On Beryllium Surveys for DOE Facilities: Lessons from the NTS Worker Environment Beryllium Characterization Study

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About This Talk

The North Las Vegas (NLV) and Nevada Test Site (NTS) ***Worker Environment Beryllium Characterization Study*** **(DOE/NV/25946—850)**

- **Scope**
- **Evolution of Decision Quality Objectives (DQOs), 2002-2009**
- **Evolution of analytical methodology**
- **"Lessons Learned"**

- **(NTS is now the Nevada National Security Site – NNSS)**

About This Talk

Conceptual and Technical Challenges

- Interpreting regulatory language
- "Dirty until shown clean" or "Clean until shown dirty"?
  - We use the first for wipe samples, but what about bulk samples?
  - NLV/NTS Characterization based almost entirely on wipe samples, using "Dirty until shown clean" analyses
- Distinguishing between anthropogenic and naturally occurring beryllium

The NTS Worker Environment Beryllium Characterization Study

March 2002

- NNSA/NSO learned of office worker in NLV with CBD
  - Conducted some preliminary investigations
- Headquarters investigation ensued, beginning September 2002
- HQ investigation limited to 4 facilities in NLV
  - M&O contractor and EnviroStat interfaced with HQ team, but did not contribute to their findings

HQ investigation started

- Borrowed 10 CFR 850.31 Release Criterion (RC) for releasing objects to the public
- Regulation doesn't say WHAT should be compared with RC or HOW!

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Pre-evacuation survey

- BEFORE B1, B2, and B3 were evacuated, we sampled personal computers and Individual Work Areas (IWAs).
- HQ team initially uncertain that RC = 0.2 µg / 100 cm^2 would be adequately protective
  - Temporarily set RC at 0.02; ultimately HQ team decided that 0.2 is OK
  - Initially set up stratified sampling plan to compare mean with 0.02
    - Greater sampling weight on cubicles near air ducts with "detects"; this turned out to be irrelevant!

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- **Statistical treatment after RC = 0.2 µg / 100 cm^2 was deemed OK**
  - **Problem: contractor had promised to protect "all" workers; need to translate that into statistical model and procedure**
  - **IWAs: used non-standard approach to <u>sampling</u>**
  - **Idea: what would you do if you had to sample surfaces in one cubicle?**

    Tell samplers to swipe dirtiest corners; get 4-6 wipes; if all ≤ RC, OK. If any exceeds RC, further investigation needed.

    "Random Sample" of surfaces in an occupied cubicle is a mathematical fiction!
  - **Used Total Be; did not attempt to distinguish anthropogenic from natural**

