ATTACHMENT 2

-- Non-proprietary Information --

"ISA Consequence Assessment for Airborne Releases"
Attachment C, "Material at Risk/UF_6 Release Source Terms"
(Non-proprietary Version)

Attachment C

Material at Risk/UF_6 Release Source Terms

Table of Contents

1. Purpose

This Attachment calculates the UF_6 release at different locations of the proposed facility. The areas of interest include the UF_6 Handling Areas, the Cascade Halls, the Blending & Liquid Sampling Area, and the Centrifuge Test Facility. The UF_6 release is calculated in grams.

2. Method

The rate of UF_6 release from difference sources (Feed, Purification, Product, Uranium Byproduct Cylinders, and Cold Traps) were obtained from Reference 1. The release rate calculation is based on area of (20mm x 20mm) 400 mm^2. Since cold trap (feed and product) area is based on 40mm by 40mm, an adjustment to the release calculation has been performed for Cold Trap by multiplying the release by (40/20) * $(40/20)^{3/2}$ per Eq. 21 of Reference 5.

3. Design Inputs

The design input for calculating the UF_6 release include the geometry, and number of modules, and assays that exist in the proposed facility. There are 3 modules and 2 assays per module in the facility (Reference 3). The design input assumes that per assay there are 5 cylinders in the Feed area, one cylinder for Purification, 3 cylinders for Product, 7 cylinders for Uranium Byproduct Cylinders, one cylinder Cold trap in Feed and one cylinder for Cold Trap in the Product area.

The rate of UF_6 release from various cylinders in different areas is obtained from Reference 1. The volume and the amount of UF_6 present in the piping area are obtained from Reference 2.

4. Assumptions

The major assumptions for calculating the UF_6 release are:

1. The UF_6 release for Feed is calculated at 500 mbar (p. 10 of Reference 12). Reference 1 provides the rate of release at this pressure.
2. The UF_6 release for Purification is calculated at -25 °C (p. 44 of Reference 13). Reference 1 provides the rate of release this temperature.
3. The UF_6 release for Product is calculated at -25 °C (Reference 9). Reference 1 provides the rate of release at this temperature.
4. The UF_6 release for Uranium Byproduct Cylinders is calculated at -25 °C (Reference 11). Reference 1 provides the rate of release at this temperature.
5. The UF_6 release for Receiver is calculated at -25 °C (p. 44 of Reference 13) Reference 1 provides the rate of release at this temperature.
6. The UF_6 release for Cold Trap (Feed & Product) is calculated at – 60 °C and 20 °C (Reference 10). Reference 1 provides the rate of release at this temperature.
7. It is assumed that the UF_6 inventory in the piping and cascades empties in 30 minutes following the event.
8. It is assumed that the outdoor ambient temperature is 100 °F (37.8 °C).
9. It is assumed that the indoor ambient temperature is 77 °F (25 °C).
10. It is assumed that the outdoor wind speed is 0.6 m/sec. (See footnote 12 of Attachment A).
11. It is assumed that the indoor CRDB ambient temperature is 95 °F (35 °C).

5. Computer Use

There is no major computer program for the calculation in this Attachment.

6. Results

The UF_6 release was obtained for different areas of the facility in the event of a hypothetical accident. The locations include UF_6 Handling Areas 1&2 and 3&4/5&6 (lumped together), Cascade Halls1&2 and 3&4/5&6 (lumped together), Blending & Liquid Sampling Area, and Centrifuge Test Facility.

UF_6 Handling Area Releases

The UF_6 Handling Areas contain Feed, Purification, Product, Uranium Byproduct Cylinders, and cold trap for Feed and Product. Additionally, UF_6 is present in the piping for Feed, Product, and Uranium Byproduct areas.

The section calculates the total release of UF_6 in 30 minutes time period. It is assumed that all the inventories in the piping area will be emptied in 30 minutes time period.

