Implementation of ANSI/HPS N13.37

Experiences with Implementation and Automation at Exelon

Larry Wolfe

Ian Lake

ChemStaff

Exelon Generation®

Objective

- Develop a semi-automated record keeping tool that can provide compliance with DG-4019, Section 4 “Data Analysis Techniques Provided in ANSI N13.37”
  - Data Entry
  - Evaluate Element Readings
  - Determine Extraneous Dose
  - Determine Field Dose
  - Determine Historical Monitoring Data
  - Determine Quarterly Facility-Related Dose (FRD)
  - Determine Annual FRD

Where to Begin?

- Determine baseline background dose – this will be the first set of data analyzed under the process outlined under DG-4019
  - Establish Minimum Differential Dose (MDD) to calculate FRDs
    - Historical monitoring period must be established, at least 5 years
    - MDD is for the measurement system
  - Provide best background data for the dosimetry system
    - Same dosimeter/badge type
    - Same vendor reader
    - Minimal changes in facility affect on dose
      - ISFSI pad installation, Hydrogen Water Chemistry, Power Uprate, etc.

Historical Monitoring Period

- Potential issues
  - Vendor Changes
  - Implementation of new badge types
  - Quality of historical records to meet the ANSI Standard for Evaluating Element Readings
    - Sites may not have always received raw element reading data
- With an appropriate monitoring period selected and records located the Data Analysis Can Begin

Data Entry
Attached dosimetry log included

- Not crucial to data evaluation but an attached log allows tracking of crucial events such as location moves or lost dosimeters

Field Monitoring Location Observations

Sector	Monitoring Location	Dosimeter Location Description	Geological and Physical Conditions	Changes to Station Conditions	Badge Type	Element 1 Filtration Char	Element 1 Phosphor Char	Element 2 Filtration	Element 2 Phospho	Element 3 Filtration	Element 3 Phospho	Element 4 Filtration	Element 5 Phospho	Element 5 Filtration	Element 5 Phospho	Element 6 Filtration	Element 6 Phospho
1	DR991	350 feet N of site near pond dock 0.9m off ground	Near boat dock	Dock was replaced last year and dosimeter is 0.1m closer to ground	3 element TLD	none	CaCO3/Dy	none	CaCO3/Dy	none	CaCO3/Dy	none	LiF	none	LiF	none	LiF
2																	

Data Entry
Enter or Import Element Readings

- Information needed
  - Monitoring location
  - Badge Number
  - Dates In/Out of Field
  - Read Date
  - Readings from each element

Only 9 columns of entry required.

4 Optional columns...

Data Entry
Enter or Import Element Readings

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Monitoring Location	Wearer Number	Wearer # 2	Date IN	Date Out	Read Date	Internal Use Only	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6	COMMENTS		Days in Field	Mean (G Dose, m
2	DR01	1	2	12/29/2009	4/6/2010	4/7/2010		13.437	12.627	12.606	14.551	13.413	15.266				
3	DR02	3	4	12/29/2009	4/6/2010	4/7/2010		11.016	11.550	11.374	11.601	11.263	11.528				
4	DR03	5	6	12/29/2009	4/6/2010	4/7/2010		10.406	11.263	12.005	12.392	11.682	11.606				
5	DR04	7	8	12/29/2009	4/6/2010	4/7/2010		13.778	13.608	13.586	13.24	12.162	13.184				
6	DR05	9	10	12/29/2009	4/6/2010	4/7/2010		12.652	12.621	13.063	13.432	12.555	13.733				
7	DR06	11	12	12/29/2009	4/6/2010	4/7/2010		11.664	9.89	9.71	10.51	10.562	11.326				
8	DR07	13	14	12/29/2009	4/6/2010	4/7/2010		12.963	11.419	11.627	11.494	11.28	11.916				
9	DR08	15	16	12/29/2009	4/6/2010	4/7/2010		15.664	15.03	15.325	14.288	15.413	16.462				
10	DR09	17	18	12/29/2009	4/6/2010	4/7/2010		12.062	11.328	11.84	11.744	12.212	12.13				
11	DR10	21	22	12/29/2009	4/6/2010	4/7/2010		11.419	12.218	10.102	10.385	11.056	11.616				
12	DR11	23	24	12/29/2009	4/6/2010	4/7/2010		12.377	12.616	12.569	11.396	11.169	11.935				
13	DR12	25	26	12/29/2009	4/6/2010	4/7/2010		11.344	10.968	10.711	11.55	11.055	11.815				
14	DR13	27	28	12/29/2009	4/6/2010	4/7/2010		12.584	12.065	12.609	13.686	12.62	11.962				
15	DR14	31	32	12/29/2009	4/6/2010	4/7/2010		13.28	13.884	14.738	13.612	14.28	14.435				
16	DR15	33	34	12/29/2009	4/6/2010	4/7/2010		12.652	12.231	12.346	12.513	12.476	13.539				
17	DR16	35	36	12/29/2009	4/6/2010	4/7/2010		11.226	10.735	11.473	10.365	12.089	11.907				

