Beyond the Guidance

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Problems

- Guidance for the Regulations Has Not Kept Up With Maturing Industry
- Not revised in long time because we have been good.
- Most guidance documents are 30-40 years old.
  - Technical Bases for these documents is 40-50 years old.
  - Revisions to regulations do not necessarily generated revisions to guidance.

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What Do Regs Require?

- 10 CFR 50 – App A
  - GDC 64
    - Provide means to monitor effluent releases.
    - Provide means to monitor plant environs.
- 10 CFR 50 - App I
  - Section IV.B.1
    - Provide data on quantity of radioactive materials released.
  - Section IV.B.2
    - Provide data on measurable levels in environment
    - Evaluate dose to individuals from principal exposure pathways

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REMP Guidance
NRC Branch Technical Position (BTP)

- … sets forth an example of an acceptable *minimum* radiological monitoring program.
- In General The Industry Had Done That
  - Implemented a minimum acceptable REMP
  - Implemented verbatim compliance.
- The BPT "acceptable minimum" program is not a minimum effective program.

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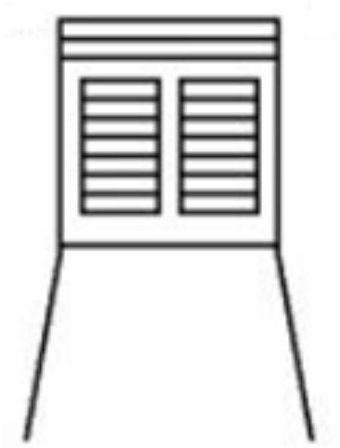
Guidance Branch Technical Position Airborne - Radioiodines and Particulates

- 5 Monitoring Stations
  - 3 Close to Site Boundary in different sectors of highest calculated D/Q.
  - 1 in Community of highest D/Q.
  - 1 in Control Location



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Air Sample Stations and Meteorology

- Reality
  - Variability of Gaussian Models Ranges from 2 to 4 for Annual Averaged Data (NCRP Report 76)
  - Bad Science to Move Location Based on 10% Change in X/Q and D/Q.
- Problems Guidance Has Caused
  - Small change in X/Q and D/Q forces change in air sample location.
  - Results in loss of trending / baseline.

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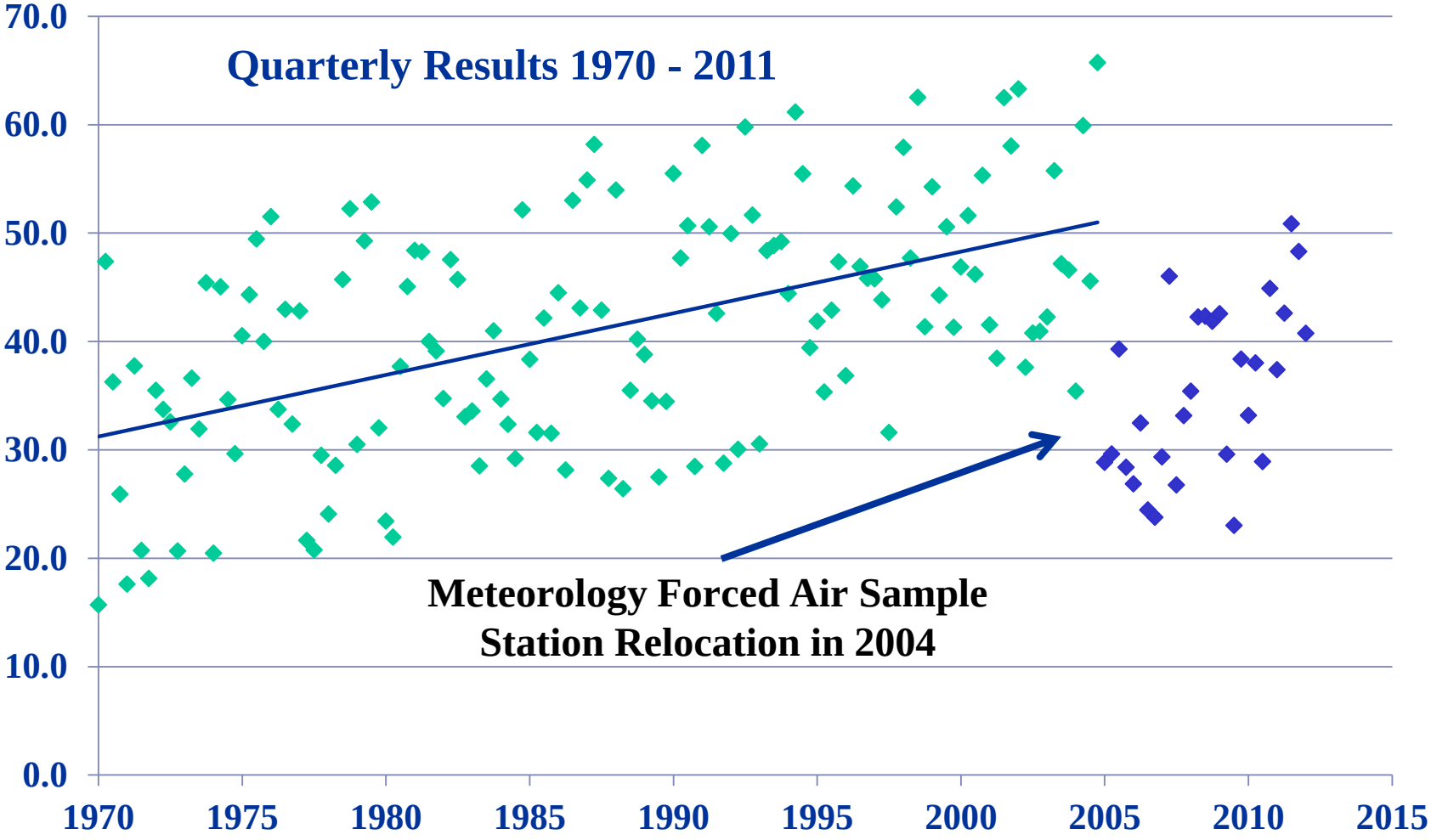
Changing Air Sampler Location



