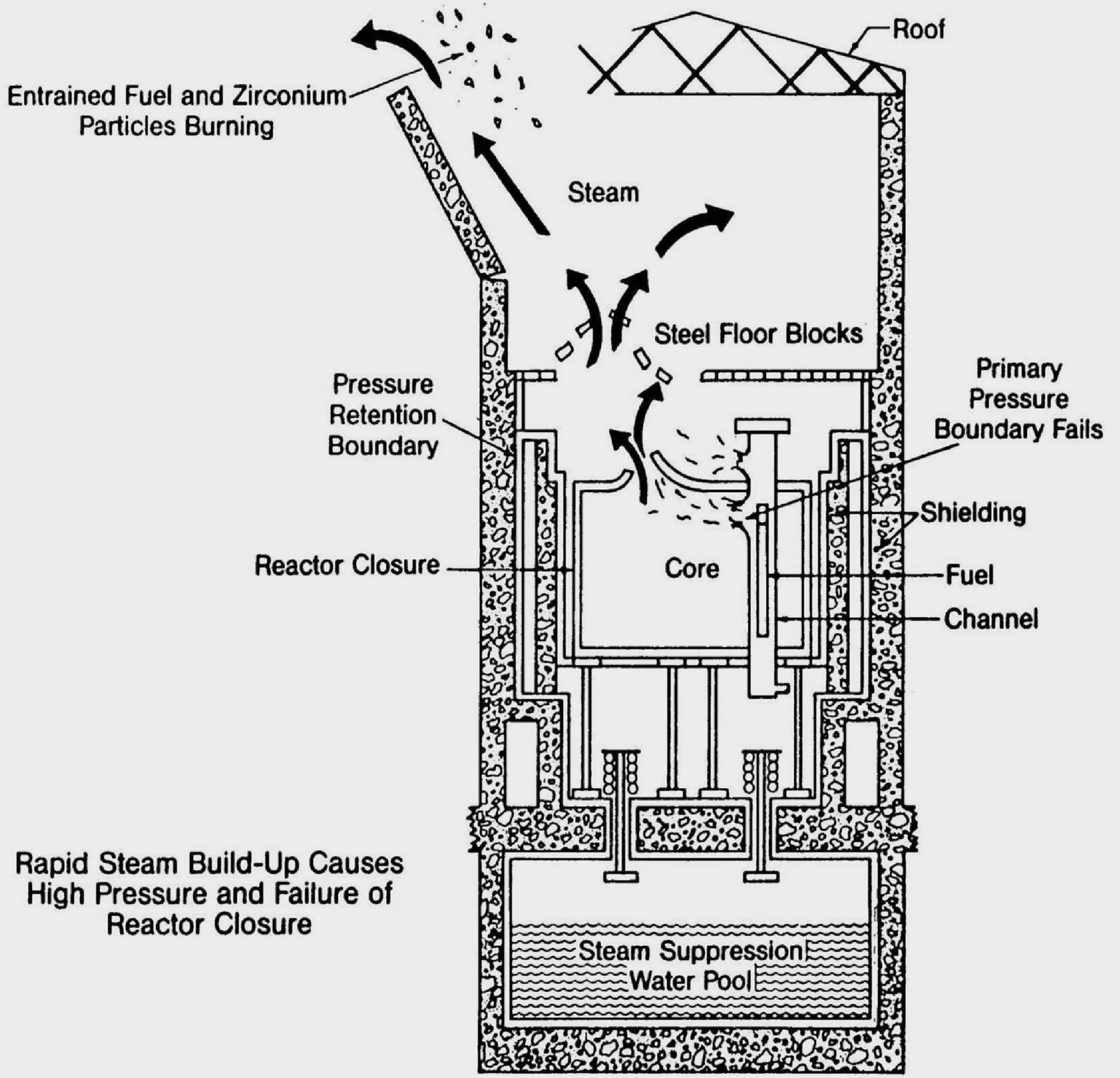


From an "Eye in the Sky"

National Geographic
For Educational Use

CHERNOBYL-4 ACCIDENT

- RADIOLOGICAL CONSEQUENCES
  - Immense Releases of Radioactive Material
    - Fission-Product Gases
    - Volatiles, Particulates & Aerosols
    - Graphite-Fuel Debris from Core



Rapid Steam Build-Up Causes High Pressure and Failure of Reactor Closure

CHERNOBYL-4 ACCIDENT

- RADIOLOGICAL CONSEQUENCES
  - Immense Releases of Radioactive Material
    - Fission-Product Gases
    - Volatiles, Particulates & Aerosols
    - Graphite-Fuel Debris from Core
  - Radiation Doses
    - Plant and Emergency-Response Staff
      - 28 Near-Term Fatalities From Radiation & Thermal Burns; 19 More by End of 2004
      - 200 Hospitalized for Radiation Injuries
      - 1000 “Large” Doses

RADIOLOGICAL CONSEQUENCES

- NEARBY POPULATION
  - No Hospitalization for Acute Exposure
  - Sheltering in Pripyat
  - Potassium Iodide [KI] Distributed
  - Evacuation
    - Early Readings Deceptively Low Because Hot Gas Plume Rose Straight Up
    - Evacuation at 36 h
    - 45,000 from Pripyat & Chernobyl w/in 3 hours
    - Exposures >0.25 Sv [25 Rem] (40-50 Rem Max)