From Appendix 1 of Reference 2 the UF_6 hold up in piping volumes for the UF_6 Handling Areas (per assay) are:

Feed:	UF_6 (gram)
Feed System	1594.5
Feed Control	61.4
Feed Station	745
Feed Purification	300.0
Vent Pipes	101.6
Hot Box	22

Product:	UF_6 (gram)
Product System	69.7
Valves (1)	50.3
Valves (2)	640.4
Product Station	40.7
Product Vent	14
Exit Product Vent	6

Uranium Byproducts:	UF_6 (gram)
Cylinders System	16
Valves (1)	401.7
Valves (2)	2663.2
Tail Station (1)	123.9
Tail Station (2)	9.9
Vent Pipe Work	22.8

The source of UF_6 release rate in the UF_6 Handling Areas is Reference 1.

In order to calculate the UF_6 (gram) in the Feed area:

The rate of release is 0.72 gram/second per cylinder per assay.

UF_6 release = (0.72 gram/sec) * (30min * 60 sec/min) * (5 cylinder per assay) * (6 assay)

= 38880 grams of UF_6

For Cold Trap Feed the UF_6 (gram) is:

The rate of release is 0.065 gram/second per cylinder per assay.

The adjustment for area for Cold Trap release is (since the area is 40x40mm instead of 20x20mm) (40/20) $(40/20)^{3/2}$ = 5.6568 (Eq. 21 of Reference 5)

UF_6 release = (0.065 gram/sec) * (30min * 60 sec/min) *(1 cylinder/assay) *(6 assay) *5.6568

= 3971.1 grams of UF_6

This process is repeated for Purification, Product, Uranium Byproduct Cylinders, and Cold Traps to obtain the UF_6 release from the assays. The amount of the release is added to the inventory in the pipe being released in the event of a hypothetical accident.

The releases were obtained for 30 minutes, 2.5 minutes and 0.17 minutes (10 seconds) time period.

SEISMIC UF_6
RELEASE
UF_6 Handling Area
PUBLIC - UNCONTROLLED

Time (min)	30	Release Duration
Assays (#)	6	

40 x 40 mm hole size instead of 20x20 mm, W=H=40 mm for Cold Trap

SOURCE of UF_6	g/sec	# cylinders per assay		grams	Comment:
Feed @ 500 mbar	0.72	5	# cylinders per assay	38880	Ref. 1
Purification @ -25C	0.002	1	# cylinders per assay	21.6	Ref. 1
Product @ -25C	0.002	3	# cylinders per assay	64.8	Ref. 1
Cylinders @ -25C	0.002	7	# cylinders per assay	151.2	Ref. 1
Cold Trap Feed @20C	0.065	1	# cylinders per assay	3971.1	Ref. 1(adj. area by W(H^3/2)
Cold Trap Product @ 20C	0.065	1	# cylinders per assay	3971.1	Ref. 1(adj. area by W(H^3/2)
		TOTAL (g) (30min)	Pouring from Cylinders	47060	

Pipes (empty in 30 minutes)
grams

1594.5	feed:	Ref. 2	per assay
61.4			
745			
300			
101.6			
22	feed =		2824.5
69.7	product:		
50.3			
640.4			
40.7			
14			
6	product=		821.1
16	Cylinders:		
401.7			
2663.2			
123.9			
9.9			
22.8	Cylinders=		3237.5
	Total from pipes	multiply by 6 for entire plant	41298
	TOTAL Cylinders and Pipes(47060+41298)=		**88358** **Grams of UF_6**

Therefore, the total UF_6 release from all the UF_6 Handling Areas is 88,358 grams. The area of UF_6 Handling Area 1&2 is one third of the total UF_6 Handling Areas.

