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Radiation Protection Standards and Guidelines



Historical

X-Rays Discovered by Roentgen – 1895

Roentgen's Radiation Protection
 Standards

X-Ray Injuries led to Protection Standards

First Therapeutic Use of X-Rays – 2/1896





Historical

- Realization of Harmful Effects 10/1896
- X-Ray Machines in Major U.S. Cities 1897
- First Known Death From X-Rays 1904
- First Radiation Exposure Guidelines 1915



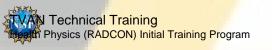


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Significant Actions

- 1954 Atomic Energy Act
- 1968 Radiation Control Health & Safety Act
- Industrial & Medical Diagnostic X-Rays
- 1974 Atomic Energy Commission Split:
 - 1. Nuclear Regulatory Commission (NRC)
 - 2. Energy Research & Development Administration (ERDA)





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Significant Actions

 1977 – ERDA Becomes the Department of Energy

NRC Regulates Radiation Safety

Agreement States Established





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Advisory Organizations - History

- 1915 Design Criteria for X-Ray Devices
- 1920-1921 Operating Requirements

 Considered
- 1925 1st Exposure Level Recommended
- 1925 ICRU Formed
- 1928 Roentgen Used as Unit of Radiation Measurement





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Advisory Organizations - History

- 1928 ICRP Formed
- 1929 Advisory Committee on X-Ray and Radiation Protection Formed in U.S.
- 1934 ICRP First Dose Recommendation
 0.2 R/day (50 R/yr)
- 1946 Advisory Council Becomes NCRP





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Advisory Organizations - History

- 1947 NCRP Lowers Dose
 - a. 'Permissible Dose'-0.3 R/wk
 - b. As Low As Practical-ALAP

- 1956 Permissible Dose Reduced to
 0.1 R/wk (5 R/yr)
- 1957 IAEA Established by UN
- 1959 Federal Radiation Council (FRC)





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Advisory Organizations - History

1964 – NCRP Chartered by Congress

 1966 – American National Standards Institute Established

 1983 - Committee for Interagency Radiation Research and Policy Coordination Established in Office of Science & Technology



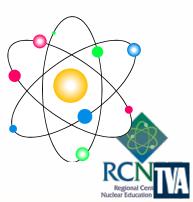


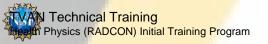
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Radiation Protection Standards and Guidelines

10 CFR 20 governs Radiation Protection

 Awareness of the requirements necessary





Philosophy

- Risk based approach to radiation protection
 - Limits stochastic effects of radiation exposure
 - Avoids non-stochastic effects of radiation exposure
- Combines internal and external dose
- Annual dose limits only
- 5 (N-18) is N/A!





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Risk Based Approach

- Stochastic risk is comparable to that for workers in other safe industries
 - Assumes ALARA program is effective
 - Cannot expose all workers to 5 Rem/year

Non-stochastic risk is ZERO





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Stochastic Effects

- No dose threshold
- Severity is NOT a function of dose
- Probability of occurrence is a function of dose
- Examples are:
 - Cancer
 - Genetic effects



ALARA

As Low As Reasonably Achievable

The Licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are As Low As Reasonably Achievable (ALARA)





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Non-stochastic Effects

- Well-defined dose threshold
- Severity <u>is</u> a function of dose
- Examples are:
 - Cataracts
 - Sterility
 - Skin reddening



Interrelationships

- License Condition Specific Requirement
- NUREG Supporting Information
- Recommendation Suggestions
- Regulation (CFR) Legal Statement
- Regulatory Guide Technical Aid
- Technical Specification 'Contract'





10 CFR 19

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Notices, Instructions & Reports

- 19.11 Posting of Notices to Workers
 - 1. 10 CFR 19 & 20 (Available)
 - 2. Operating License (Available)
 - 3. Operating Procedures (Available)
 - 4. Notice of Violations (Available)
 - 5. Form NRC-3 (Posted)