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REMP Air Sample Guidance

- Sites are forced into poor site selection for air sampling.
- Verbatim Compliance With BTP Results in Insufficient (or *No*) Compliance With Regulations

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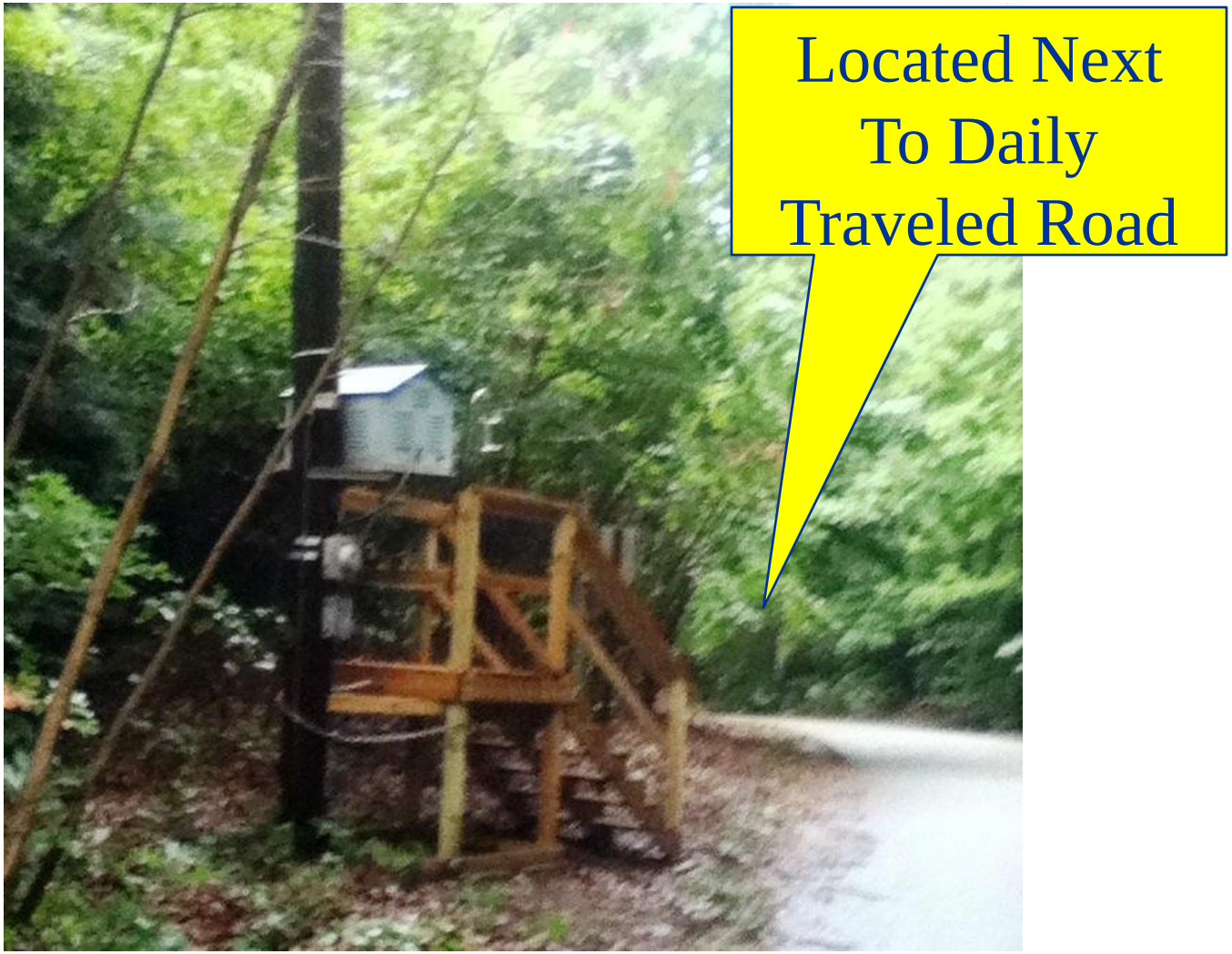
What's Wrong Here?