Therefore, the material at risk (MR) for 30 minutes is:

MR for UF_6 Handling Area 1&2 **= (1/3) * 88,358** **= 29,453 grams of UF_6**

MR for UF_6 Handling Area 3&4/5&6 **= (2/3) * 88,358** **= 58,905 grams of UF_6**

Worker Elsewhere in the Room:
For 2.5 minutes:

SEISMIC UF_6 RELEASE		
UF_6 Handling Area WORKER - UNCONTROLLED	2.5 min	
Time (min)	2.5	Release Duration
Assays (#)	6	

40 x 40 mm hole size instead of 20x20 mm, W=H=40 mm for Cold Trap

SOURCE of UF_6	g/sec	# cylinders per assay		grams	
Feed @ 500 mbar	0.72	5	# cylinders per assay	3240	Ref. 1
Purification @ -25C	0.002	1	# cylinders per assay	1.8	Ref. 1
Product @ -25C	0.002	3	# cylinders per assay	5.4	Ref. 1
Cylinders @ -25C	0.002	7	# cylinders per assay	13	Ref. 1
Cold Trap Feed @20C	0.065	1	# cylinders per assay	331	Ref. 1(adj. area by W(H^3/2)
Cold Trap Product @ 20C	0.065	1	# cylinders per assay	331	Ref. 1(adj. area by W(H^3/2)
		TOTAL (g) (2.5 min)	Pouring from Cylinders	3922	

Pipes (empty in 30 minutes)

Grams			
1594.5	feed:	Ref. 2	per assay
61.4			
745			
300			
101.6			
22	feed =		2824.5
69.7	product:		
50.3			
640.4			
40.7			
14			
6	product=		821.1
16	Cylinders:		
401.7			
2663.2			
123.9			
9.9			
22.8	Cylinders=		3237.5
	Total in 30 minutes	multiply by 6 for entire plant	41299
	Total in 2.5 minutes	(ratio by 2.5/30)	3441
	TOTAL Cylinders and Pipes(3922+3441)=		**7363** **Grams of UF_6**

Therefore, the total UF_6 release from all the UF_6 Handling Areas is 7,363 grams. The area of UF_6 Handling Area 1&2 is one third of the total UF_6 Handling Areas.

Therefore, the material at risk (MR) for 2.5 minutes is:

MR for UF_6 Handling area 1&2 = (1/3) * 7,363 = 2,454 grams of UF_6

MR for UF_6 Handling area 3&4/5&6 = (2/3) * 7,363 = 4,909 grams of UF_6

Cascade Hall Releases

*

* *Trade Secret*

*

* *Trade Secret*

Blending & Liquid Sampling Area Releases

The Blending & Liquid Sampling Area contains UF_6 in donor, receivers, and cold traps. Additionally, UF_6 is present in the piping in the Blending & Liquid Sampling Area. There is only one area of Blending & Liquid Sampling Area.

The section calculates the total release of UF_6 in 30 minutes time period. It is assumed that all the inventories in the piping area will be emptied in 30 minutes time period.

From Reference 2 the UF_6 hold up in piping volumes for Blending & Liquid Sampling Area is:

B&S:	UF_6 (gram)
Solid Donor Station	229.1
Transfer Pipes (1)	943.3
Transfer Pipes (2)	970.2
Transfer Pipes (3)	845.4
Vent System	39.5
Vent Pipe Receiver	13.1
Cold Trap	4.1

SEISMIC UF_6 RELEASE
Blending & Liquid Sampling
PUBLIC - UNCONTROLLED

Time (min) 30 Release Duration

40 x 40 mm hole size instead of 20x20 mm, W=H=40 mm for Cold Trap

SOURCE of UF_6	g/sec Ref.1	# cylinders per assay		grams	
Donor @ 53C	0.72	2	# cylinders per 3 modules	2592	Ref. 1
Receiver @ -25C	0.002	4	# cylinders per 3 modules	14.4	Ref. 1
Cold trap Donor @ 20C	0.065	1	# cylinders per 3 modules	662	Ref. 1 (adj. area by W(H^3/2)
		TOTAL (g) (30min)	Pouring from Cylinders	3268	

Pipes (empty in 30 minutes) grams

229.1		Ref. 2			
943.3					
970.2					
845.4					
39.5					
13.1					
4.1					
43.8	b&s =	3089			
		Total from pipes		3089	
		TOTAL Cylinders and Pipes(3268+3089)=		**6357**	**grams**

As seen, the total UF_6 release from the Blending & Liquid Sampling Area is 6,357 grams.