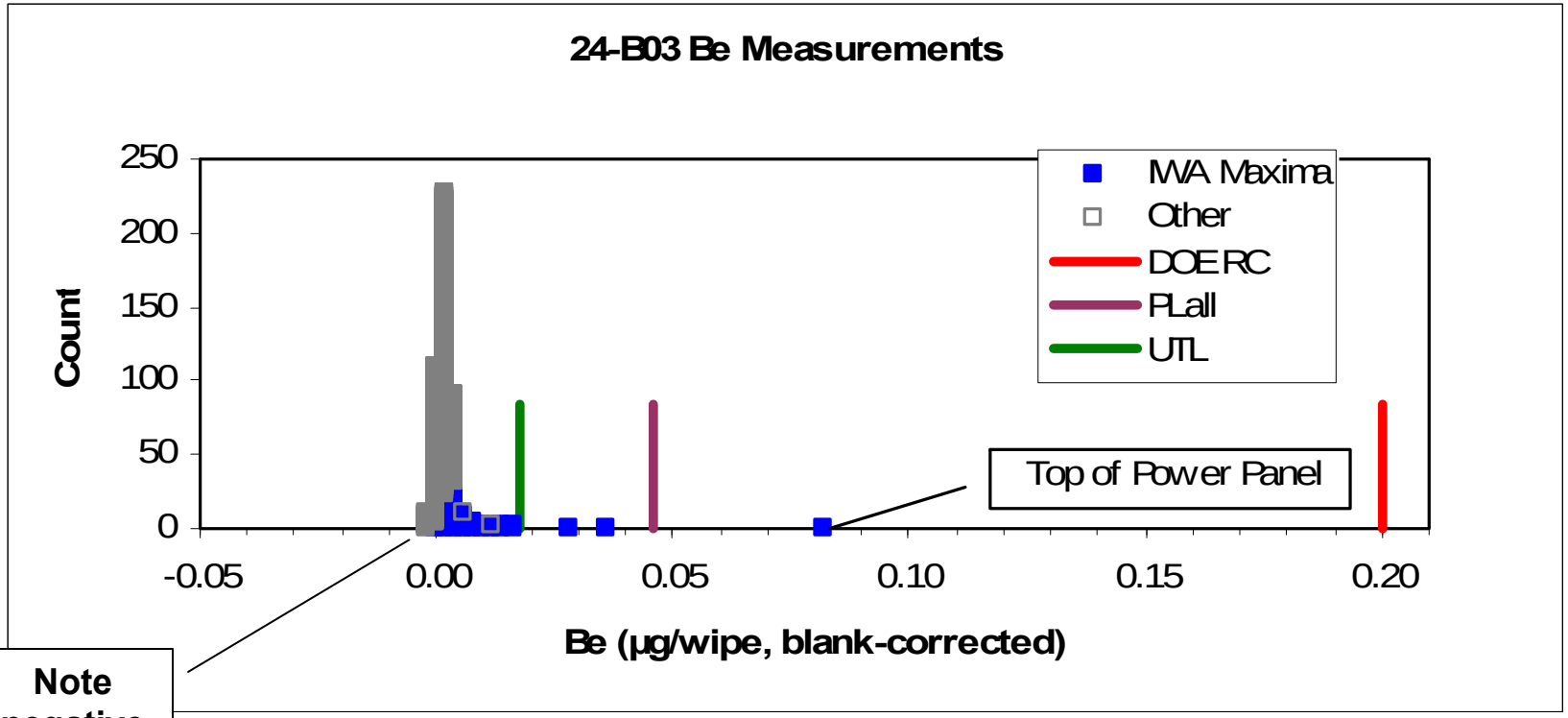
The NTS Worker Environment Beryllium Characterization Study

- IWAs: used non-standard approach to <u>statistics</u>
- Made an honest random selection of IWAs in each facility
  - (stratified random sampling)
- For each IWA used maximum measurement
- Constructed upper prediction limit (PLall) for maximum measurement in ALL unsampled IWAs for that facility
  - Confidence level 95%
- Declared facility OK if PLall ≤ RC
  - All four facilities passed
- (For small facility, would sample all IWAs, not use statistics)

The NTS Worker Environment Beryllium Characterization Study

- Methodology much more conservative than statistical comparison method in draft DOE *Technical Standard* which appeared later
  - Except for very small facilities
  - Turned out to be too conservative for use with dusty buildings at NTS
- Why is it conservative?
  - HQ draft Technical Standard prefers upper 95% confidence limit for 95th percentile (UTL) for wipe samples
  - We used Total Be without attempting to distinguish anthropogenic Be
- Sample plots from Final Report follows for one of these facilities

The NTS Worker Environment Beryllium Characterization Study



Note negative values

The NTS Worker Environment
Beryllium Characterization Study

Buildings B1, B2, and B3 then evacuated

HQ team conducted thorough facility characterization

- Carpets, floors, walls, ceiling tiles, space above ceiling tiles, B-1 High Bay
- Conclusion: Be had been tracked from NTS ER activities through High Bay to office areas of B1

Actions

- B1, B2 were demolished, B3 was renovated
- Survey mandated to see what other facilities in NLV/NTS might be similarly contaminated

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Large-scale survey began

- All occupied and incidentally occupied facilities at NLV, NTS, and ancillary locations
  - 228 facilities
- Attention still focused on worker environments
  - In particular, over-ceiling and other locations not touchable in <u>everyday</u> work activities were not sampled
  - IH evaluation of possible hazard is required for invasive work

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Sampling strategy for large-scale study

- Each facility categorized as IWA, Area, or combination
- IWA facilities

  Examples: guard stations, forward area machine shops, thirds or quarters of trailers, office buildings