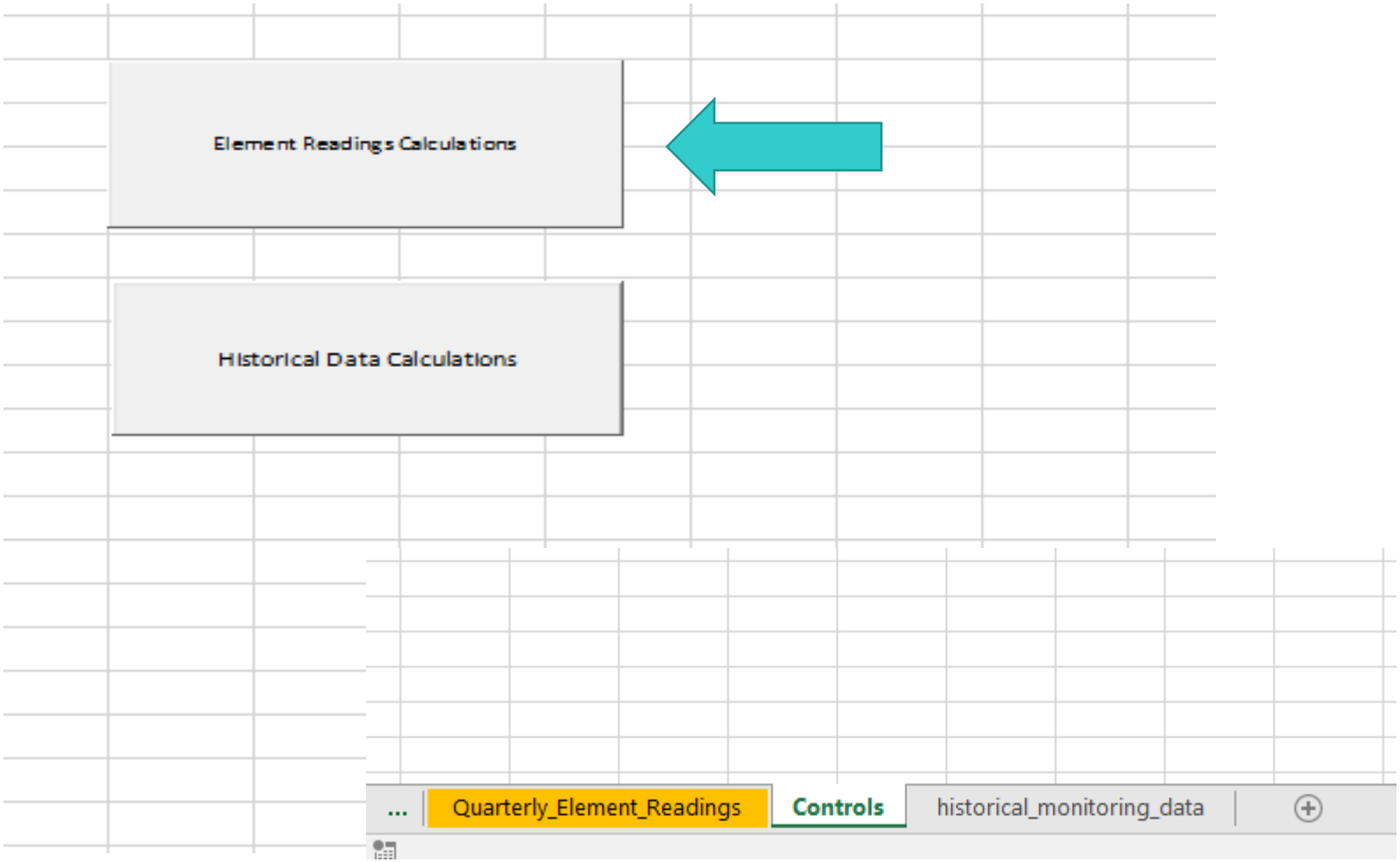
Evaluate Element Readings

K	L	M	N	O	P	Q	R	S	T	U	V	W	X
ment 4	Element 5	Element 6	COMMENTS		Days in Field	Mean (Gross Dose, mrem)	SD	CV	Requires Further Review?	background Set Name	Vault Dose	Adj date	
.02	0.02	0.02											
.02	0.02	0.02											
.02	0.02	0.02											
.02	0.02	0.02											
.551	13.413	15.266											
.601	11.263	11.528											
.392	11.682	11.606											
3.24	12.162	13.184											
.432	12.555	13.733											
0.51	10.562	11.326											
.494	11.28	11.916											
.288	15.413	16.462											
.744	12.212	12.13											
.385	11.056	11.616											
.396	11.169	11.935											
1.55	11.055	11.815											
.686	12.62	11.962											
.612	14.28	14.435											
.513	12.476	13.539											
.365	12.089	11.907											
.658	12.797	13.99											
0.92	11.145	10.877											
.099	11.121	11.818											
.067	13.78	14.609											

Evaluate Element Readings

- Quantitative Review of the Data
  - Standard Deviation
  - Coefficient of Variation (CV/RSD) (>0.1 requires review)
- Other Calculations that will help us Down The Road
  - Days in the Field
  - Mean Gross Dose
- Semi Automatic

Evaluate Element Readings



Evaluate Element Readings

M	N	O	P	Q	R	S	T	U	V	W	X
lement 6	COMMENTS		Days in Field	Mean (Gross Dose, mrem)	SD	CV	Requires Further Review?	background Set Name	Vault Dose	Adj date	
0.02			1	0.0	0.00	0.00		S-2010	0.020	1/1/2010	
0.02			1	0.0	0.00	0.00		S-2011	0.020	3/1/2011	
0.02			1	0.0	0.00	0.00		S-2012	0.020	7/1/2012	
0.02			1	0.0	0.00	0.00		S-2013	0.020	10/1/2013	
15.266			98	13.7	1.06	0.08		C-2010-1		2/16/2010	
11.528			98	11.4	0.22	0.02		C-2010-1		2/16/2010	
11.606			98	11.6	0.68	0.06		C-2010-1		2/16/2010	
13.184			98	13.3	0.58	0.04		C-2010-1		2/16/2010	
13.733			98	13.0	0.49	0.04		C-2010-1		2/16/2010	
11.326			98	10.6	0.77	0.07		C-2010-1		2/16/2010	
11.916			98	11.8	0.62	0.05		C-2010-1		2/16/2010	
16.462			98	15.4	0.72	0.05		C-2010-1		2/16/2010	
12.13			98	11.9	0.33	0.03		C-2010-1		2/16/2010	
11.616			98	11.1	0.79	0.07		C-2010-1		2/16/2010	
11.935			98	12.0	0.62	0.05		C-2010-1		2/16/2010	
11.815			98	11.2	0.41	0.04		C-2010-1		2/16/2010	
11.962			98	12.6	0.61	0.05		C-2010-1		2/16/2010	
14.435			98	14.0	0.55	0.04		C-2010-1		2/16/2010	