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What's Wrong Here?

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What's Wrong Here?

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Key Solutions

And Here?

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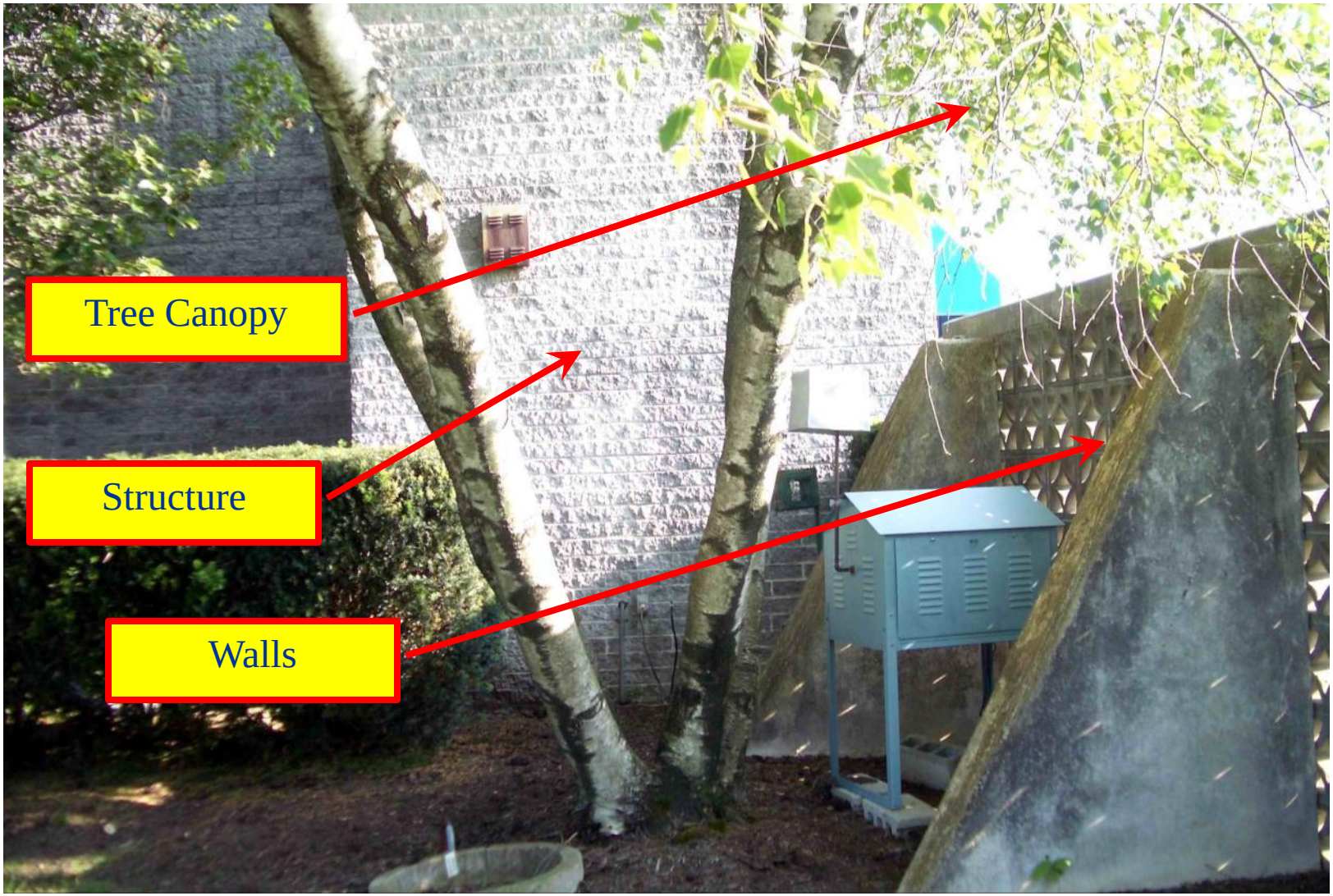
What's Wrong With This Picture?



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Any Clues on This One?

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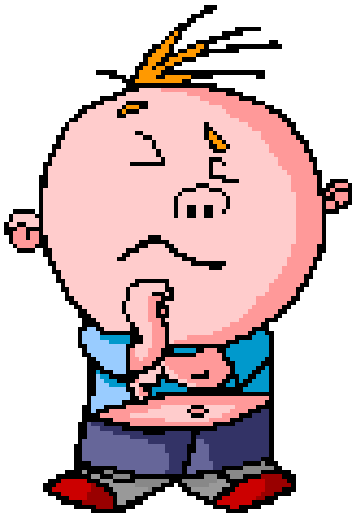
All In Literal Compliance with BTP

- Any Of These Meet the Spirit of the Guidance?
- Any Of These Meet The Intent of the Regulations?