  – If only a few IWAs, sample all IWAs using previous strategy

  – If multiple IWAs, randomly select IWAs
- Area facilities

  – Use systematic (grid-like) sampling

  Examples: warehouses, shops
- Combinations

  Examples: cafeterias, fire stations

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Statistical strategy for large-scale study

- IWA facilities
  - If only a few IWAs, pass if largest measurement ≤ RC
  - If multiple IWAs, story gets interesting
- Area facilities
  - Use 95-95 UTL per common IH practice
    - Promoted in draft DOE *Technical Standard*
- Combinations
  - Use IWA strategy for IWA parts, UTL for Area parts

The NTS Worker Environment Beryllium Characterization Study

- Ultimately obtained over 11,000 wipe samples
- Following MARSSIM guidance, obtained uncensored analytical values for nearly all samples
  - Very educational
  - Several papers resulted
  - Such large datasets of uncensored data are rare
  - Usual statistical treatments of censored data use models that are simpler than appropriate, and it does matter!
  - Developed statistical methods for dealing with uncensored data

The NTS Worker Environment Beryllium Characterization Study

- Data problems with samples from shops and forward areas
  - Second lab had problems with iron interferences in ICP-AES analyses
    - "Lesson learned"
    - Developed ad hoc correction that worked for many facilities
    - Eventually went to ICP-MS for facilities where this didn't work; story is in report

The NTS Worker Environment Beryllium Characterization Study

- Evolution of IWA statistical approach
  - Draft DOE *Technical Standard* was under development during this period
    - Promotes UTL approach
  - UTL approach is acceptable, not so conservative as PLall
    - Easier to pass, except for really small facilities!
    - Explicitly incorporates "Dirty until shown clean" principle
  - Eventually, due to small numbers of IWAs in some facilities, went to UTL method for 95th percentile of distribution of ALL measurements, not just IWA maximum values, called UTL_Cluster Method; see report
  - Considered atypical sample values and sampling locations during data analysis

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- **Forward area samples contain more Total Be than urban samples**
  - **Example: heavy equipment shop in forward area**

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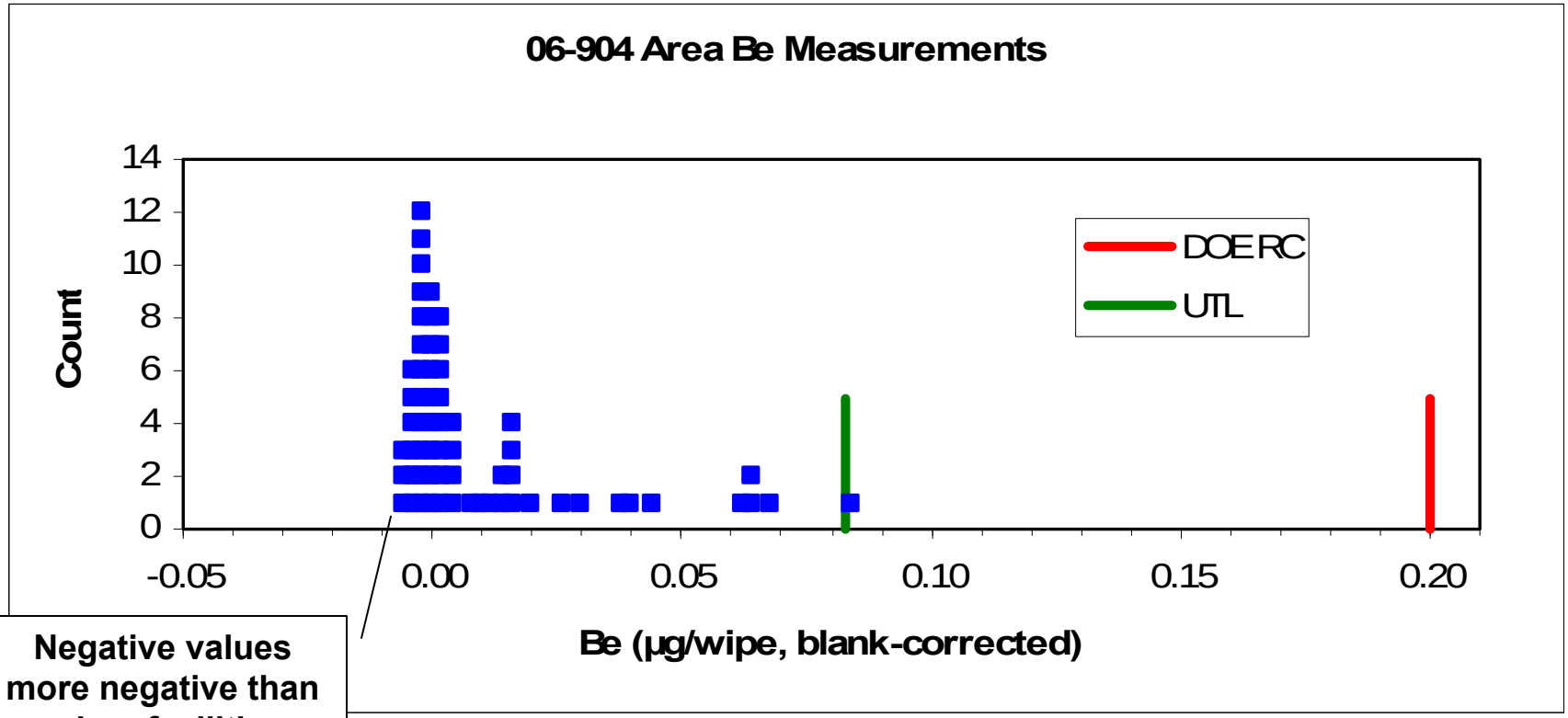