Scroll through and find CV>.1

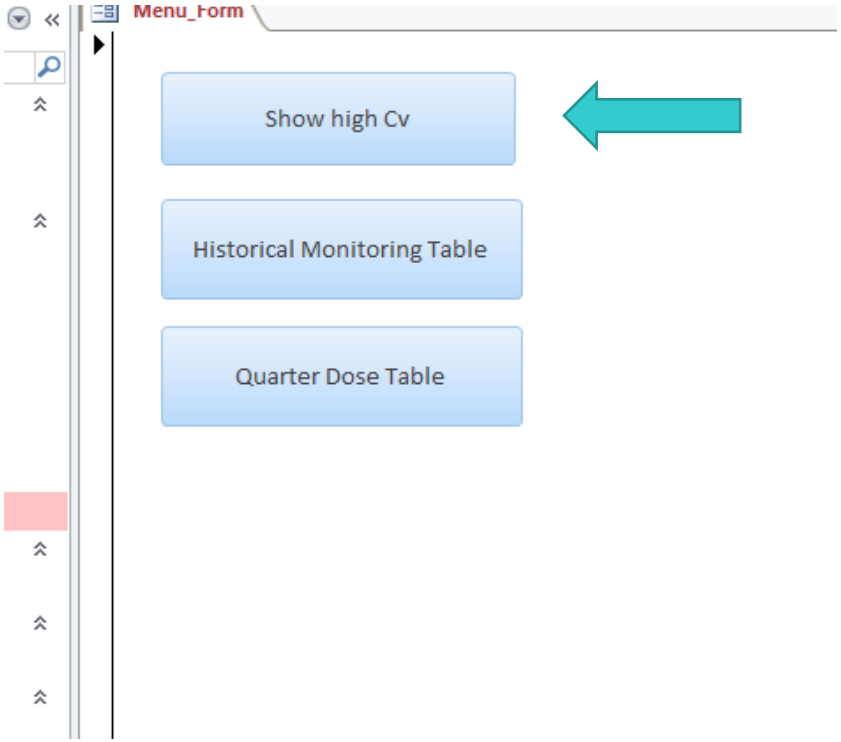
Evaluate Element Readings

CV > 0.1

O	P	Q	R	S	T	U	V	W	X
	Days in Field	Mean (Gross Dose, mrem)	SD	CV	Requires Further Review?	background Set Name	Vault Dose	Adj date	
	98	22.4	1.62	0.07		C-2010-1		2/16/2010	
	98	18.0	0.63	0.03		C-2010-1		2/16/2010	
				0.15	YES	C-2010-1		2/16/2010	
	98	30.0	2.83	0.09		C-2010-1		2/16/2010	
	98	15.9	0.77	0.05		C-2010-1		2/16/2010	
	98	33.7	6.60	0.20	YES	C-2010-1		2/16/2010	
	98	34.2	2.38	0.07		C-2010-1		2/16/2010	
	98	52.6	9.63	0.18	YES	C-2010-1		2/16/2010	
	98	25.7	3.66	0.14	YES	C-2010-1		2/16/2010	
	98	17.2	1.08	0.06		C-2010-1		2/16/2010	
	98	23.7	1.54	0.06		C-2010-1		2/16/2010	
	98	38.6	2.95	0.08		C-2010-1		2/16/2010	
	98	41.3	3.32	0.08		C-2010-1		2/16/2010	
	98	53.0	4.85	0.09		C-2010-1		2/16/2010	
	98	41.2	3.84	0.09		C-2010-1		2/16/2010	
	98	53.6	3.29	0.06		C-2010-1		2/16/2010	
	98	117.8	5.05	0.04		C-2010-1		2/16/2010	
	98	25.0	1.05	0.04		C-2010-1		2/16/2010	
	98	25.3	1.90	0.08		C-2010-1		2/16/2010	
	98	73.9	3.30	0.04		C-2010-1		2/16/2010	
	98	47.8	1.82	0.04		C-2010-1		2/16/2010	
	98	39.9	1.73	0.04		C-2010-1		2/16/2010	

Evaluate Element Readings

- It would be nice to have a report also…



Evaluate Element Readings

Menu_Form | CV_Check_report

Monitoring Locati	Date IN	Date Out	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6	Mean (Gross	CV	CV_fail
CCS-Q4-10	1/5/2011	1/6/2011	0.00	0.23	0.00				0.08	1.732	YES
CCT-Q3-10	7/7/2010	7/8/2010	0.00	0.00	0.14				0.05	1.732	YES
DR22	4/6/2010	7/8/2010	0.00	0.00	0.00	0.08	0.00	0.07	0.02	1.552	YES
DR27	6/20/2012	10/2/2012	0.18	0.26	0.20	10.96	11.38	11.65	5.77	1.056	YES
CCT-Q3-10	10/6/2010	10/7/2010	0.00	0.16	0.07				0.08	1.018	YES
CCS-Q1-10	4/5/2010	4/6/2010	0.21	0.14	0.00				0.12	0.908	YES
CCS-Q3-10	7/7/2010	7/8/2010	0.00	0.06	0.09				0.05	0.897	YES
CCT-Q2-10	7/7/2010	7/8/2010	0.00	0.07	0.08				0.05	0.878	YES
CCT-Q1-10	4/5/2010	4/6/2010	0.27	0.08	0.07				0.14	0.784	YES
DR22	10/2/2012	1/3/2013	0.24	0.21	0.31	0.08	0.07	0.07	0.16	0.641	YES
DR02	1/3/2013	4/5/2013	0.00	0.12	0.06	0.08	0.06	0.07	0.06	0.609	YES
CCS-Q1-10	12/28/2009	12/29/2009	0.22	0.55	0.20				0.32	0.599	YES
CCS-Q2-10	7/7/2010	7/8/2010	0.16	0.21	0.07				0.15	0.470	YES
CCS-Q4-10	10/6/2010	10/7/2010	0.07	0.07	0.15				0.10	0.458	YES
DR11	10/2/2012	1/3/2013	0.06	0.06	0.06	0.14	0.06	0.06	0.08	0.415	YES
DR01	1/6/2011	3/30/2011	0.13	0.19	0.15	0.23	0.22	0.30	0.20	0.307	YES
CCS-Q3-10	10/6/2010	10/7/2010	0.16	0.24	0.16				0.19	0.260	YES
DR17	9/30/2014	1/8/2015	0.69	0.35	0.48	0.53	0.43	0.64	0.52	0.244	YES
CCS-Q2-10	4/5/2010	4/6/2010	0.22	0.14	0.20				0.19	0.238	YES
CCT-Q1-10	12/28/2009	12/29/2009	0.14	0.22	0.21				0.19	0.219	YES
DR32	10/2/2012	1/3/2013	0.14	0.15	0.21	0.15	0.14	0.22	0.17	0.217	YES
CCT-Q4-10	1/5/2011	1/6/2011	0.16	0.16	0.23				0.18	0.209	YES
DR22	9/27/2011	1/4/2012	13.60	13.33	14.22	20.38	12.46	13.72	14.62	0.197	YES
SFDR10	12/29/2009	4/6/2010	31.58	30.48	43.19	28.92	27.43	40.85	33.74	0.196	YES
SFDR10	4/6/2010	7/8/2010	26.62	26.44	34.78	23.11	22.46	34.21	27.94	0.192	YES
DR17	6/20/2012	10/2/2012	0.20	0.19	0.19	0.23	0.12	0.19	0.19	0.190	YES
CCT-Q4-10	10/6/2010	10/7/2010	0.22	0.22	0.16				0.20	0.186	YES
SFDR12	12/29/2009	4/6/2010	50.96	47.17	66.40	43.36	45.04	62.54	52.58	0.183	YES
SFDR10	7/8/2010	10/7/2010	28.84	26.75	39.25	29.10	28.35	38.68	31.83	0.176	YES
SFDR10	7/1/2014	9/30/2014	25.07	20.31	26.10	29.23	24.77	33.89	26.56	0.173	YES
SFDR10	1/6/2011	3/30/2011	25.01	24.57	35.65	28.51	29.92	35.83	29.91	0.165	YES
RPDR05	7/1/2014	9/30/2014	26.52	29.97	37.37	34.27	40.17	40.43	34.79	0.162	YES
SFDR12	1/4/2012	3/28/2012	43.14	47.33	56.36	38.36	38.63	52.81	46.10	0.161	YES
SFDR15	7/1/2014	9/30/2014	20.31	18.93	23.77	17.08	15.51	22.33	19.65	0.159	YES
SFDR13	4/6/2010	7/8/2010	25.09	19.04	22.19	26.61	18.56	19.27	21.79	0.157	YES
DR09	7/6/2011	9/27/2011	13.32	13.32	13.55	9.41	10.29	10.92	11.80	0.154	YES

Human intervention required here. Determine outliers and remove from dataset.

Determine Extraneous Dose

- Definition: The extra dose accumulated on a dosimeter prior to and after field deployment.
- ANSI Equation:

$$\{M_C - (V \times t_s)\}$$

where:

Mc = average gross dose of at least 3 control dosimeter measurement (mrem)

V = known dose rate in the shielded storage vault provided by vendor (mrem/day)

ts = dose period the control dosimeters were stored in the shielded storage vault (days)

Determine Extraneous Dose

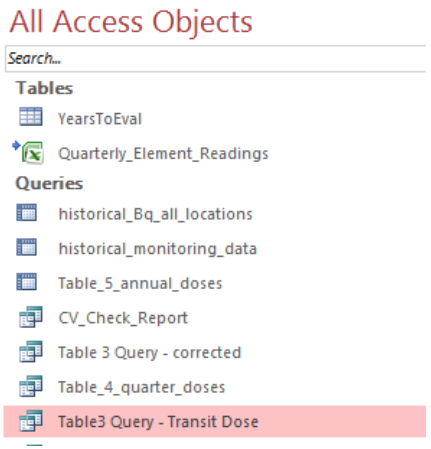
- Another Issue… Control Dosimeters
- ANSI Definition:

Control Dosimeter: The "control dosimeter" is used to account for extraneous dose. The "control dosimeter" shall accompany field dosimeters except while the field dosimeters are deployed, and must be stored in a shielded storage vault during the field deployment period.