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BTP and REMP Vegetation Sampling

- Principal food products (produce) from area irrigated by water affected by liquid radwaste releases.
- Three kinds of broad leaf vegetation … in highest D/Q.

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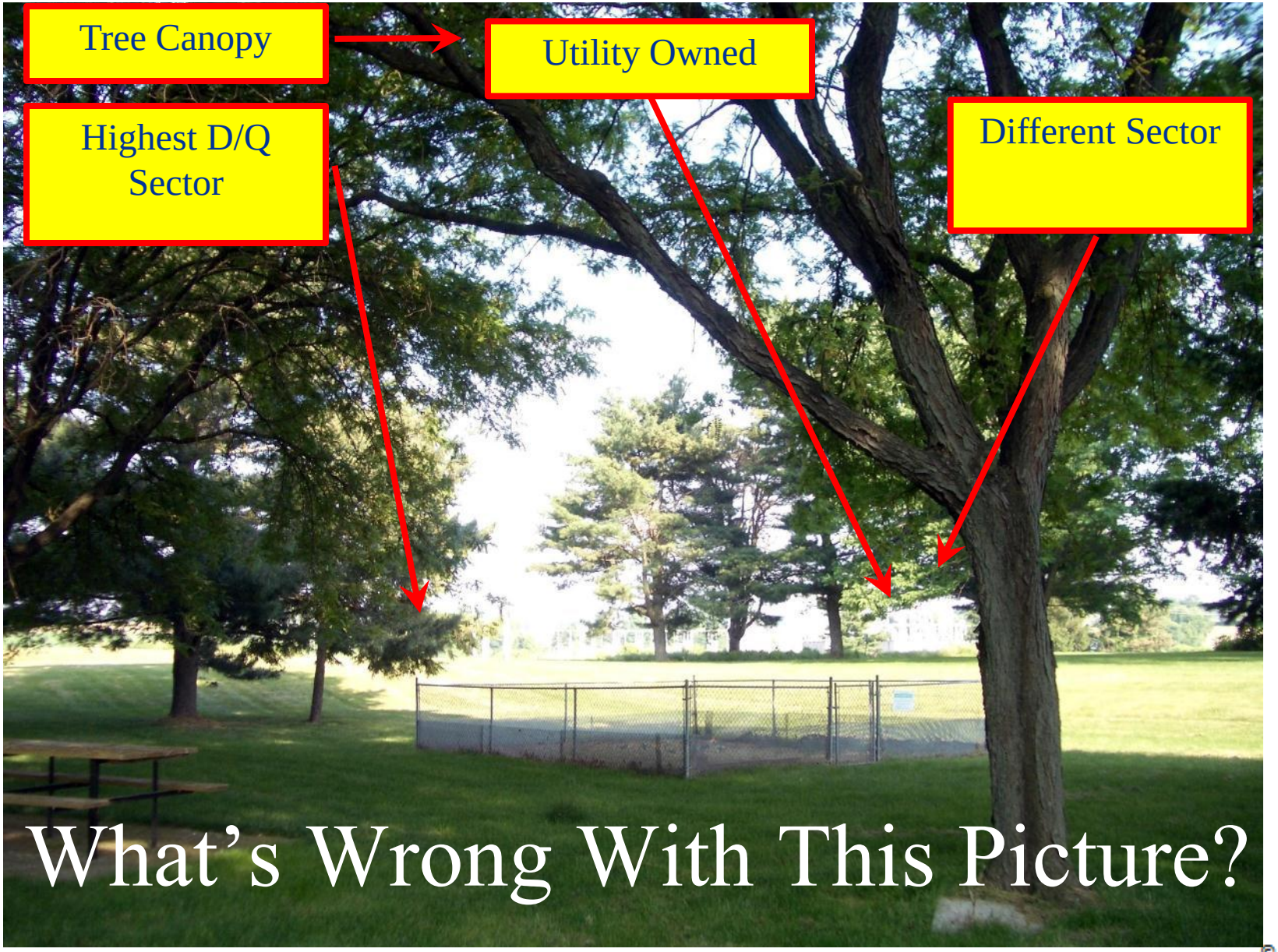
Tree Canopy
Utility Owned
Highest D/Q Sector
Different Sector
What's Wrong With This Picture?

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The Utility's Solution?

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Why Problems?

- Utilities Limited in Choice of Placement
  - May Not Have Access to Highest D/Q Location
    - Not Owned or Controlled by Utility.
    - Forced to Select Inappropriate Site
  - Ideal Site Location
    - But Is Not In Verbatim Compliance
- Two Options
  - Do Bad Science (verbatim guidance compliance)
  - Do Good Science (meet intent of regulation)

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When In Doubt?