Pripyat -- Chernobyl's Bedroom Community

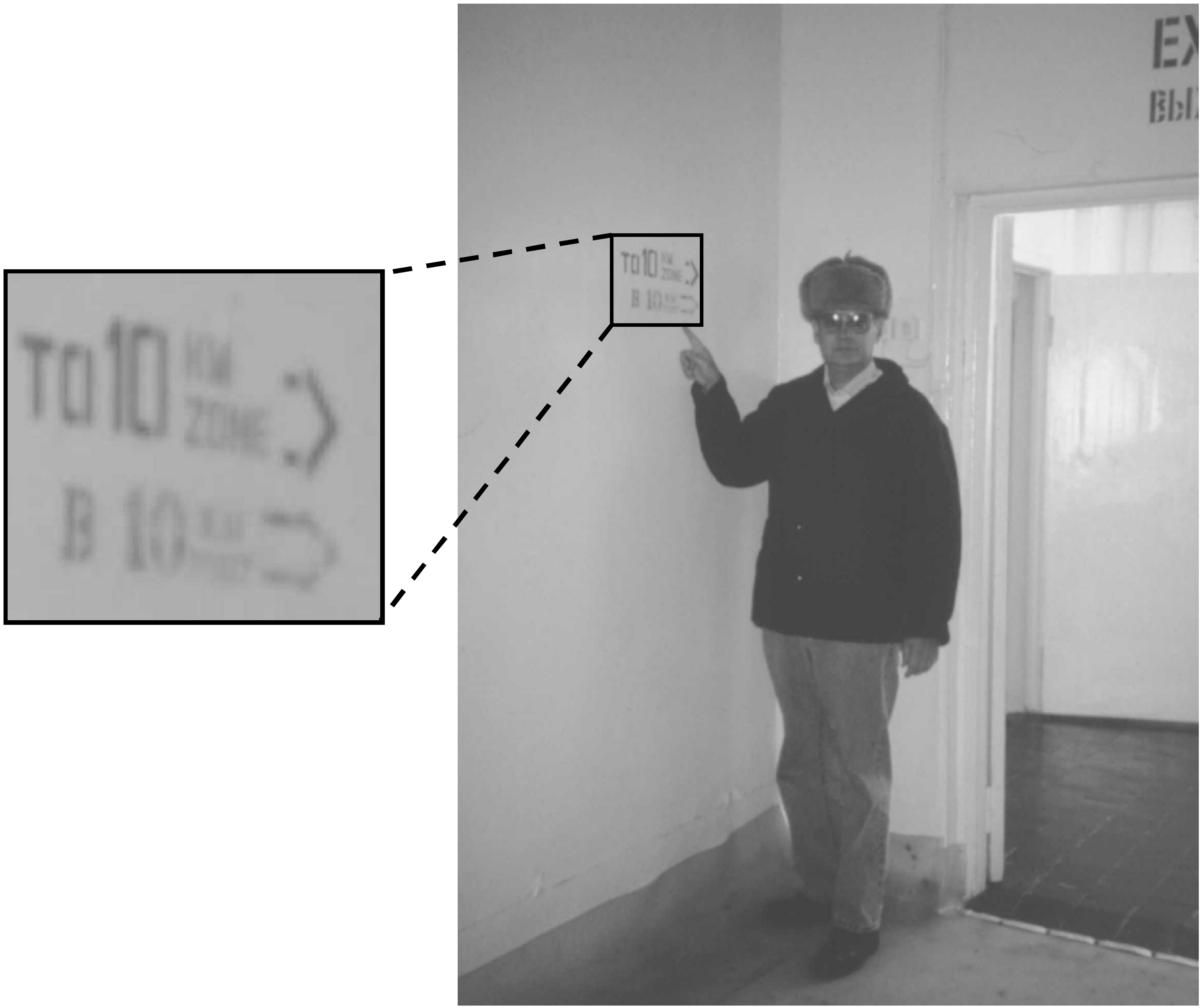
30-Km Zone Boundary

Rules
for the
30-Km Zone

Don’t Eat . . .


зона відчуження
ПОЛЮВАННЯ, ЗБІР
ГРИБІВ І ЯГІД СУВОРО
ЗАБОРОНЕНО !
*ДСВКЛП „Чорнобильліс" тел.5 - 23 - 23

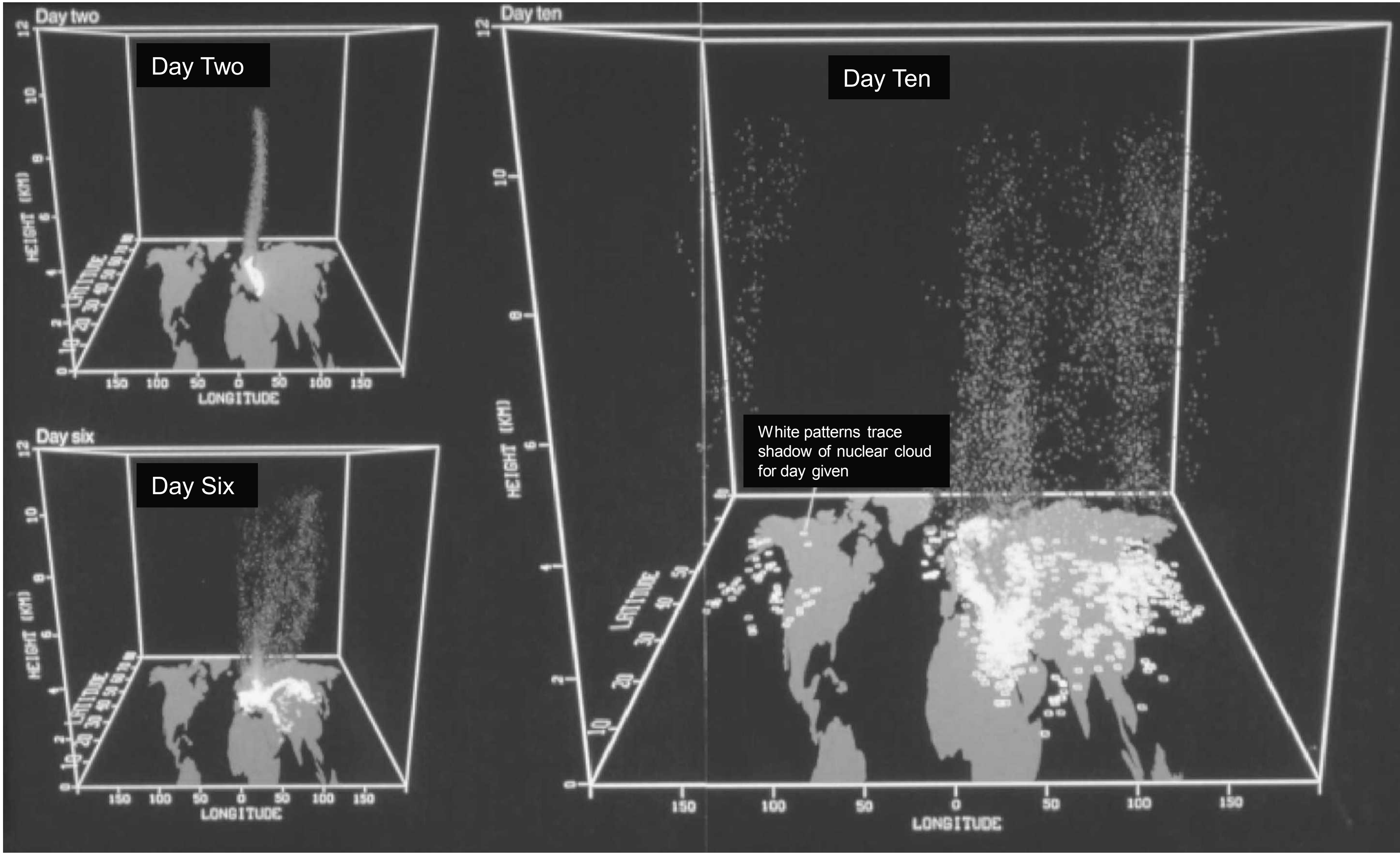
Gateway to the 10-Km Zone



CHERNOBYL-4 ACCIDENT

- ENVIRONMENTAL RELEASE PHASES
  - Gas Plume from Explosions & Fires
    - Day 0
      - 1- to 2-km high
      - Travels North at Lower Altitudes
      - Travels Southeast at Upper Altitudes
    - Day 1
      - 9-km High
      - Moves NE Across Poland Toward Scandinavia

Radioactivity Releases



National Geographic
For Educational Use

CHERNOBYL-4 ACCIDENT

- ENVIRONMENTAL RELEASE PHASES
  - Gas Plume from Explosions & Fires
    - Days 2-6
      - Particulate Content & Releases Declining
    - Days 7-13
      - Volatiles Increase Due to Ineffectiveness of "Stabilization" Efforts
    - Day 13
      - Rapid Decrease w/ Success in Cooling

CHERNOBYL-4 ACCIDENT

- SOURCE TERM > 100 MCi

Comparison of Chernobyl & TMI-2
Accident Source Terms

Constituent	Chernobyl	TMI-2
Noble Gases	100%	< 8 %
Iodine	40%	$< 2x10^{-5}$ %
	(20 MCi)	(18 Ci)
Cs	25%	--
Te	>10%	--
Particulate	3-6%	--

LONG-TERM HEALTH EFFECTS

- UNITED NATIONS STUDY [Sept 2005]
  - Estimates that 4,000 Could Die from Radiation-Induced Cancers
  - To Date
    - 47 Emergency Workers (Direct Radiation)
    - Thyroid Cancer
      - 4,000 Cases – Mostly Children or Adolescents During Accident
      - 9 have died

LONG-TERM HEALTH EFFECTS

- UNITED NATIONS STUDY [Sept 2005]
  - Most Emergency Workers and Local Residents Received Whole-Body Doses Comparable to Natural Background
  - No Evidence of Increases in Leukemia or Other Cancers, Decreased Fertility or Congenital Malformations.