10 CFR 19 Rev. 4 Page 18 of 63 Notices, Instructions & Reports

19.12 – Instructions to Workers

 19.13 – Notices & Reports to Individuals



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10 CFR 20

Standards for Protection Against Radiation; Final Rule





10 CFR 20 Subpart A

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20.1001 – Purpose:

• 20.1002 – Scope:

• 20.1003 - Definitions (Almost 100)





Important Terms

- ALARA
- ALI (Annual Limit on Intake)
- CDE (Committed Dose Equivalent)
- CEDE (Committed Effective Dose Equivalent)
- DDE (Deep Dose Equivalent)
- DAC (Derived Air Concentration)
- DAC Hour (DAC Times Exposure Time)





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Important Terms

- Declared Pregnant Woman
- Eye Dose Equivalent (LDE)
- Fetus/Embryo Dose
- Generally Applicable Environmental Radiation Standards (Issued by EPA)
- Nonstochastic Effect





Important Terms

- Planned Special Exposure (PSE)
- SDE (Shallow Dose Equivalent)
- Stochastic Effect
- TEDE (Total Effective Dose Equivalent)
 (DDE + CEDE)
- TODE (Total Organ Dose Equivalent)
 (DDE + CDE)



10 CFR 20 Subpart B

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- Radiation Protection Programs Requirements
 - 1. Radiation Protection Program
 - 2. ALARA Program
 - 3. Annual Review of Programs





10 CFR 20 Subpart C

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- 20.1201 Occupational Dose Limits
- 20.1202 Sum Internal & External Doses
- 20.1203 External Dose for Airborne
- 20.1204 Determine Internal Exposure
- 20.1206 Planned Special Exposures
- 20.1207 Occupational Dose Limits for Minors
- 20.1208 Dose to Embryo/Fetus/Worker





10 CFR 20

- Subpart D Radiation Dose for Individual Members of the Public Limited to 100 mrem (1 mSv) per year.
- Subpart F Surveys & Monitoring
- Subpart G Control of Exposure External Sources in Restricted Areas
- Subpart L Records
- Subpart M Reports





OE16645

- Improper Posting
- Causes:
 - Inadequate Training
 - Inadequate Communications
- Error Prevention Tools:
 - Two Minute Rule
 - Effective Communications
 - Self-Checking
 - Questioning Attitude





10 CFR 20 Subpart L - Records

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- 20.2102 Radiation Protection Program
- 20.2104 Prior Occupational Dose
- 20.2105 Planned Special Exposures
- 20.2106 Individual Monitoring Results (NRC Form 5)
- 20.2107 Dose to Member of the Public





10 CFR 20 Subpart M - Reports

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- 20.2202 Immediate & 24-hour
 Notifications to NRC
- 20.2203 Reports Documenting Exceeding Limits
- 20.2204 Reports of Planned Special Exposures
- 20.2206 Reports of Individual Monitoring (NRC Form 5)





Occupational Adult Dose Limits

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Category

NRC Limit

TEDE (External + Internal) 5 rem/year

TODE (External + Organ) 50 rem/year

Skin or Extremities 50 rem/year

Lens of Eye 15 rem/year





Additional Dose Limits

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<u>Category</u> <u>NRC Limit</u>

Occupational Dose Limits -10 % of Limit

For Minors for adults

Declared Pregnant Worker -500 mrem for

Gestation

Lifetime -No Limit

Memb<mark>er of Pub</mark>lic -100 mrem/

year

Member of Public





TVA's

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Administrative Dose Levels

- Up to 0.5 rem/year (5 mSv)
 - 1. Current Year Estimate
 - 2. No Authorization Required

- To Exceed 0.5 rem/year (5 mSv)
 - 1. Initiate Form 4
 - 2. Attempt to Verify Current Year Dose
 - 3. No Authorization Required





TVA's Rev. 4 Page 33 of 63 Administrative Dose Levels

- To Exceed 1.0 rem/year (1 cSv)
 - 1. Initiate Form 4
 - 2. Attempt to Verify Current Year Dose
 - 3. Approvals:

Site RadCon Manager/RSO



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TVA's

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Administrative Dose Levels

- To Exceed 5.0 rem/year (5 cSv)
 - 1. Initiate Form 4, Verify Information
 - 2. Initiate Planned Special Exposure
 - 3. Authorizations:
 - a. Site RadCon Manager
 - b. Plant Manager
 - c. Site or Applicable VP
 - d. VP, Nuclear Operations
 - e. Senior VP, Nuclear Operations





TVA's

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Administrative Dose Levels

- To Exceed 1N (TEDE shall not exceed 1N rem, where N = Individual's age)
 - 1. Form 4, Must be Verified
 - 2. Authorizations:
 - a. Site RadCon Manager
 - b. Plant Manager
 - c. Site VT
 - d. VP, Nuclear Operations





EPA Guidance for Nuclear Incidents

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EPA Dose Equivalent Remarks

< 0.1 rem (< 0.1 cSv)

1 rem (1 cSv)

1-5 rem (1-5 cSv)

25 rem (25 cSv)

> 25 rem (> 25 cSv)

No Sheltering

Sheltering Initiated

Public Evacuation

Administer Stable

Iodine

Save Lives/Protect Large Populations





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Planned Special Exposures

- 1. Annual Limits:
 - a. 10 rems TEDE (5 Routine & 5 PSE);
 or 100 rems to any organ (50 Routine and 50 PSE); and
 - b. 30 rems LDE (15 Routine & 15 PSE); and
 - c. 100 rems Skin or Extremity (50 Routine & 50 PSE)





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Planned Special Exposures

- 2. Lifetime Dose Limits
 - a. 25 rems TEDE or 250 rems to Organ or Tissue; and
 - b. 75 rems to the Eye (LDE); and
 - c. 250 rems to the Skin or Extremity





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Conditions for PSEs

- An Exceptional Situation
- Written Authorization Before Exposure
- Individual Informed of Dose/Risk
- Instructed in ALARA Techniques
- Document all Prior Doses
- Special Records Maintained
- Limits: Annual 5 rem; Lifetime 25 rem





Voluntary Prenatal Exposure Program

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- Training by RadCon to all Employees
- Minimize Risk to Embryo/Fetus
- Counseling Services Upon Request
- Strictly Voluntary Written Records Kept
- Dose to Embryo/Fetus Should be:
 - 1. ALARA
 - 2. ≤ 50 mrem/mo. & 500 mrem/Gestation
 - 3. Excluded from PSE Activities



ALARA: Concepts

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- Law Balance Exposure & Economics
- Lead to Lower Dose Limits
- ALARA guidelines:
 - 1. Regulatory Guide 8.8
 - 2. Regulatory Guide 8.10
 - 3. Regulatory Guide 8.13
- Respiratory Protection Reg Guide 8.15
- TVA's Radiation Exposure Tracking





ALARA:

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Bases

 Any Change in Body from Ionizing Radiation Potentially Detrimental

 Any Dose in Any Amount is Potentially Harmful

 Cells Part of Delicate, Balanced System, Easily Disrupted by Radiation





ALARA: Implementation

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Management Commitment & Support

Careful Design of Facilities & Equipment

Well Trained, Committed & Aware Workers





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ALARA:

Organizational Responsibilities

- Plant RadCon Staff:
 - Implementation
 - Operation
 - Planning
 - Protection
 - Training
- Plant Supervision:
 - Procedures & Work Orders





ALARA:
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Individual Responsibilities

Individual Employee - Most Important:

- Reduce own Dose
- Follow Procedures
- Report Radiological Hazards



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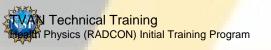


ALARA: Program Elements

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- ALARA Policy/Management Commitment
- Worker/Line Management Commitment
- Collective Dose Data Base System
- ALARA Job Reviews
- ALARA Design Reviews



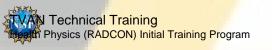


ALARA: Program Elements

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- ALARA Coordinator
- Goals & Associated Tracking System
- Employee Incentives to Reduce Dose
- Management Incentives to Reduce Cost