- Always go back to the regulation.
  - What is the *intent*?
  - *Why* is this regulation here?
- 10 CFR 50 - App I, Section IV.B.2
  - Provide data on measurable levels in environment
- Intent is Obvious:
  - Determine impact of plant operations on the environment.
  - Why? Prime purpose is to protect the public.

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The C-14 Problem

- Highest Offsite Dose Contributor
  - Via Ingestion Of Produce
    - Grains
    - Non-Leafy Vegetation
- Why? – Compare to Leafy Vegetation
  - Higher Consumption of Produce
    - 520 kg/yr Produce
    - 26 kg/yr Leafy
  - Higher Carbon Fraction in Produce
  - Result is Higher Consumption of C-14

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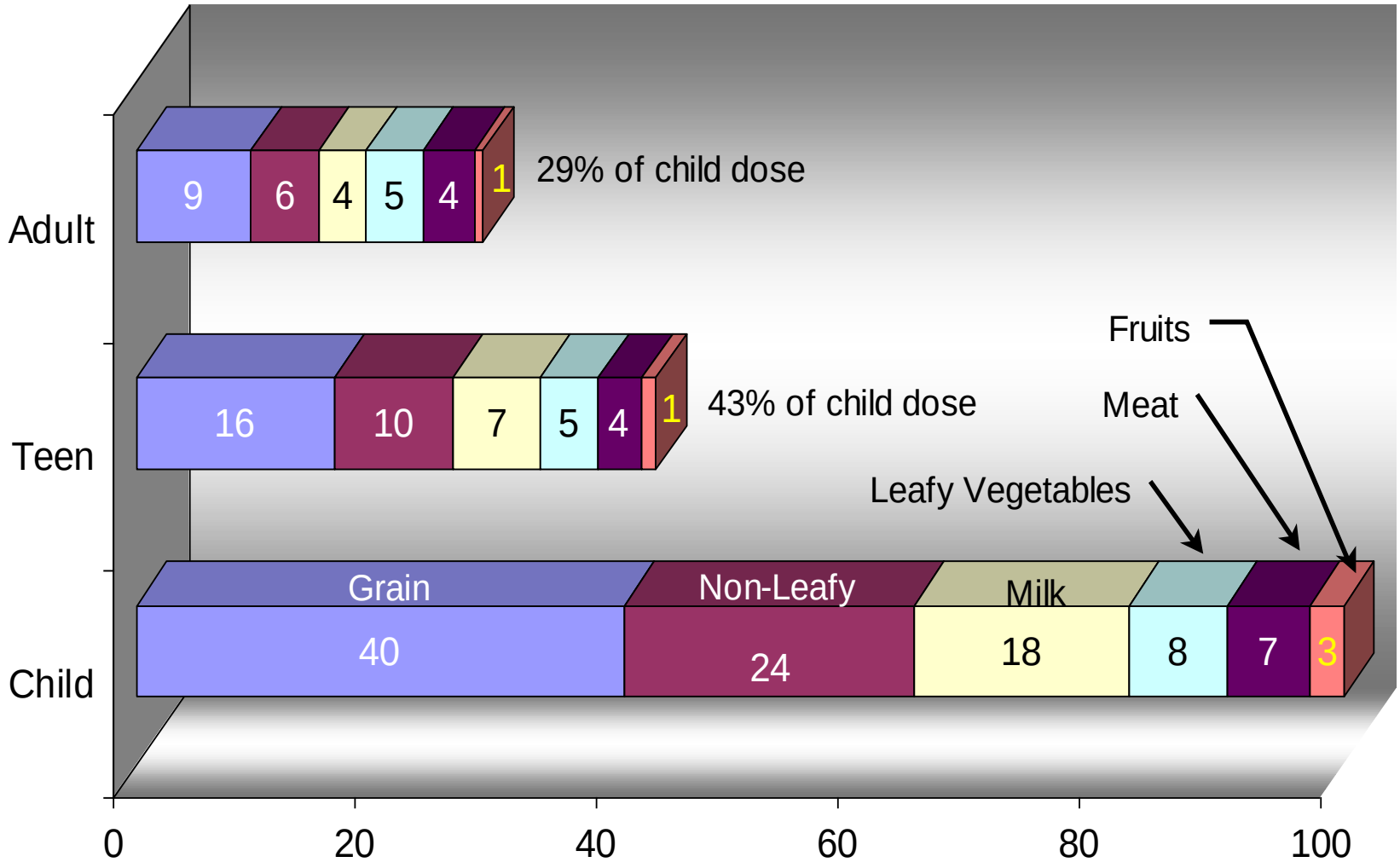
C-14 Food Group Dose Contributions



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REMP - BTP Guidance

- Principal food products (produce) from area irrigated by water affected by liquid radwaste releases.

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BTP Problem

- Reality - C-14 has changed this…
  - BTP Irrigation Criteria for Produce is Irrelevant
    - Only significant dose is due to C-14 incorporation into the human food chain via photosynthesis.
  - Sampling only broad leaf vegetation assumes that deposition of particulates and radionuclides generates the highest vegetation ingestion dose.
  - Highest dose is now from consumption of non-leafy vegetation and grains.