LONG-TERM HEALTH EFFECTS

- UNITED NATIONS STUDY [Sept 2005]
  - “Largest Public Health Problem Created by the Accident”
    - Poverty, Mental Health Problems & “Lifestyle” Diseases – e.g., Alcoholism & Tobacco Dependency – Pose Greater Threat Than Radiation Exposure.
    - Relocation Proved “Deeply Traumatic” for 350,000 Evacuees

LONG-TERM HEALTH EFFECTS

- UNITED NATIONS STUDY [Sept 2005]
  - "Largest Public Health Problem Created by the Accident"
    - Persistent Myths & Misperceptions About Radiation Have Resulted in "Paralyzing Fatalism;" Seeing Themselves as "Victims" Rather Than "Survivors" Has Led to Overcautious & Exaggerated Health Concerns

CHERNOBYL-4 ACCIDENT

- POST-ACCIDENT RESPONSE
  - Plant Recovery
    - Fire Fighting
    - Unit 3 Shut Down (When Last Fire Out)
    - Units 1 & 2 Operated for Nearly a Day Longer

Fire Fighter Memorial

Chernobyl Fire Station

Mural-Sculpture

CHERNOBYL-4 ACCIDENT

- POST-ACCIDENT RESPONSE
  - Plant Recovery
    - Unsuccessful Attempts to Use Emergency and Auxiliary Water Supplies to:
      - Reduce Reactor Temperature
      - Prevent Graphite Combustion
    - Fill Cavity w/ Materials to:
      - Dissipate Heat
      - Filter Discharge
      - Prevent Potential Buildup of Explosive Compositions of Hydrogen & Carbon Monoxide

Bombardment

PLANT RECOVERY

- EXTREMELY HIGH RADIATION LEVELS
  - Waves of Workers
  - Short Stay Times
  - Robots on Limited Basis
  - Bulldozers w/Operators in Shield Cabs Most Useful
  - Paving Material to Immobilize Radioactive Dust

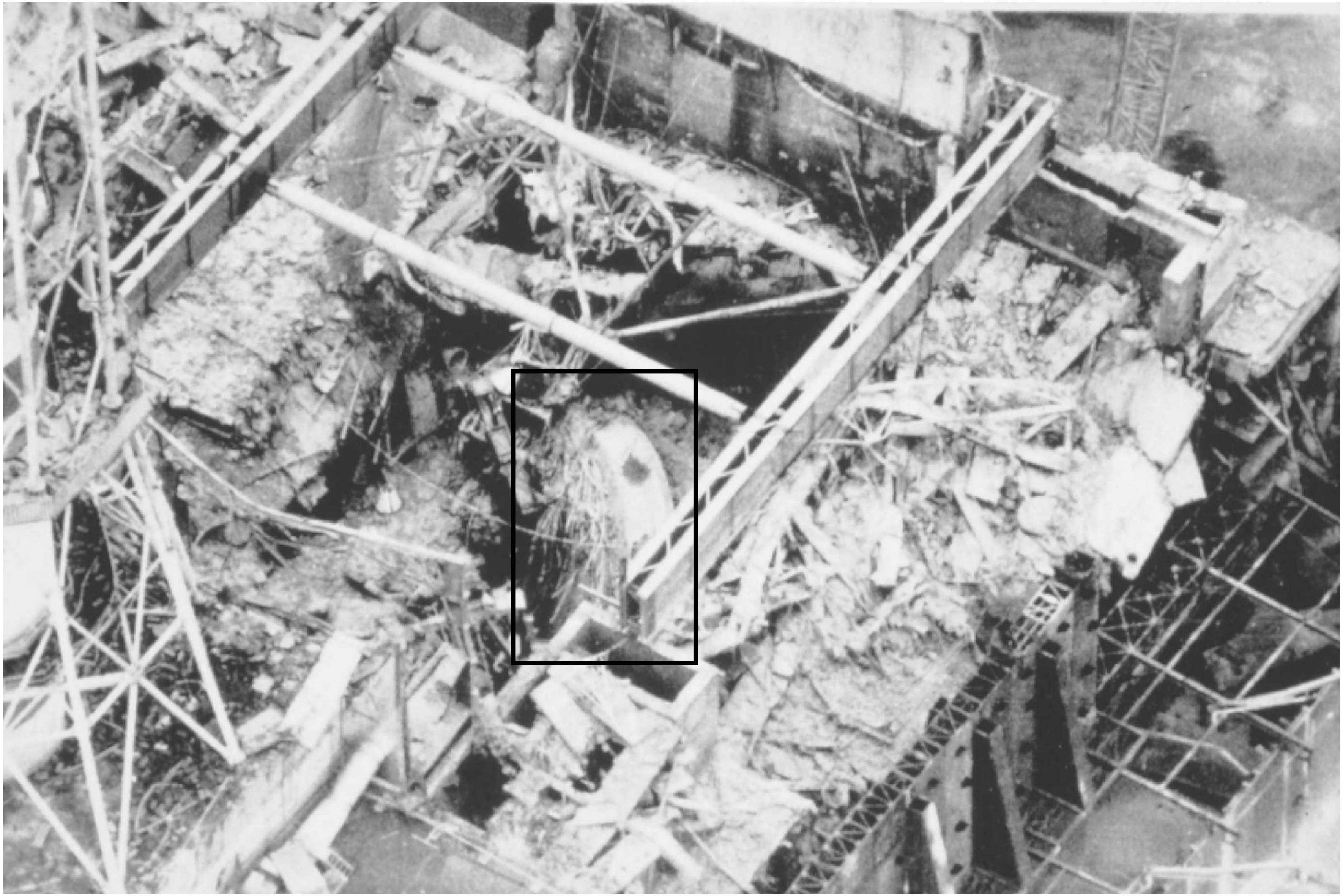
Protective Clothing

“Bio-Robots”