Therefore, the material at risk (MR) for 30 minutes is:

MR for Blending & Liquid Sampling Area = 6,357 grams of UF_6

Worker Elsewhere in the Room:
For 2.5 minutes:

SEISMIC UF_6 RELEASE Blending & Liquid Sampling WORKER - UNCONTROLLED	2.5 min	
Time (min)	2.5	Release Duration
Assays (#)	6	

40 x 40 mm hole size instead of 20x20 mm, W=H=40 mm for Cold Trap

SOURCE of UF_6	g/sec Ref. 1	# cylinders per assay		grams	
Donor @ 53C	0.72	2	# cylinders per 3 modules	216	
Receiver @ -25C	0.002	4	# cylinders per 3 modules	1.2	
Cold trap Donor @ 20C	0.065	1	# cylinders per 3 modules	55	adj. area by W(H^3/2
		TOTAL (g) (2.5 min)	Pouring from Cylinders	272	

Pipes (empty in 30 minutes)
Grams

		Ref. 2
229.1		
943.3		
970.2		
845.4		
39.5		
13.1		
4.1		
43.8	b&s =	3089

Total from pipes		3089
Total in 2.5 minutes	(ratio by 2.5/30 min)	258
TOTAL Cylinders and Pipes (272+258)=		**530 g**

As seen, the total UF_6 release from the Blending & Liquid Sampling Area is 530 grams.

Therefore, the material at risk (MR) for 2.5 minutes is:

MR for Blending & Liquid Sampling Area = 530 grams of UF_6

Centrifuge Test Facility Releases

*

* *Trade Secret*

[redacted] *

** Trade Secret*

Cascade Hall Releases (Manifold Connections Only)

The following release calculation evaluated the UF_6 release from the Cascade Halls for 30 minutes time duration. The UF_6 that contain in the manifold connections (Feed, Product, and Uranium Byproduct Cylinders to one Assay) is calculated below (FF9). The remaining 2 assays are calculated in FF11-2.

FIRE UF_6 RELEASE

Centrifuge FF9	All three UF_6 manifold connections (feed, product, and Uranium Byproduct Cylinders)		
1594.5	feed:	Ref. 2	per assay
61.4			
745			
300			
101.6			
22	feed total=		2824.5
69.7	product:		
50.3			
640.4			
40.7			
14			
6	product=		821.1
16	Cylinders:		
401.7			
2663.2			
123.9			
9.9			
22.8	Cylinders=		3237.5
Total (g)			6883.1

FF11-2	All six UF_6 manifold connections (feed, product, and Uranium Byproduct Cylinders)

The UF_6 release for this case is twice the FF9 since it is 6 manifolds instead of 3

Total (g) = 2 * 6883.1 = 13766.2 g

Single Cylinder Releases

The Single Cylinder Releases are calculated for various areas. The total release of UF_6 includes 30 minutes, 2.5 minutes, and 10 seconds time period.

Single Cylinder Releases (See Note 1)
Run in Building with HVAC on for Controlled Case