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Reg Guide 1.109 Problem

- Underestimates Carbon Fraction
  - NUREG 3332 states:

    "… carbon fraction of vegetation is *substantially underestimated* in …" RG 1.109
- Compartmental Equilibrium Model
  - NUREG 3332, NCRP 76, IAEA SRS 19 (and many others)
  - Once Equilibrium is Reached (~90 days) Then Dose from Consumption of Animal Products is Independent of Animal Consumption Rate

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Fruits and Root Vegetables

- Can Have Substantially Higher Carbon Fractions Than Leafy Vegetation

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Grain and Cereals

- Carbon Fraction ~ 390 gm-C / kg (Fresh Weight)

CORN

WHEAT

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Short Term Releases

- Intermittent in Nuclide Concentrations or Flow
  - Gas Storage Tanks
  - Containment or Dry Well Purges
  - Etc.
- "Operational Occurrence" Release > 50% of Long Term Release Activity
  - Less than 500 hrs per year,
  - Not more than 150 hrs in any quarter.

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Short Term Releases and Annual Average X/Q

- NUREG 0133 – Sec 3.3
  - Determination of doses due to short-term releases can use the annual average X/Q if it can be demonstrated that past short-term releases were ***random*** in time and duration…
  - Assumes release periods not dependent solely on atmospheric conditions or time of day.
- Most Sites Use Annual Average X/Q For Short Term Releases
- Very Likely No Longer Appropriate

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X/Q and Short Term Releases

- Nocturnal Releases to Minimize C-14 Dose
  - Should use night time X/Q
  - But less dispersion at night time means higher dose from other radionuclides
- Outages Often Occur at the Same Season of the Year
  - Obvious seasonal bias in meteorology
- WGDT
  - Discharges have become very infrequent.
  - Releases commonly take place prior to outage.
- Result – Assumption of Randomness is Invalid

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Short Term Meteorology

- NUERG 2919 Defines a “Short Term” Dispersion Factor – “x/q”
  - Not Real Time
  - Based on Statistics of Historical Met Data
  - Dependent On Cumulative Duration of Short Term Releases
- Process
  - Calculate 8760 One-Hour X/Qs (for 1 year data set)
  - Sort Hourly X/Qs and Generate Cumulative Probability Distribution
  - Select 15 Percentile One-Hour Value (e.g. value which is exceeded only 15% of the time)

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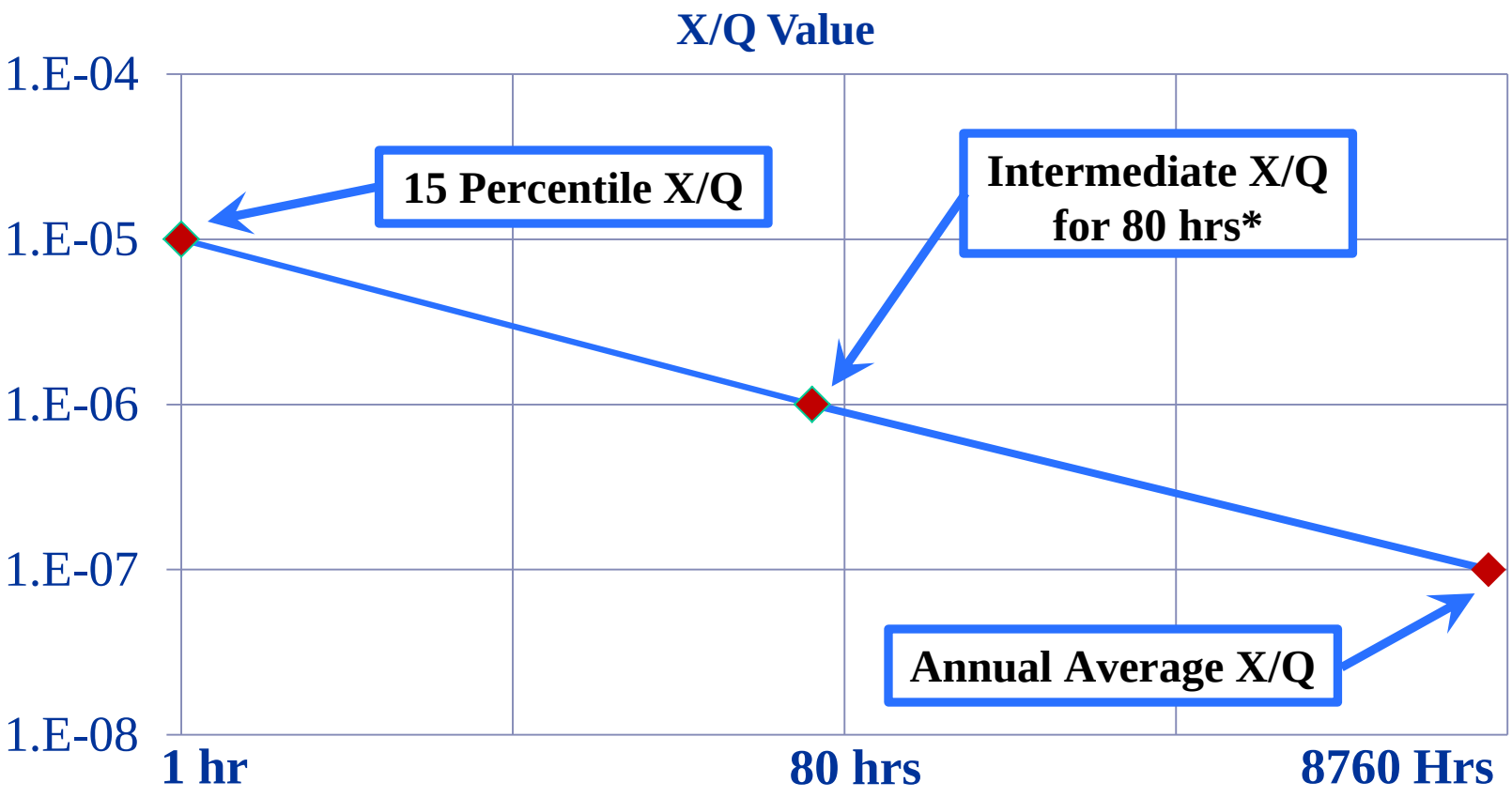
Short Term X/Q and Release Duration