National Geographic
For Educational Use

Molten Fuel -- Elephant’s Foot

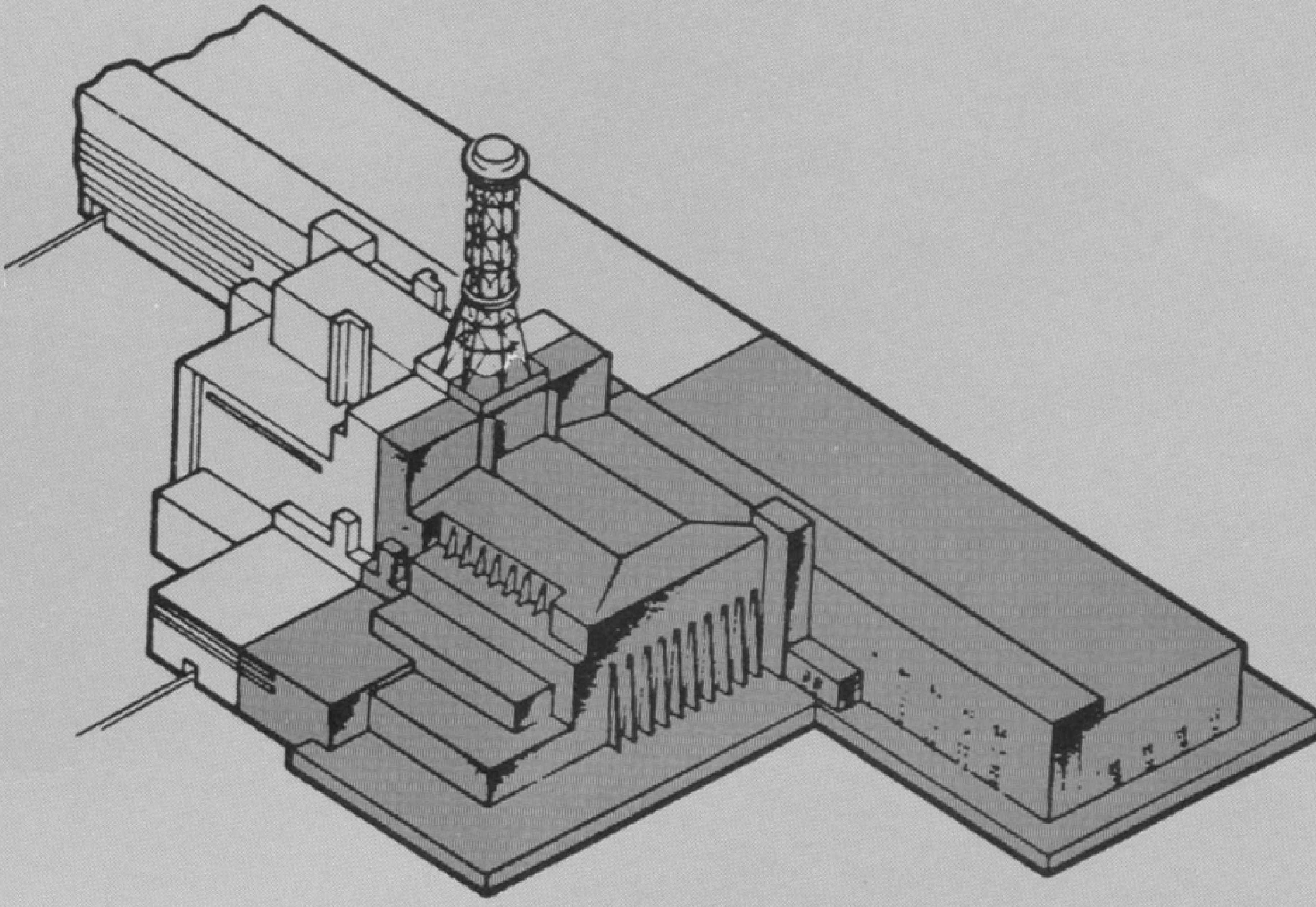
Shield Plug



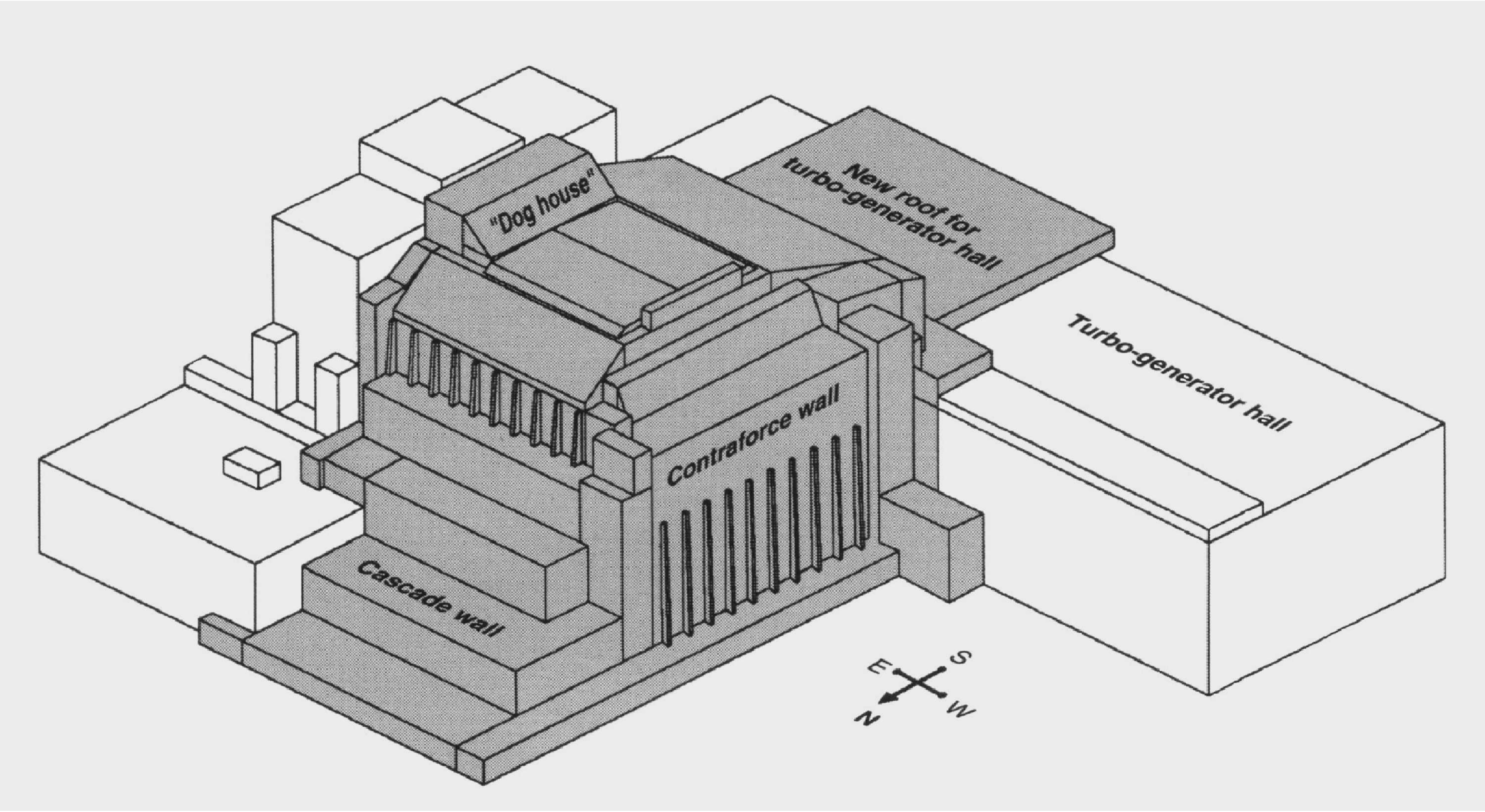
PLANT RECOVERY

- REACTORS
  - Construct Sarcophagus Around Unit 4
  - Construct Heavy, Metal Partition Between Unit 2 and Unit 3

Unit 4 entombed



Sarcophagus



Visitors at the Sarcophagus

This Bridge Has a Story to Tell

Those Who Came Here to Watch the
“Spectacular Colors” of the Chernobyl Fires
Received Substantial Radiation Doses

PLANT RECOVERY

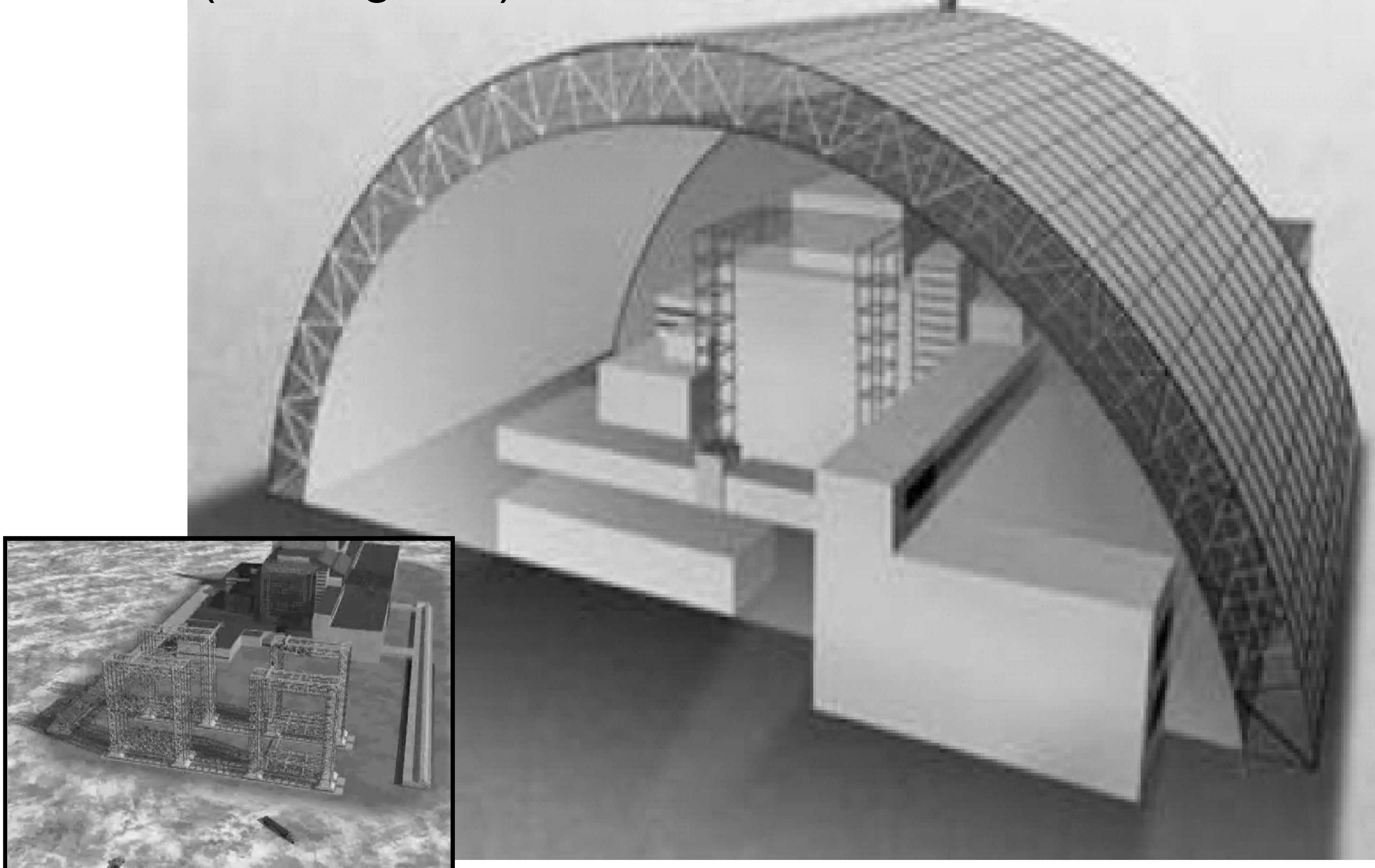
- REACTORS
  - Units 1 and 2 Restarted Late in 1986
  - Unit 3 Restarted End of 1987
    - Extensive Decontamination
    - Refitting
  - Continuing Substantial Need for Electricity in Ukraine
  - Eventually All Shutdown by 2003