  - Vendor Terminologies are not consistent – some examples
    - Control Dosimeter
    - Transit Dosimeter
    - Deploy Dosimeter
    - Lead Pig Dosimeter
- Is it possible to determine these historically?
  - Best estimates may differ
- Driving vendor change to ANSI suggested 3 Control Dosimeters and Vault Dose Rate where necessary

Determine Extraneous Dose

- Extraneous dose may differ for each site or vendor
  - Determination requires a dedicated algorithm for each case
- Microsoft access allowed prototype handling of differing needs




```
SELECT "C-20" & Right$([monitoring
location],2) & "-" & Mid$([monitoring
location],6,1) AS [Background Set Name],
Sum(Quarterly_Element_Readings.[Mean
(Gross Dose, mrem)]) AS Cor_mrem,
Quarterly_Element_Readings.[Monitoring
Location], "S-20" & Right$([monitoring
location],2) AS [Vault Set Name]
FROM Quarterly_Element_Readings
GROUP BY "C-20" & Right$([monitoring
location],2) & "-" & Mid$([monitoring
location],6,1),
Quarterly_Element_Readings.[Monitoring
Location], "S-20" & Right$([monitoring
location],2)
HAVING
(((Quarterly_Element_Readings.[Monitoring
Location]) Like 'C*' And
(Quarterly_Element_Readings.[Monitoring
Location]) Not Like 'CCT*'));
```

Determine Extraneous Dose

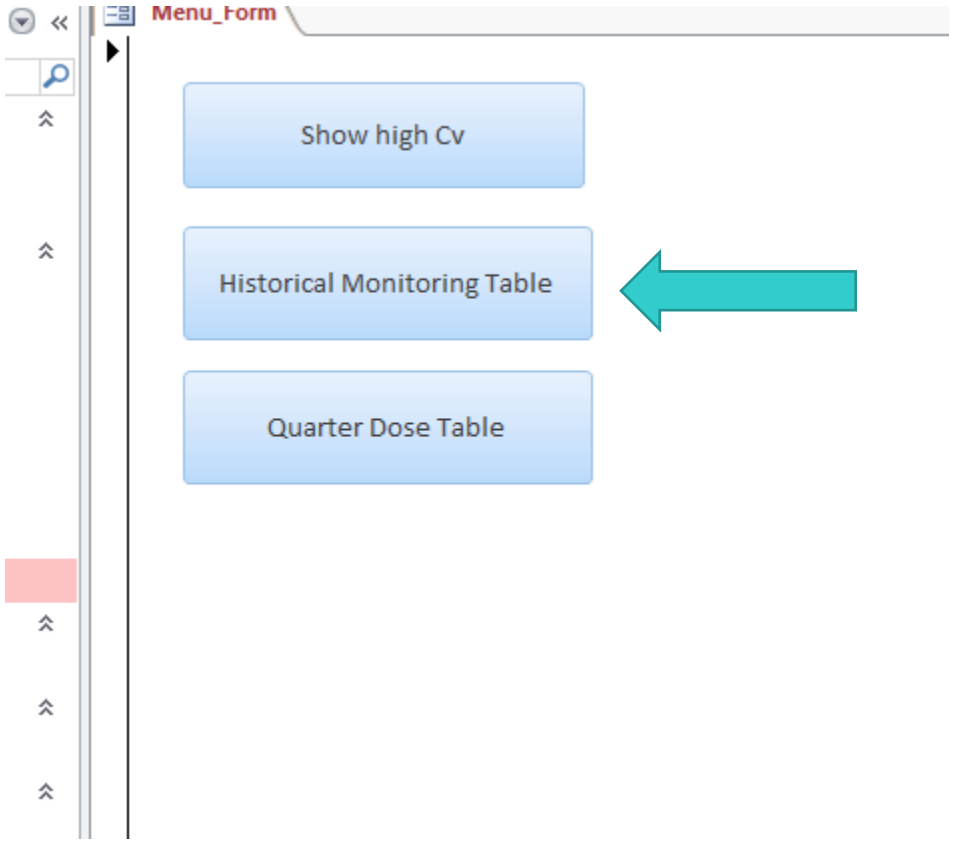
Menu_Form | Table3 Query - Transit Dose

Background Set Name	Ext_Dose_Cor_mrem	Monitoring Locati	Vault Set Name
C-2010-1	0.442	CCS-Q1-10	S-2010
C-2010-2	0.335	CCS-Q2-10	S-2010
C-2010-3	0.238	CCS-Q3-10	S-2010
C-2010-4	0.177	CCS-Q4-10	S-2010

Determine Historical Monitoring Data

- Use Historical Monitoring period data evaluated with previous steps
- Determine the dosimetry system's quarterly and annual minimum differential dose (MDD)
  - MDD is the 3 times 90th Percentile monitoring location standard deviation
- Determine the base-line background dose (average dose over monitoring period)