* Cumulative Duration of Short Term Releases: (80 releases of 1 hour duration, 20 releases of 4 hour duration, etc.)

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XOQDOQ Code Output

X/Q and Freq That Value is Reached or Exceeded					
X/Q	6.16E-06	2.64E-06	2.62E-06	1.78E-06	…
Freq	0.101	0.404	0.606	1.704	…
X/Q	4.00E-07	3.27E-07	2.67E-07	2.00E-07	…
Freq	55.232	55.635	76.814	80.109	…
X/Q	3.16E-08	2.37E-08	1.96E-08	0.00E+00	…
Freq	97.4	99.899	100	0	…

"THE 15TH PERCENTILE IS: 7.68E-07"

- **XOQDOQ Provides This Information For Each Receptor**

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40 CFR 190 and Calcs

- NUREGs 1301/1302 Implement Appendix I
  - Liquid
    - Real Individual
    - Ingestion of Aquatic Animals Only
    - No Aquatic Vegetation
  - Noble Gases (Highest Air Dose)
    - Limits Gamma and Beta Air Dose (mrads)
      - Air Dose Is Not Real Dose
  - Radioiodine, Particulates and Tritium (RPTs)
    - At Location of Real Individual Receiving Highest Dose
    - Critical Receptor or Maximum Individual

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40 CFR 190 Calcs

- EPA Limit Does Not Dictate Exposure Pathways
  - Liquid
  - Noble Gases
    - Dose to Real Individual
      - Organ Dose (mrem) not Air Dose (mrad)
    - Real Individual Means Residence
  - Radioiodines, Particulates and Tritium
  - Direct Radiation
  - Others….

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40 CFR 190 Calcs

- Not likely same individual would be receiving *highest* liquid, noble gas, RPT and direction radiation dose.
- It is possible for one individual to simultaneously receiving organ doses from:
  - Noble Gases (organ dose to real individual)
  - RPT
  - Direct Radiation
- This individual may or may not be the same maximum individual as identified for App I purposes.

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How Low Do We Go?

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Where Did the LLD Number Come From?

- LLDs in Current Guidance Based On

  "What (we thought) the technology would be capable of by the time the RETS were in force."
- Based on 30+ Year Old Technology

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How Low Do We Go?

Reg Guide 4.1

"…the detection capability of environmental measurements should be the most sensitive that is practicably achievable for measuring plant-contributed radionuclides in the environment."

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How Low Do We Go?

- Ideally Environmental Detection Limits Should be a Small Fraction of the Reporting Limits
- This Implies LLDs of 1% – 5% of Reporting Limit
- NUREGs Specify (Drinking Water)
  - 10% for Tritium
  - 36% for Cs-137
  - 50% for I-131

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Where Do We Stop?

- Depends – How Paranoid Are You?

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Tritium – How Low Did We Go?

2000 pCi/L

1000 pCi/L

500 pCi/L

400 pCi/L

200 pCi/L

100 pCi/L

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Where Are We Now?