CHERNOBYL-4 ACCIDENT

- EVACUATION & RELATED ACTIVITIES
  - Initial Response $\rightarrow$ Sheltering
  - Full-Scale Local Evacuation w/in 36-hours
  - Livestock Evacuated or Killed
  - Evacuation of Ukraine & Byelorussia Took About a Week
    - 176 Communities within 30 km; Total of 135,000
    - New Cities Established (Slavutich 20-30,000)

The Ukraine Post-Chernobyl

New Safe Containment
(In Progress)



CHERNOBYL UNIT 4

THE REACTOR

THE ACCIDENT

THE CONSEQUENCES

CHERNOBYL-4 ACCIDENT

- ECONOMIC & OTHER CONSEQUENCES
  - Direct Cost
    - 4-Billion Rubles (~ $14B U.S.) for Recovery
      - Entombment & Decontamination
      - 21,000 Houses & 15,000 Apartments
      - Evacuee Compensation 900-M Rubles
    - 4-Billion Rubles Replacement Power
  - Outside Soviet Union ~$1 Billion

ECONOMIC & OTHER CONSEQUENCES

- PLANT OPERATIONS MANAGEMENT AND STAFF
  - Radiation-Related Illness; Two Fatalities
  - Senior Officials Fired for Negligence or Desertion
  - Three-Week Trial in Chernobyl
    - Six Convicted & Sentenced to Labor Camps
      - "Gross Violation of Safety Rules"
      - "Criminal Negligence"
      - "Abuse of Power"

ECONOMIC & OTHER CONSEQUENCES

- OTHER ACTIONS
  - Legal Action Threatened – But Not Implemented – for Design, Construction & Regulatory Personnel
  - Communist Party Expelled 27 Members for “Cowardice & Alarmism”
  - Valery Legasov - Deputy Head of Kurchatov Institute – Committed Suicide

CHERNOBYL-4 ACCIDENT

- ACCIDENT CAUSES & LESSONS LEARNED
  - 500 Separate Commissions Worldwide
  - Most Significant Lesson → Importance of Learning from Experience
    - Soviet Precursors at Kursk (1980) & Perhaps Leningrad
    - *Failure to Evaluate TMI-2 Lessons Learned*
  - Initial Soviet Evaluation → Operator Error
  - World Evaluation Added → Design Management Systems

CHERNOBYL-4 ACCIDENT

- INTERNATIONAL PERSPECTIVE
  - No Significant New Lessons
  - Urgency for Completion of Post-TMI-2 Modifications, e.g., France:
    - "Physical States" (Symptom-Oriented) Procedures
    - Minimized Protection System Inhibitions
    - Reassess Reactivity Accidents
    - Improved Reactor Safety Training
    - Stocks of Equipment & Devices in Irradiated Areas
    - Improved Public Information System

- Unfortunately, in the Union of Soviet Socialist Republics (USSR), this accident was virtually ignored. In 1984, Academician A. Aleksandrov, President of the USSR Academy of Sciences and Director of the Kurchatov Institute, stated in *Pravda* that
  - "this [TMI-2] accident could only have happened in a capitalist country, where profit is more important than safety."

CHERNOBYL-4 ACCIDENT

- INTERNATIONAL PERSPECTIVE
  - Redirection of Research & Development
    - Source-Term / Atmospheric Modeling
    - Radiation Effects on Populations / “Living Laboratory”
    - Containment Behavior
    - Corium [Molten Fuel] Cooling & Concrete Interaction
  - International Emergency Planning Agreements

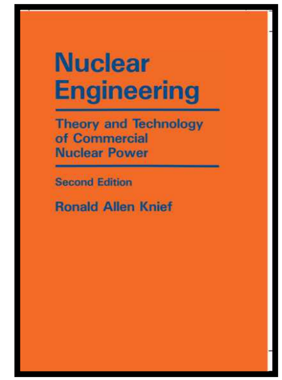
CHERNOBYL-4 ACCIDENT

- INTERNATIONAL PERSPECTIVE
  - World Organization of Nuclear Operators [WANO]
    - Charter
      - Maximize Safety / Reliability of Operation
      - Exchange Information
      - Encourage Comparison, Emulation & Communication
      - Improve Plant Reliability and Safety
    - 144 Nuclear-Utility Members
    - Reg Centers - Atlanta/Moscow/Paris/Tokyo
  - Communication Between Nuclear Industry and Public

REFERENCES

Ronald Allen Knief, *Nuclear Engineering: Theory and Technology of Commercial Nuclear Power*, 2nd Ed., 1992 (Reprinted 2008, American Nuclear Society, LaGrange Park, IL)

Chapter 1:	Introduction
Chapters 9-11:	Fuel & Reactors
Chapters 13-14:	Reactor Safety
Chapter 15:	Reactor Operating Events (TMI & Chernobyl)
Bibliography	



Nuclear Engineering International [Website]

David Mosey, *Reactor Accidents, Nuclear Engineering International,* 2006

George Vargo (Ed.), *The Chornobyl Accident: A Comprehensive Risk Assessment*, Battelle Press, 2000.

CHERNOBYL UNIT 4

THE REACTOR

THE ACCIDENT

THE LESSONS

CHERNOBYL-4 ACCIDENT

- ACCIDENT CAUSES & LESSONS LEARNED
  - – 500 Separate Commissions Worldwide
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    - Soviet Precursors at Kursk (1980) & Perhaps Leningrad
    - *Failure to Evaluate TMI-2 Lessons Learned*
  - – Initial Soviet Evaluation → Operator Error
  - – World Evaluation Added → Design Management Systems

ACCIDENT CAUSES & LESSONS LEARNED

- OPERATOR ERROR
  - Control Rods Mispositioned
  - Low Power Level
  - Excess Coolant Flow
  - Scram Signals Bypassed
  - Emergency Core Cooling Systems (ECCS) Turned Off

ACCIDENT CAUSES & LESSONS LEARNED

- DESIGN DEFICIENCIES
  - Positive Coolant-Void Feedback
  - Easy-to-Block Safety Systems
  - Slow Scram
  - No Fission-Product Control or Containment

ACCIDENT CAUSES & LESSONS LEARNED

- MANAGEMENT SYSTEM DEFICIENCIES
  - Test Aborted by Dispatcher
  - Test Continued from Unplanned Conditions
  - Approval to Override Safety Systems
  - Test w/o Understanding of Reactor Safety
  - No Simulator Training
  - No Anticipation of Event Type by Designers, Management or Operators

e.g., Inadequate Safety Culture

ACCIDENT CAUSES & LESSONS LEARNED

- KEY ERRORS
  - Operators Had Two Masters
  - Operators Should Have Terminated Test or Returned to Preestablished Conditions
  - Efforts to Complete Test Despite Deterioration
  - Plant Conditions Not Covered by Procedures Nor Experience

The Accident precursors….