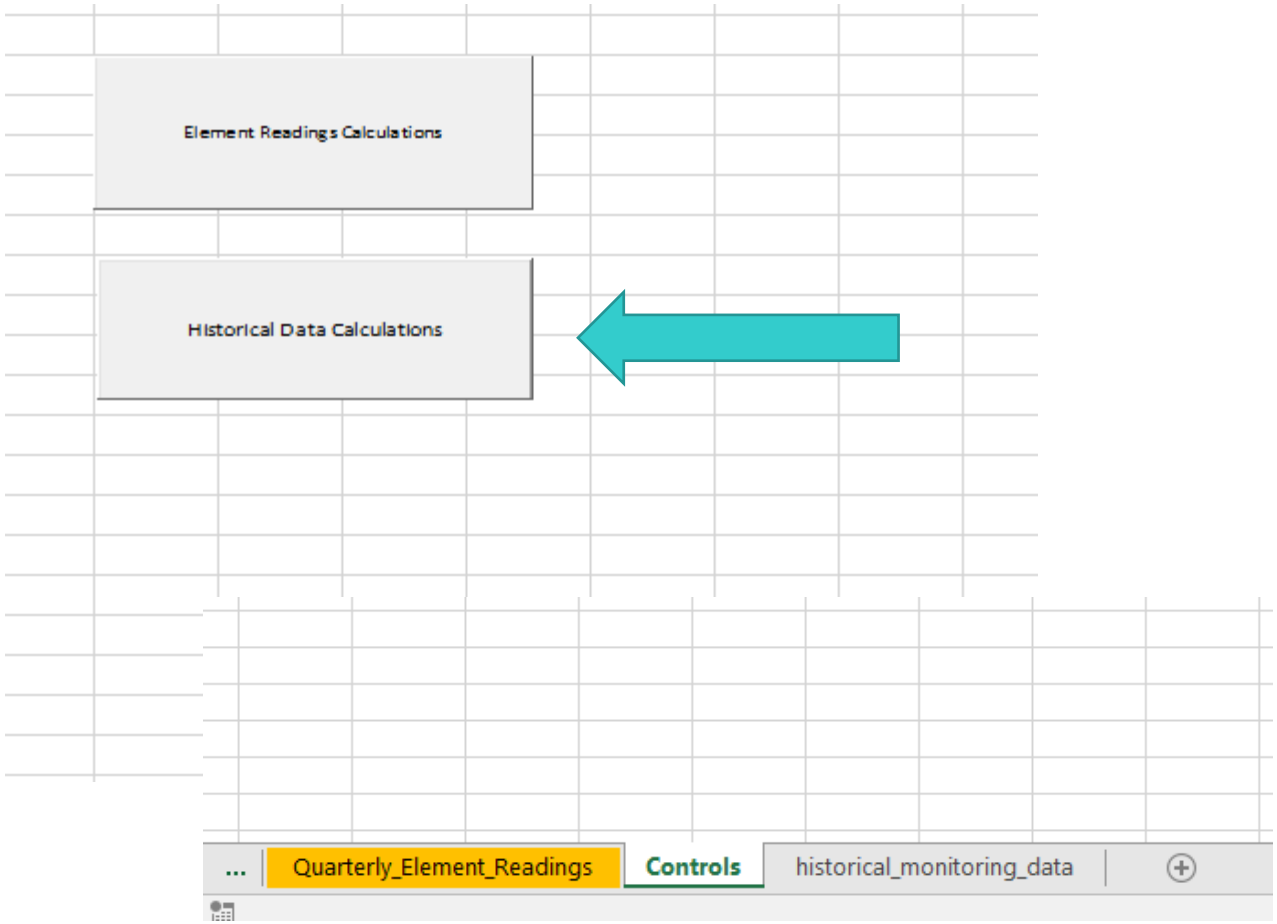
Determine Historical Monitoring Data



Determine Historical Monitoring Data

Monitoring Location	2010-1	2010-2	2010-3	2010-4	2011-1	2011-2	2011-3	2011-4	2012-1	2012-2	2012-3	2012-4	2013-1	2013-2	2013-3	2013-4	2014-1	2014-2	2014-3	2014-4
DR01	12.25	10.11	13.08	13.76		16.20	12.54	13.84	12.92	13.85	13.03	17.02	14.42	16.07	13.44	17.37	13.26	13.27	13.82	13.74
DR02	10.15	10.06	11.24	11.11	9.56	13.31	13.59	11.51	11.20	10.89	11.01	12.90		12.23	11.16	13.11	11.31	11.41	10.92	11.47
DR03	10.31	9.64	11.42	11.15	10.81	13.45	1.85	11.74	11.02	11.04	10.16	12.42	12.73	12.04	10.89	13.01	11.15	10.94	10.62	11.36
DR04	11.89	11.03	13.04	12.72	12.21	15.63	15.54	13.03	12.90	12.55	12.25	14.27	13.92	13.88	12.99	15.56	12.86	12.71	11.61	13.21
DR05	11.66	10.83	12.44	12.68	12.32	15.26	14.69	13.33	12.73	12.87	12.33	13.87	13.54	13.62	12.34	15.27	12.85	12.06	11.55	13.02
DR06	9.43	8.83	10.35	10.84	10.25	13.11	12.71	11.26	10.75	10.95	10.37	11.84	11.06	11.81	10.71	12.44	10.90	11.01	11.18	11.13
DR07	10.52	9.39	10.91	11.23	10.31	13.25	13.26	11.48	10.78	10.74	10.50	11.82	11.66	11.76	10.87	12.59	10.81	10.50	9.90	11.22
DR08	13.84	13.47	14.86	15.60	15.19	19.11	18.24	15.77	15.03	15.02	15.02	17.07	16.33	16.62	15.89	18.53	15.51	15.39	14.05	16.09
DR09	10.61	10.43	12.16	11.80	11.73	13.97	11.19	11.83	10.99	11.39	10.95	12.86	12.33	12.06	11.35	12.84	10.89	10.85	11.40	11.50
DR10	9.92	9.24	10.95	10.84	10.94	13.03		11.35	11.23	10.88	11.12	12.34	11.66	11.88	11.00	13.01	11.11	11.04	11.16	11.13
DR11	10.73	9.73	11.78	11.25	11.42	13.67	11.72	12.08	11.23	11.46	11.06		12.10	11.56	10.95	12.85	11.21	10.83	10.82	11.80
DR12	10.02	9.45	10.95	11.42	10.55	13.65	11.49	11.71	10.93	10.92	10.83	12.66	11.81	11.87	11.29	13.06	11.60	10.97	10.65	11.55
DR13	11.27	10.99	12.34	12.47	12.05	14.82	12.61	12.98	12.21	12.38	12.18	14.41	13.30	13.80	12.41	14.87	12.29	12.39	13.32	
DR14	12.61	12.54	14.09	13.74	13.34	16.92	13.96	14.59	13.86	13.57	13.42	16.18	14.50	15.55	14.26	16.91	13.96	13.43	13.30	14.52
DR15	11.30	10.81	12.45	12.33	12.13	14.69	12.55	12.43	12.47	12.13	11.99	13.92	12.80	15.21	12.00	14.56	12.23	12.02	9.86	12.35
DR16	10.07	9.73	11.10	10.92	10.80	13.79	10.89	11.41	10.55	11.47	11.02	12.81	12.42	12.13	10.92	12.60	11.08	10.81	9.39	11.29
DR17	12.00	11.26	12.99	12.69	12.26	15.66	13.07	13.63	12.75	13.22		14.95	13.86	13.96	12.65	15.42	12.48	12.14	12.50	
DR18	9.66	8.57	10.37	10.51	10.74	12.31	10.00	10.64	10.11	10.21	9.35	11.72	10.67	11.17	9.83	12.31	10.18	9.78	9.82	10.20
DR19	10.44	10.42	11.16	11.67	11.01	13.89	11.09	11.72	10.92	10.93	10.67	13.15	12.07	12.41	11.39	14.04	11.45	11.36	12.25	11.40
DR20	12.76	12.27	13.97	13.86	13.47	16.62	14.06	14.25	13.25	13.97	13.14	15.79	14.46	15.05	14.44	16.31	13.74	13.48	11.51	14.33
DR21	11.83	11.19	12.96	12.72	12.67	15.22	12.58	13.31	12.17	12.87	12.02	13.96	13.77	13.29	13.51	14.83	13.21	12.53	12.89	13.20
DR22	10.75		11.70	11.84	11.44	14.28	11.64	12.38	11.44	11.84	11.21		12.76	11.81	12.46	12.92	12.08	11.29	11.14	11.46
DR23	14.38	15.39	17.52	16.39	15.23	20.57	16.55	15.97	14.40	16.13	17.20	18.22	18.18	17.96	17.77	20.71	16.58	15.94	16.82	16.94
DR24	11.22	10.79	12.23	12.17	11.92	14.91	12.36	12.68	11.54	11.86	11.24	14.05	12.93	13.65	12.33	14.63	12.01	12.16	11.55	12.83
DR25	13.03	11.43	13.93	12.99	13.18	15.95	13.33	14.03	13.13	13.23	12.72	15.16	14.10	14.51	13.52	15.96	13.53	12.98	10.15	13.88
DR26	10.36	9.98	11.25	11.47	10.94	13.83	11.54	11.72	11.17	11.06	10.85	13.10	12.46	12.52	11.57	13.40	11.24	11.10	10.03	11.72
DR27	10.98	9.77	11.01	11.24	11.22	14.22	11.29	11.91	11.21	11.49	9.91	13.59	12.95	13.33	12.66	14.36	12.70	11.69	10.81	12.35
DR28	13.45	12.90	15.17	14.81	13.36	18.03	13.93	13.98	12.67	14.82	14.87	15.82	16.55	15.61	15.19	18.03	14.03	13.61	13.69	15.61
DR29	14.40	13.67	15.12	15.71	14.74	19.18	14.54	15.21	14.22	14.34	14.75	16.91	17.54	17.12	15.93	18.28	15.44	14.50	14.88	16.21
DR30	11.99	10.87	12.28	12.11	12.10	14.85	11.86	12.62	15.79	19.35	16.21	15.21	13.69	13.24	13.41	14.63	13.22	11.97	10.79	12.68
DR31	14.36	14.84	15.54	16.47	15.29	21.03	16.40	16.38	14.72	14.70	14.47	17.23	16.88	16.68	15.53	18.97	14.88	14.65	14.03	16.21
DR32	13.73	13.87	16.39	15.43	14.37	19.41	15.84	14.75	13.94	14.63	15.53		16.38	14.57	16.98	16.63	14.59	14.61	15.14	16.58
DR33	14.68	13.81	16.74	16.25	14.78	20.15	16.10	16.16	15.06	15.63	15.81	17.28	18.29	17.35	16.26	19.05	15.55	15.24	15.21	16.93
DR34	9.57	8.85	10.10	10.27	9.79	11.94	10.30	10.51	9.89	9.84	9.71	11.25	11.19	11.05	10.79	12.24	10.51	9.84	8.18	10.22