	% Report Limit	Comments
2000 pCi/L	10 %	Current Requirement
1000 pCi/L	5 %	Could Do Better
500 pCi/L	2.5 %	Good
400 pCi/L	2 %	Good
200 pCi/L	1 %	Some Plants Are Currently Measuring In This Range
100 pCi/L	0.5 %	

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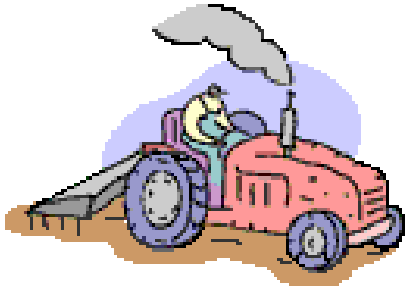
Original NRC REMP Program Design Was Driven By:

- Monitoring of Human Food Chain
  - Does not necessarily ensure accurate assessment of environmental impact.
  - More environmentally sensitive indicators may be overlooked.
- Assumed Demographics
- Assumed Environmental Usage (Agricultural)
- Assumed Likely Critical Exposure Pathways



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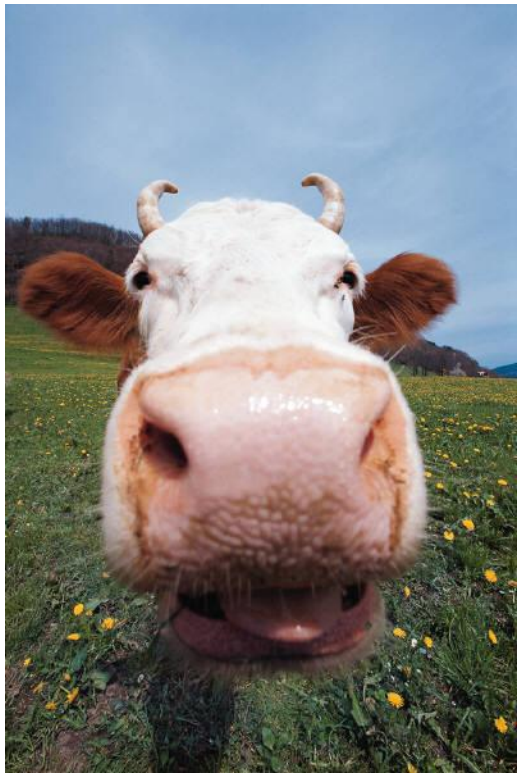
Ole McDonald Had a Farm

Once upon a time is was not unusual for radioiodine to be routinely present in airborne releases.

- Small Farm With Local Consumption
- Highest Dose Pathway Was Typically Cow Milk



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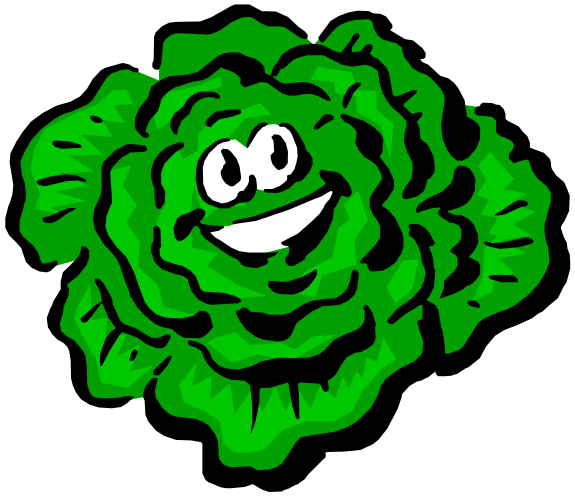
Changes

- Release of Radioiodine Were Drastically Reduced
- Many Sites No Longer Have Milk Pathway
- Particulates Now Drove the Dose
  - Ground Plane
  - Ingestion of Leafy Vegetation



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Now C-14 Is In Charge

- C-14 Dose
  - No Ground Plane Exposure
  - Minor Inhalation Dose
  - Liquid Pathway Not Substantial
  - Milk and Meat Not Substantial
  - Leafy Vegetation Not Substantial
- But these are the pathways REMP focuses On

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REMP Program

- Based On NRC Assumptions (30 years ago)
- Are Assumed Demographics Still Valid at Your Site?
- Is Assumed Environmental Usage Still Valid at Your Site?
- Are Assumed Critical Pathways Still Valid at Your Site?
- Are There Non-Critical Pathways That Need Monitoring – More Environmentally Sensitive?

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BTP and Sediment Sampling

- Guidance
  - Semiannually
  - “One sample from downstream area with existing or potential recreational value.”
- Reality
  - Need upstream or control sample.
  - Good idea to sample whether or not it meets the above criteria.

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We Ignored Ground Water

- **Why?**
  - **Look at REMP Guidance (BTP)**
    - **"Only if likely to be affected by plant releases"**
  - **No one discharges to GW**
  - **No need to look**
  - **Management – Don't Want To Look**
- **Lower LLDs?**
  - **No! Afraid We Might Find Something**

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SO….

- How Did The Ground Water Issue Work Out For Everybody?
  - NRC?
  - ANI?
  - Licensees?

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REMP Must Stay Proactive

- Must Meet the Intent of the Regulations
  - Cannot Necessarily Rely on Guidance for Compliance With Regs.
- Remember What It's Really All About

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