- A new operating staff, little nuclear experience.
- A strong central design bureau
- Non-conservative reactor parameters.
- A disregard for safety precautions and procedures

What happened?
The History of the Accident

- On 26 April 1986 at 1:23:40 am, Reactor #4 of Chornobyl's Nuclear Power Plant exploded.
- The explosion released more than thirty times the amount of fallout of the Hiroshima nuclear weapon.
- The plume contaminated much of Ukraine and Northern Europe.
- It resulted in the resettlement of nearly 336,000 people.
- 57 people died with a few days of the immediate accident, and it is estimated that several thousand have died as a consequence of radiation atmospheric exposure.

History (cont.)

- The test had been done once before, with all safety systems still in play.
- The results though were negative – that is, they showed that the turbines would not generate enough power for the RCP's to provide minimum flow.
- The turbines were thus, modified, in the hope that they would now pass the test.
- Consequently, they needed another coast-down test at Chornobyl U-4.

History (cont.)

- This whole cycle created a positive reactivity feedback loop. When the operators commanded a power reduction from the normal 3.2 GW thermal to 1 GW thermal power level that the test called for, the reactor power dropped to 30 MW thermal, less than 5% of what was called for to perform the turbine coastdown test .
- To increase power, the operators pulled the automatic control rods in banks beyond what is allowed by safety regulations. This could only increase the power to 200MW, less than one-third the power desired for the experiment.
- At 1:05am on April 26, the water pumps that were to be driven by the turbine generator were turned on, increasing water flow beyond what is allowed by safety regulations. The cooler water also absorbed neutrons, further decreasing reactor power.
- To compensate, the operators now pulled the manual control rods.
- With nearly all of the control rods pulled out, the only thing keeping the reactor at a low power level was the xenon-135 buildup.

History (cont.)

- At 1:23am the experiment began. The first experiment step was to shutoff the steam to the turbines. As the water slowed down, it absorbed less neutrons. Since the steam was not being directed to the turbines from the reactor, more steam was now in the reactor core.

- This created “hot spots” in the coolant lines and the reactor itself. The reactor was designed poorly and had what is called a positive “void coefficient”. That means that as voids occur, reactivity actually goes up.

- As the power increased, the xenon-135 was “burned” more rapidly. Since all of the control rods were pulled, they could not respond fast enough to counter the increase in reactivity.

History (cont.)

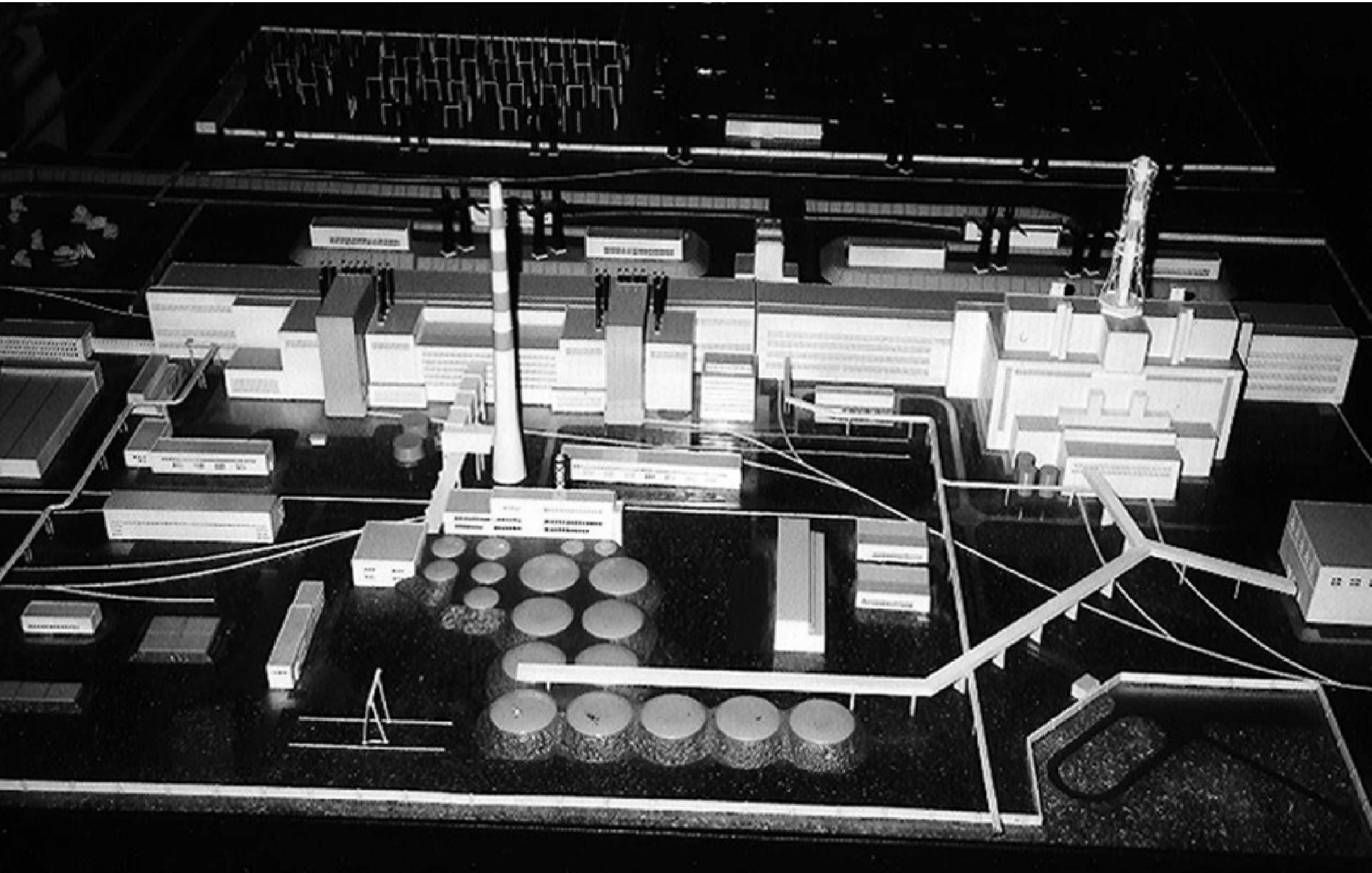
- At 1:23:40, the operators pressed the AZ-5 (Rapid Emergency Defense 5) button that ordered a “SCRAM” – a shutdown of the reactor, fully inserting all control rods, including manual rods.
- Due to the slow insertion rate, there was more “voiding” of steam in regions of the fuel, driving the reactivity to climb further. The vertical water channel design contributed to this.
- The fuel at this point started to fracture, as well as the coolant channels.
- Hot fuel came in contact with hot water, creating a large steam explosion that blew the top of the reactor off. A short time later, a second explosion blew the bottom of the reactor core barrel off.
- This second explosion ejected most of the fuel into the surrounding graphite moderator, igniting the graphite like a large briquette. Much of Europe’s contamination is due to this.