Determine Historical Monitoring Data



Determine Historical Monitoring Data

	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
-4	2014-1	2014-2	2014-3	2014-4		Bq	Sq	MA1	MA2	MA3	MA4	MA5	Ba	Sa			MDDq	MDDa		Sq of 90th	Sa of 90th
7	13.26	13.27	13.82	13.74		13.89	1.74	49.19	42.58	56.82	61.30	54.09	52.80	7.21			5.09	22.72		1.70	7.57
1	11.31	11.41	10.92	11.47		11.48	1.10	42.57	47.97	46.00	36.50	45.10	43.63	4.43							
1	11.15	10.94	10.62	11.36		10.89	2.34	42.52	37.85	44.64	48.67	44.07	43.55	3.91							
6	12.86	12.71	11.61	13.21		13.19	1.28	48.68	56.40	51.96	56.34	50.40	52.76	3.50							
7	12.85	12.06	11.55	13.02		12.96	1.17	47.61	55.60	51.80	54.78	49.47	51.85	3.40							
4	10.90	11.01	11.18	11.13		11.05	1.02	39.45	47.34	43.91	46.02	44.22	44.19	2.99							
9	10.81	10.50	9.90	11.22		11.17	1.01	42.04	48.30	43.84	46.87	42.42	44.69	2.77							
3	15.51	15.39	14.05	16.09		15.83	1.50	57.78	68.32	62.14	67.38	61.05	63.33	4.44							
4	10.89	10.85	11.40	11.50		11.66	0.87	45.01	48.73	46.19	48.58	44.64	46.63	1.94							
1	11.11	11.04	11.16	11.13		11.25	0.90	40.95	35.32	45.57	47.55	44.44	42.77	4.81							
5	11.21	10.83	10.82	11.80		11.49	0.84	43.50	48.88	33.75	47.47	44.66	43.65	5.94							
6	11.60	10.97	10.65	11.55		11.37	0.98	41.83	47.40	45.33	48.03	44.77	45.47	2.45							
7	12.29	12.39	13.32			12.79	1.07	47.07	52.45	51.17	54.38	38.00	48.62	6.51							
1	13.96	13.43	13.30	14.52		14.26	1.25	52.98	58.81	57.03	61.21	55.22	57.05	3.18							
6	12.23	12.02	9.86	12.35		12.51	1.28	46.89	51.80	50.51	54.57	46.46	50.05	3.41							
0	11.08	10.81	9.39	11.29		11.26	1.06	41.82	46.89	45.85	48.07	42.57	45.04	2.73							
2	12.48	12.14	12.50			13.19	1.19	48.93	54.61	40.92	55.89	37.13	47.50	8.28							
1	10.18	9.78	9.82	10.20		10.41	0.93	39.10	43.70	41.39	43.98	39.98	41.63	2.18							
4	11.45	11.36	12.25	11.40		11.67	1.03	43.69	47.72	45.67	49.91	46.47	46.69	2.32							
1	13.74	13.48	11.51	14.33		14.04	1.25	52.86	58.41	56.15	60.25	53.07	56.15	3.25							
3	13.21	12.53	12.89	13.20		13.04	0.95	48.71	53.78	51.03	55.40	51.83	52.15	2.57							
2	12.08	11.29	11.14	11.46		11.91	0.82	34.28	49.73	34.49	49.94	45.97	42.88	7.92							
1	16.58	15.94	16.82	16.94		16.94	1.69	63.68	68.32	65.96	74.62	66.28	67.77	4.16							
3	12.01	12.16	11.55	12.83		12.45	1.12	46.41	51.88	48.69	53.54	48.56	49.82	2.85							
6	13.53	12.98	10.15	13.88		13.54	1.34	51.37	56.48	54.24	58.08	50.53	54.14	3.23							
0	11.24	11.10	10.03	11.72		11.56	1.04	43.07	48.02	46.18	49.94	44.10	46.26	2.81							
6	12.70	11.69	10.81	12.35		11.94	1.30	43.01	48.64	46.20	53.31	47.56	47.74	3.76							
3	14.03	13.61	13.69	15.61		14.81	1.51	56.33	59.30	58.18	65.38	56.93	59.22	3.63							
8	15.44	14.50	14.88	16.21		15.63	1.48	58.90	63.67	60.22	68.87	61.03	62.54	3.95							
3	13.22	11.97	10.79	12.68		13.44	2.07	47.26	51.44	66.56	54.96	48.65	53.77	7.73							
7	14.88	14.65	14.03	16.21		15.96	1.70	61.21	69.10	61.11	68.06	59.78	63.85	4.37							
3	14.59	14.61	15.14	16.58		15.44	1.39	59.42	64.37	44.10	64.56	60.92	58.67	8.44							
5	15.55	15.24	15.21	16.93		16.32	1.55	61.48	67.19	63.77	70.94	62.93	65.26	3.81							
4	10.51	9.84	8.18	10.22		10.30	0.96	38.79	42.55	40.68	45.26	38.75	41.21	2.76							