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Other Regulations - 1

10 CFR 21 – Reporting Noncompliance

10 CFR 30 – Byproduct Materials License

• 10 CFR 31 – General Licenses





OE15307

- Leak Test Not Performed
- Causes:
 - Inadequate Attention to Detail
 - Inadequate Communications
- Error Prevention Tools:
 - Effective Communications
 - Self-Checking
 - Peer-Checking
 - Questioning Attitude





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Other Regulations - 2

- 10 CFR 34 Radiography
- 10 CFR 50 Power Production Facilities
- 10 CFR 61 Radioactive Waste
- 10 CFR 71 Transporting Rad Materials
- 49 CFR 100-199 Transportation Regs





10 CFR 50

- 50.5 Deliberate Misconduct
 Subject to fine
- 50.7 Employee Protection
 "Whistleblower" protection
- 50.9 Completeness and Accuracy Of Information (Provided to the NRC)
- 50.36- Technical Specifications





Completeness and Rev. 4 Page 52 of 63 Accuracy of Information

- Requirement 10 CFR 50.9
 Information must be:
 - 1. Complete
 - 2. Accurate
- Implementation TVAN Business Practice-213
- Interface Nuclear Licensing
 - 1. Licensing Documents
 - 2. Meetings
 - 3. Conversations with NRC





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Rule Violation

 The Requirement that all Information be Complete and Accurate may be Violated even though the Incorrect Information Submitted was:

- Not in Writing
- 2. Not Under Oath
- 3. Not Intentional





Incomplete or Rev. 4 Page 54 of 63 Inaccurate Information

- False Statements
- Omission
- Inadequate Review
- Failure to Review
- Careless Disregard or Deliberateness
- Negligence not Careless Disregard
- Inadvertent Error
- Failure to Correct or Update



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Responsibilities for Accurate Information

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- Chief Nuclear Officer/Executive VP Receive Material from NRC & Assign
- Nuclear Licensing
 - 1. Log Correspondence
 - 2. Review Commitments
 - 3. Responsible Organization for each Commitment
- Responsible Organizations
 Evaluate Compliance with Commitments





Responsibilities for Accurate Information

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- Organization Managers Assign Technical Lead
- Technical Lead
 - Coordinate on Specific Input Data
 - 2. Monitor Performance vs. Schedule
 - Provide Documentation
 - Prepare Response; Submit to Licensing





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Error Prevention Tools

- Pre-Task Briefings
- Research Bases and History
- Follow Procedures
- Verify Non-Routine Information
- Ensure Independent Technical Review
- Use Self-Checking or Peer-Checking





Responsibilities of All Employees

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TVAN Personnel

- 1. Document Commitments
- 2. Maintain Procedures
- 3. Coordinate NRC Contacts with Nuclear Licensing





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Technical Specifications

- Safety Limits
- Limiting Conditions for Operation
- Surveillance Requirements
- Design Features
- Administrative Controls
- Decommissioning
- Initial Notification
- Written Reports

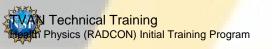




OE11952

- Improper Control of Sources in Transit
- Causes:
 - Inadequate Attention to Detail
 - Inadequate Communications
- Error Prevention Tools:
 - Effective Communications
 - Self-Checking
 - Peer-Checking
 - Questioning Attitude





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TVA Documents

- Radiation Protection Plan
 - Minimum Requirements and Management Controls for Radiation Protection
 - 2. Verbatim Compliance Not Required
- Plant RadCon Manuals
 - 1. Implement Radiation Protection Plan
 - 2. Verbatim Compliance Required





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Summary

- Significant Advisory Organizations:
 - 1. ICRU
 - 2. ICRP
 - 3. NCRP
 - 4. FRC (EPA)
- Significant Regulatory Agencies:
 - 1. AEC
 - 2. ERDA
 - 3. NRC
 - 4. DOE



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Questions

- How much radiation is required to redden the skin (ESD)?
- Why is there a need for radiation dose limits and guidelines?
- What is the function of the NRC?
- What is meant by an "Agreement State?"
- What information is given in Title 10 Code of Federal Regulations Part 20, and what organization has the responsibility for regulating it?
- What does ALARA mean?