AZ-5 Shutdown Switch

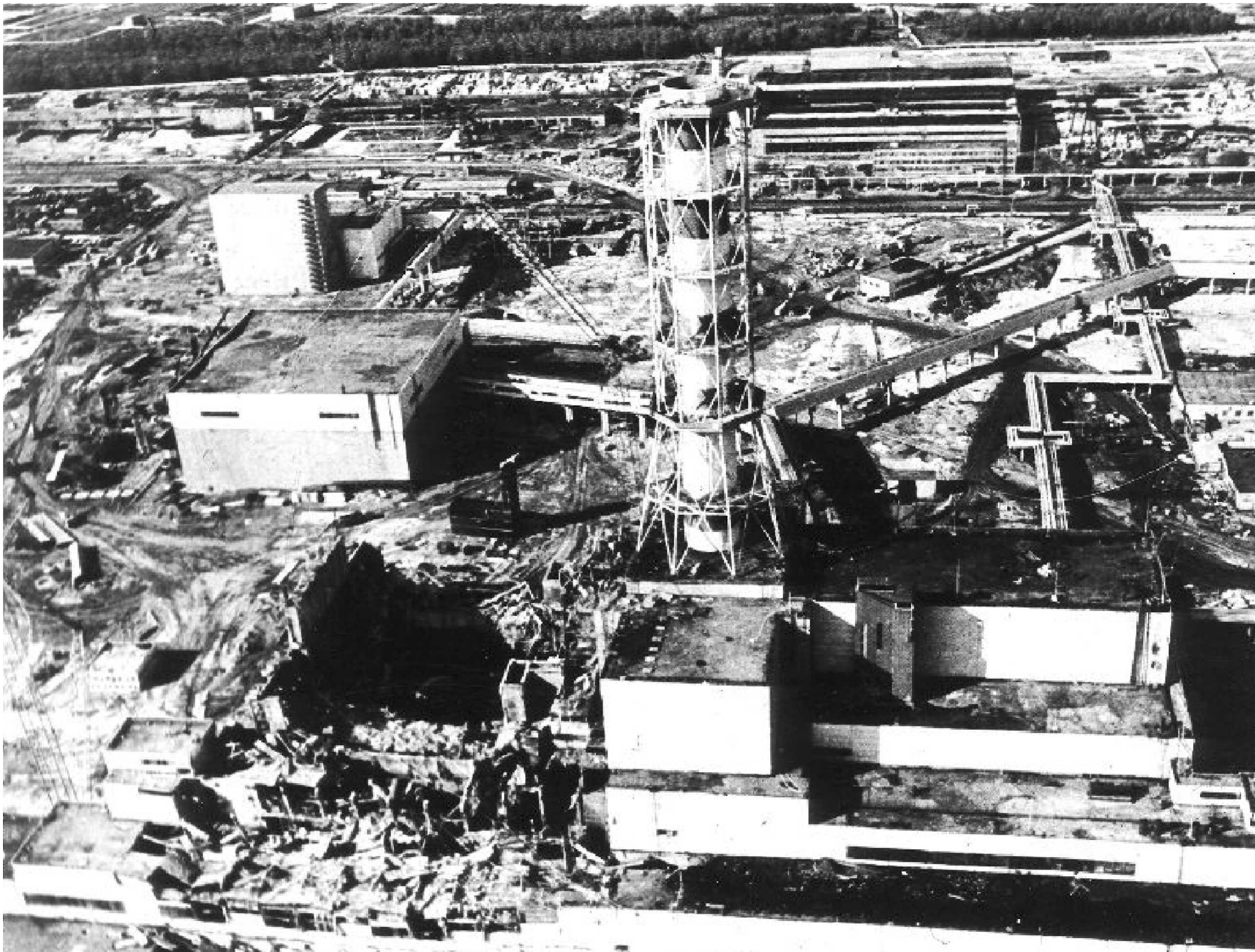
History (cont.)

- Fifty-seven people died as a direct consequence of the lethal radiation, several being fire fighters.
- It is postulated that several thousands have died as a consequence of the contamination and the plume due to the fire.
- Pripyat, a city of fifty-thousand people located adjacent to the plant was evacuated a few days later. Many residents stood out on their porches and watched as “a building” burned. Little did they know that they were exposing themselves to large doses of radiation.
- The existing Shelter was built rapidly to house the destroyed contents of U-4.
- 700,000 people built the existing “Ukritia” or “Object Shelter” between May and November 1986. It was constructed under extreme dose and time-constraint conditions.
- There are few bolted or welded joints. It is largely constructed on the walls that remained after the explosion, much as you might build a lincoln-log set.