ring_data

Determine Field Dose

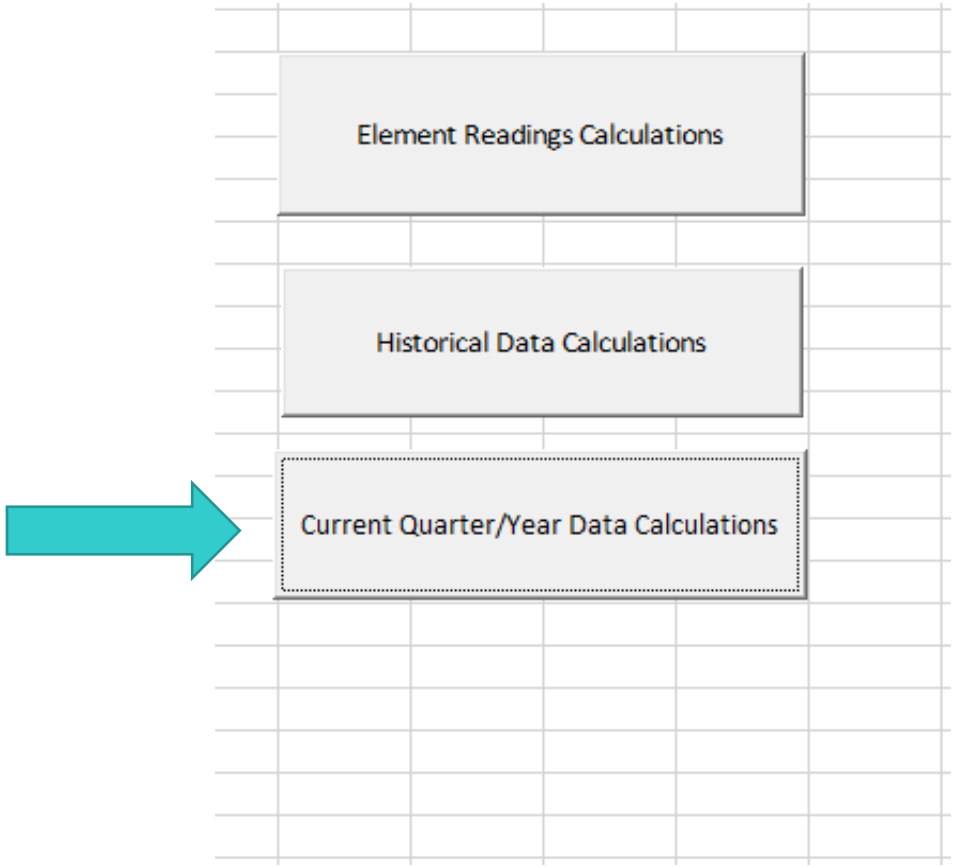
- Normalize Mean Gross Dose to Standard 91 Day Quarter
- Subtract Extraneous Dose

Determine the Field Doses

	A	B	C	D	E	F	G	H
1	Monitoring Location	Date IN	Date Out	Days in Field	MFG	MFGnr	MQ	
2	DR01	1/8/2014	4/2/2014	84	12.24	13.26	13.26	
3	DR02	1/8/2014	4/2/2014	84	10.44	11.31	11.31	
4	DR03	1/8/2014	4/2/2014	84	10.29	11.15	11.15	
5	DR04	1/8/2014	4/2/2014	84	11.87	12.86	12.86	
6	DR05	1/8/2014	4/2/2014	84	11.86	12.85	12.85	
7	DR06	1/8/2014	4/2/2014	84	10.06	10.90	10.90	
8	DR07	1/8/2014	4/2/2014	84	9.98	10.81	10.81	
9	DR08	1/8/2014	4/2/2014	84	14.31	15.51	15.51	
10	DR09	1/8/2014	4/2/2014	84	10.05	10.89	10.89	
11	DR10	1/8/2014	4/2/2014	84	10.26	11.11	11.11	
12	DR11	1/8/2014	4/2/2014	84	10.34	11.21	11.21	
13	DR12	1/8/2014	4/2/2014	84	10.70	11.60	11.60	
14	DR13	1/8/2014	4/2/2014	84	11.34	12.29	12.29	
15	DR14	1/8/2014	4/2/2014	84	12.89	13.96	13.96	
16	DR15	1/8/2014	4/2/2014	84	11.29	12.23	12.23	
17	DR16	1/8/2014	4/2/2014	84	10.23	11.08	11.08	
18	DR17	1/8/2014	4/2/2014	84	11.52	12.48	12.48	
19	DR18	1/8/2014	4/2/2014	84	9.40	10.18	10.18	
20	DR19	1/8/2014	4/2/2014	84	10.57	11.45	11.45	
21	DR20	1/8/2014	4/2/2014	84	12.68	13.74	13.74	
22	DR21	1/8/2014	4/2/2014	84	12.20	13.21	13.21	
23	DR22	1/8/2014	4/2/2014	84	11.15	12.08	12.08	
24	DR24	1/8/2014	4/2/2014	84	11.09	12.01	12.01	
25	DR25	1/8/2014	4/2/2014	84	12.48	13.53	13.53	
26	DR26	1/8/2014	4/2/2014	84	10.37	11.24	11.24	
27	DR27	1/8/2014	4/2/2014	84	11.73	12.70	12.70	
28	DR30	1/8/2014	4/2/2014	84	12.20	13.22	13.22	

... | Controls | historical_monitoring_data | **table_4_quarter_doses**

Determine FRD's



Determine Quarterly FRDs

- Use the sum of the MDD and quarterly baseline background ($B_Q + 3\sigma_{90th}$) at each location
- Compare to the newest quarter's results at each location