Negative values more negative than urban facilities with ICP-AES

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- Eventually started looking at metal ratios and bulk samples for problem facilities
- Final conclusions

Count of Results			
		Number of	
	Result	Whole facilities	Portions of facilities
	Pass	195	9
	Pass if outlier(s) in unusual locations omitted	10	3
	Pass taking bulk Be and/or metal ratios into account	8	9
	Fail	4	1

Issues/Challenges

On using bulk samples and/or metal ratios

- **NTS approach for bulk samples**
  - **With bulk samples we looked at Be concentration AND metal ratios**
    Y/Be, Nb/Be (most consistent across site), others
  - **Did NOT rely on Be concentration in bulk samples alone, but took bulk concentrations AND wipe and bulk ratios into consideration**

95% Tolerance Intervals for NTS Soil Data			
Be (µg/g)	0.4	–	1.9
Y/Be	5.5	–	13.6
Nb/Be	2.2	–	6.2

Issues/Challenges

- **THIS IS NOT CONSISTENT WITH CURRENT REGULATION**
  - **Regulation does not mention metal ratios**
    But clearly does not want to apply to natural Be
  - **But current Facility Survey practice is not actually in regulation, but is borrowed from regulation (10 CFR 850.31) for release of items to public**
- **"Clean until shown dirty" or "Dirty until shown clean" issue**
  - **NTS approach for bulks and ratios is still "Clean until …"**
  - **But insists on using multiple lines of evidence, not just Be concentration**
  - **Trying to do "Dirty until shown clean" is unsatisfactory for Be concentration alone, difficult for metal ratios in bulk samples**
  - **Research underway; see last slide!**

Lessons Learned

Steve Lee's request: "The One Thing I Would Change"

- **Too many candidates!**
- **Importance of on-going, careful QA of analytical data**
  - **Love, but don't trust, your data!**

Lessons Learned

Research results:

- Published and/or presented
  - "What is a Be Measurement: A Critical Look at Be Quantitation" – at Be Symposium
  - "When Laboratories Should Not Censor Analytical Data, and Why" – at EPA conference
  - Chapter on Data Reporting in Beryllium Book
  - "A Model for Measurements of Lognormally Distributed Environmental Contaminants" – at BHSC and at Joint Statistical Meetings

Lessons Learned

Research results:

- In progress
  - "A Statistician Looks at 'Ten Less Than a Tenth' and Similar Rules of Thumb"

    Nearly Distribution-Free UTLs using smaller numbers of observations
  - "On Using Metal Ratios in DOE Beryllium Facility Characterization"

    Using metal ratios to provide conservative estimates of the anthropogenic fraction of total Be for use in "Dirty until shown clean" UTLs

Discussion?

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