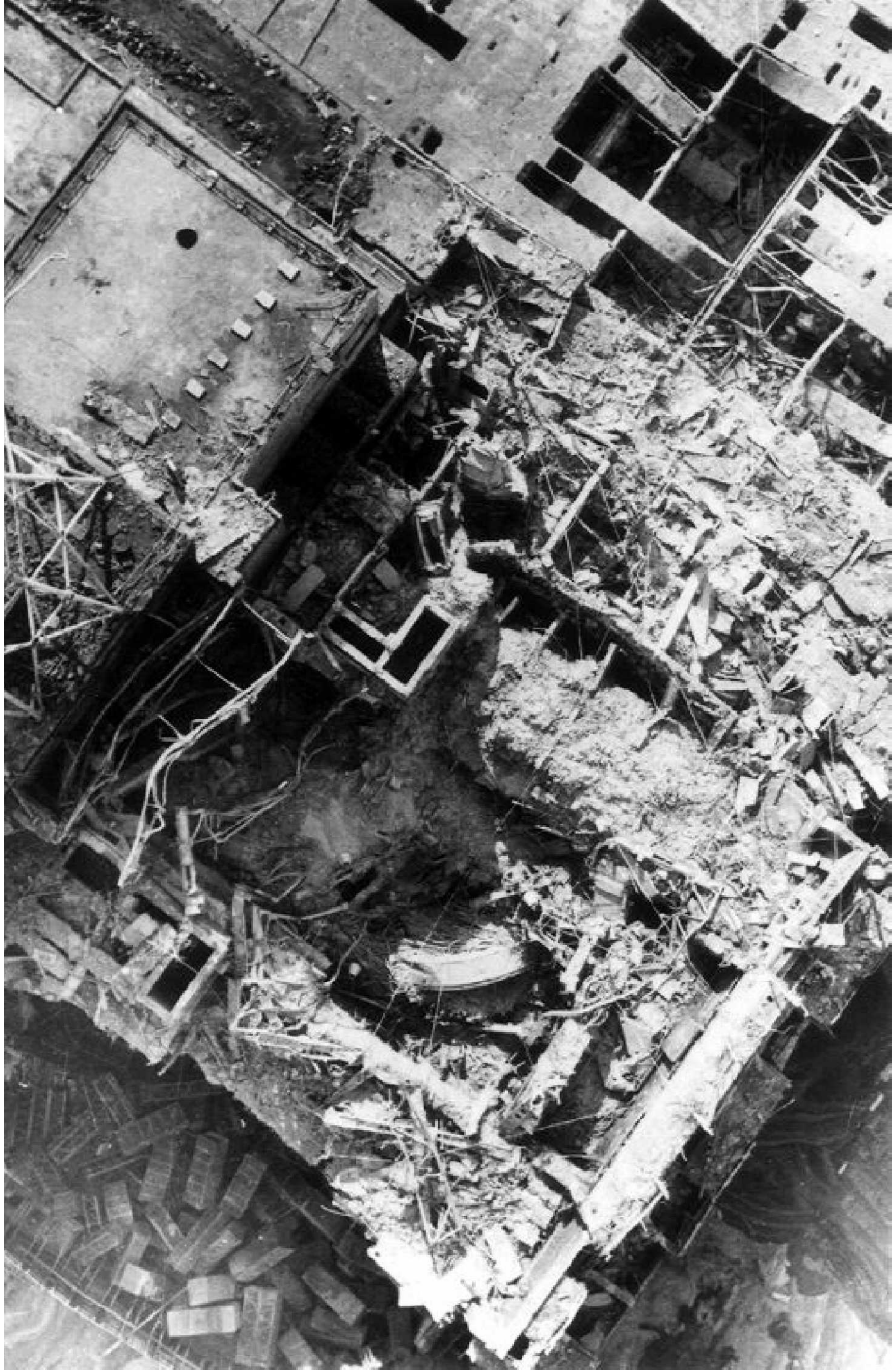
Chornobyl Before the Accident



After the accident…



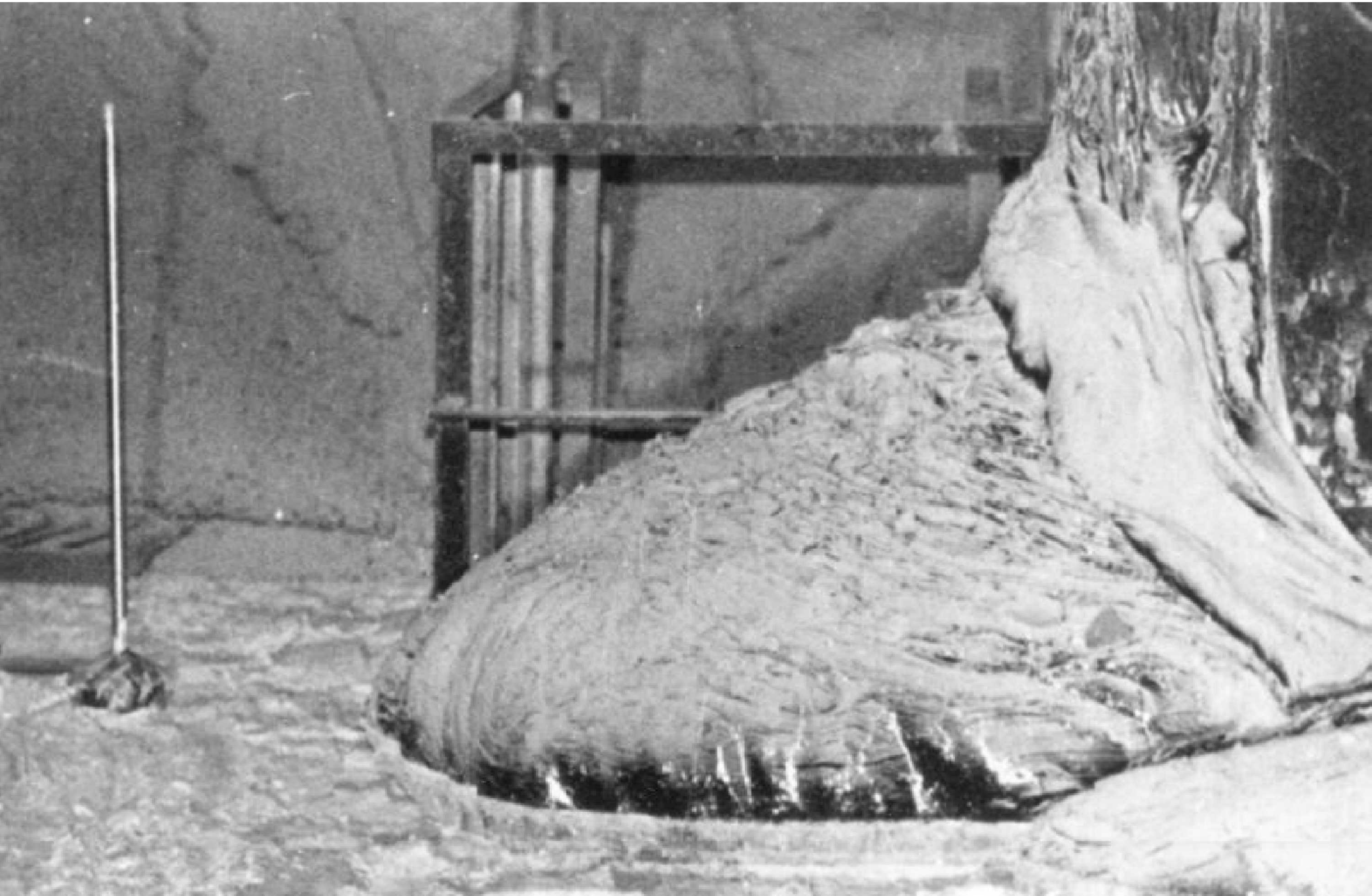
Down view, showing Elena



Elena plus control rods

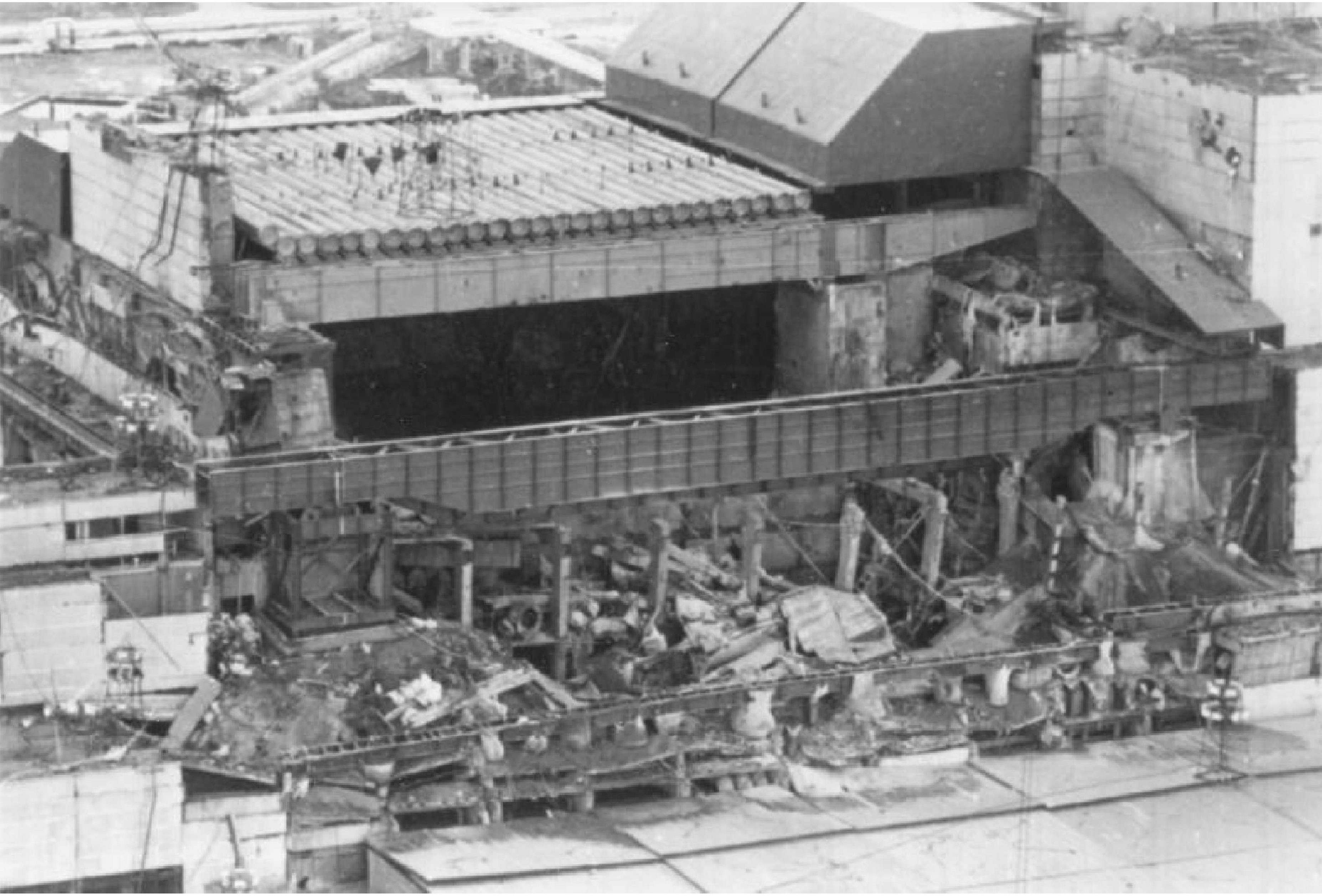
Fuel Containing Mass (FCM)

Elephant’s foot FCM



Construction of the first supports

Building the Shelter – The beams



Construction of the top plates

The Buttress supports

What is The New Safe Confinement?

- The New Safe Confinement is the structure that is being built to confine the rubble from the Chornobyl Unit 4 Accident in April 1986.
- It will be built over the top of the existing Shelter.
- It is meant to confine, not to contain.