Determine Quarterly FRDs

A	B	C	D	E	F	G	H	I	J	K
Monitoring Location	Date IN	Date Out	qtr	MFG	MFGnr	MQ		Bq	Bq+3sig	FRD
DR01	1/8/2014	4/2/2014	2014-1	12.244	13.26433	13.26433		13.9524	18.94	ND
DR02	1/8/2014	4/2/2014	2014-1	10.43617	11.30585	11.30585		11.54028	16.53	ND
DR03	1/8/2014	4/2/2014	2014-1	10.29283	11.15057	11.15057		10.94348	15.94	ND
DR04	1/8/2014	4/2/2014	2014-1	11.87217	12.86151	12.86151		13.24474	18.24	ND
DR05	1/8/2014	4/2/2014	2014-1	11.85767	12.84581	12.84581		13.01795	18.01	ND
DR06	1/8/2014	4/2/2014	2014-1	10.05833	10.89653	10.89653		11.10277	16.10	ND
DR07	1/8/2014	4/2/2014	2014-1	9.977667	10.80914	10.80914		11.22927	16.22	ND
DR08	1/8/2014	4/2/2014	2014-1	14.3125	15.50521	15.50521		15.88869	20.88	ND
DR09	1/8/2014	4/2/2014	2014-1	10.04967	10.88714	10.88714		11.71285	16.71	ND
DR10	1/8/2014	4/2/2014	2014-1	10.25717	11.11193	11.11193		11.31273	16.31	ND
DR11	1/8/2014	4/2/2014	2014-1	10.3445	11.20654	11.20654		11.54564	16.54	ND
DR12	1/8/2014	4/2/2014	2014-1	10.704	11.596	11.596		11.42369	16.42	ND
DR13	1/8/2014	4/2/2014	2014-1	11.342	12.28717	12.28717		12.85198	17.84	ND
DR14	1/8/2014	4/2/2014	2014-1	12.88683	13.96074	13.96074		14.31795	19.31	ND
DR15	1/8/2014	4/2/2014	2014-1	11.29267	12.23372	12.23372		12.56711	17.56	ND
DR16	1/8/2014	4/2/2014	2014-1	10.22783	11.08015	11.08015		11.3159	16.31	ND
DR17	1/8/2014	4/2/2014	2014-1	11.519	12.47892	12.47892		13.25521	18.25	ND
DR18	1/8/2014	4/2/2014	2014-1	9.398833	10.18207	10.18207		10.46289	15.46	ND
DR19	1/8/2014	4/2/2014	2014-1	10.572	11.453	11.453		11.72862	16.72	ND
DR20	1/8/2014	4/2/2014	2014-1	12.68067	13.73739	13.73739		14.09266	19.08	ND
DR21	1/8/2014	4/2/2014	2014-1	12.1965	13.21288	13.21288		13.09304	18.09	ND
DR22	1/8/2014	4/2/2014	2014-1	11.15117	12.08043	12.08043		11.95656	16.95	ND
DR24	1/8/2014	4/2/2014	2014-1	11.08983	12.01399	12.01399		12.51005	17.50	ND
DR25	1/8/2014	4/2/2014	2014-1	12.48483	13.52524	13.52524		13.59111	18.58	ND
DR26	1/8/2014	4/2/2014	2014-1	10.37483	11.2394	11.2394		11.62029	16.61	ND
DR27	1/8/2014	4/2/2014	2014-1	11.72567	12.70281	12.70281		11.991	16.98	ND
DR30	1/8/2014	4/2/2014	2014-1	12.20017	13.21685	13.21685		13.4993	18.49	ND
DR34	1/8/2014	4/2/2014	2014-1	9.7005	10.50888	10.50888		10.35698	15.35	ND
SFDR01	1/8/2014	4/2/2014	2014-1	17.5185	18.97838	18.97838		18.83159	23.82	ND
SFDR02	1/8/2014	4/2/2014	2014-1	17.32433	18.76803	18.76803		20.32617	25.32	ND
SFDR03	1/8/2014	4/2/2014	2014-1	35.207	38.14092	38.14092		39.32689	44.32	ND
SFDR04	1/8/2014	4/2/2014	2014-1	29.394	31.8435	31.8435		34.51691	39.51	ND
SFDR05	1/8/2014	4/2/2014	2014-1	18.1095	19.61863	19.61863		20.61826	25.61	ND
SFDR06	1/8/2014	4/2/2014	2014-1	15.43717	16.7236	16.7236		17.58152	22.57	ND
SFDR07	1/8/2014	4/2/2014	2014-1	11.67133	12.64394	12.64394		13.25594	18.25	ND
SFDR08	1/8/2014	4/2/2014	2014-1	25.7395	27.88446	27.88446		29.84122	34.83	ND
SFDR09	1/8/2014	4/2/2014	2014-1	13.814	14.96517	14.96517		15.84424	20.84	ND

... | table_4_quarter_doses | table_5_annual_doses | Quarterly_Element_Readings | Tools | historical_monitori

Determine Annual FRDs

- Use the sum of the MDD and quarterly baseline background ($B_A + 3\sigma_{90th}$) at each location
- Compare to the newest year's results at each location
- If a location is determined to have an FRD, use the sum of squares to determine dose to nearest resident
  - Report this dose as part of ARERR

Determine Annual FRDs

	A	B	C	D	E	F	G	H	I	J	K	L
1	Monitoring Location	MQ	2014-1	2014-2	2014-3	2014-4	MQ		Bq	Bq+3sig	FRD	Dose to Nearest Res
2	DR01	54.09	13.26	13.27	13.82	13.74	59.18		54.09	59.18	ND	ND
3	DR02	45.10	11.31	11.41	10.92	11.47	50.20		45.10	50.20	ND	ND
4	DR03	44.07	11.15	10.94	10.62	11.36	49.17		44.07	49.17	ND	ND
5	DR04	50.40	12.86	12.71	11.61	13.21	55.49		50.40	55.49	ND	ND
6	DR05	49.47	12.85	12.06	11.55	13.02	54.56		49.47	54.56	ND	ND
7	DR06	44.22	10.90	11.01	11.18	11.13	49.31		44.22	49.31	ND	ND
8	DR07	42.42	10.81	10.50	9.90	11.22	47.52		42.42	47.52	ND	ND
9	DR08	61.05	15.51	15.39	14.05	16.09	66.14		61.05	66.14	ND	ND
10	DR09	44.64	10.89	10.85	11.40	11.50	49.73		44.64	49.73	ND	ND
11	DR10	44.44	11.11	11.04	11.16	11.13	49.53		44.44	49.53	ND	ND
12	DR11	44.66	11.21	10.83	10.82	11.80	49.75		44.66	49.75	ND	ND
13	DR12	44.77	11.60	10.97	10.65	11.55	49.86		44.77	49.86	ND	ND
14	DR13	38.00	12.29	12.39	13.32		43.09		38.00	43.09	ND	ND
15	DR14	55.22	13.96	13.43	13.30	14.52	60.31		55.22	60.31	ND	ND
16	DR15	46.46	12.23	12.02	9.86	12.35	51.55		46.46	51.55	ND	ND
17	DR16	42.57	11.08	10.81	9.39	11.29	47.66		42.57	47.66	ND	ND
18	DR17	37.13	12.48	12.14	12.50		42.22		37.13	42.22	ND	ND
19	DR18	39.98	10.18	9.78	9.82	10.20	45.07		39.98	45.07	ND	ND
20	DR19	46.47	11.45	11.36	12.25	11.40	51.56		46.47	51.56	ND	ND
21	DR20	53.07	13.74	13.48	11.51	14.33	58.16		53.07	58.16	ND	ND
22	DR21	51.83	13.21	12.53	12.89	13.20	56.92		51.83	56.92	ND	ND
23	DR22	45.97	12.08	11.29	11.14	11.46	51.06		45.97	51.06	ND	ND
24	DR23	66.28	16.58	15.94	16.82	16.94	71.38		66.28	71.38	ND	ND
25	DR24	48.56	12.01	12.16	11.55	12.83	53.65		48.56	53.65	ND	ND
26	DR25	50.53	13.53	12.98	10.15	13.88	55.63		0.00	5.09	50.53	12.63
27	DR26	44.10	11.24	11.10	10.03	11.72	49.19		44.10	49.19	ND	ND
28	DR27	47.56	12.70	11.69	10.81	12.35	52.65		47.56	52.65	ND	ND
29	DR28	56.93	14.03	13.61	13.69	15.61	62.02		56.93	62.02	ND	ND
30	DR29	61.03	15.44	14.50	14.88	16.21	66.12		61.03	66.12	ND	ND
31	DR30	48.65	13.22	11.97	10.79	12.68	53.75		48.65	53.75	ND	ND
32	DR31	59.78	14.88	14.65	14.03	16.21	64.87		59.78	64.87	ND	ND

← Bq changed for demo

Nearest Resident

	A	B	C	D	E	F
1	Monitoring Location	Nearest Resident (miles)	Distance from dosimeter to major radiation source (miles)			
2	DR25	1	0.5			
3	DR90	2	0.5			
4						
5						
6						
7						
8						
9						

Other Concerns

- Most dosimetry data reported in mR not mrem
  - Assume 1 mR= 1 mrem unless approaching regulatory limits

Future Considerations

- Once program has been established add tables as an Appendix to AREOR
- Establish a Dosimetry QA Program
  - Annual Blind Spike Testing
  - Annual Audits
  - Triannual vendor/processor audits

Questions

ChemStaff