Exposure Duration (min)	Release Duration (min)	Receptor	Uncontrolled /IROFS	Temperature (°C)	Pressure (mbar)	Release Rate (g/sec)	Release Volume (grams)	Case
Single Feed Cylinder Release in the UF_6 Feed Area						Ref. 1		SCR-1
30	30	Public	Uncontrolled		500	0.72	1296	
2.5	2.5	Worker	Uncontrolled		500	0.72	108	
0.17	0.17	Local W.	Uncontrolled		500	0.72	7.2	
Single Product or Tail Cylinder Release in the UF_6 Feed Area								SCR-2
30	30	Public	Uncontrolled	-25		0.002	3.6	
2.5	2.5	Worker	Uncontrolled	-25		0.002	0.3	
0.17	0.17	Local W.	Uncontrolled	-25		0.002	0.02	
Single Product Cold Trap or Feed Cold Trap in the UF_6 Feed Area 40mm vs. 20mm used in pouring. Scale up using Eq. 21 from Ref. 5 Pouring is proportional to ratio of W(H^3/2), W=H=40 mm								SCR-3
30	30	Public	Uncontrolled	-60		0.0001	1.02	
2.5	2.5	Worker	Uncontrolled	-60		0.0001	0.08	
0.17	0.17	Local W.	Uncontrolled	-60		0.0001	0.01	

Single Feed or Product Cold Trap in the UF_6 Feed Area in De-Gas Mode SCR-4
40mm vs. 20mm used in pouring. Scale up using Eq. 21 from Ref. 5
Pouring is proportional to ratio of W(H^3/2), W=H=40 mm

30	30	Public	Uncontrolled	20	0.065	662
2.5	2.5	Worker	Uncontrolled	20	0.065	55
0.17	0.17	Local W.	Uncontrolled	20	0.065	4

Single Uranium Byproduct Cylinders at 100 °F=37.8 °C SCR-5

30	30	Public	Uncontrolled	37.8	0.43	774
2.5	2.5	Worker	Uncontrolled	37.8	0.43	64.5
0.17	0.17	Local W.	Uncontrolled	37.8	0.43	4.3

Single Uranium Byproduct Cylinders at 86 °F=30 °C SCR-5_a

30	30	Public	Uncontrolled	30	0.234	421.2
2.5	2.5	Worker	Uncontrolled	30	0.234	35.1
0.17	0.17	Local W.	Uncontrolled	30	0.234	2.34

Single Uranium Byproduct Cylinder at 77 °F=25 °C — SCR-6

30	30	Public	Uncontrolled	25	0.144	259.2
2.5	2.5	Worker	Uncontrolled	25	0.144	21.6
0.17	0.17	Local W.	Uncontrolled	25	0.144	1.4

Pouring Cylinder at 86 °F=30 °C, 10 mm^2 (Reference 1) instead of 400 mm^2 — SCR-6_a
Pouring is proportional to ratio of W(H^3/2), and adj. for the area sqrt 400=20mm to sqrt 10= 3.16mm,W=H=3.16 mm

30	30	Public	Uncontrolled	30	0.234	4.18
2.5	2.5	Worker	Uncontrolled	30	0.234	0.35
0.17	0.17	Local W.	Uncontrolled	30	0.234	0.02

Pouring Cylinder at 77 °F=25 °C, 4.2 mm^2 (Reference 1) instead of 400 mm^2 — SCR-6_b
Pouring is proportional to ratio of W(H^3/2), and adjusting for the area sqrt 400=20 mm to sqrt 4.2=2.05mm

30	30	Public	Uncontrolled	25	0.144	0.87
2.5	2.5	Worker	Uncontrolled	25	0.144	0.07
0.17	0.17	Local W.	Uncontrolled	25	0.144	0.005

Single Product (Donor) in the Blending & Liquid Sampling Area — SCR-7

30	30	Public	Uncontrolled	500	0.72	1296
2.5	2.5	Worker	Uncontrolled	500	0.72	108
0.17	0.17	Local W.	Uncontrolled	500	0.72	7.2

Single Product (Receiver) in the Blending & Liquid Sampling Area SCR-8

30	30	Public	Uncontrolled	-25	0.002	3.6
2.5	2.5	Worker	Uncontrolled	-25	0.002	0.3
0.17	0.17	Local W.	Uncontrolled	-25	0.002	0.02

Single Donor Cold Trap in the Blending & Liquid Sampling Area at -60 °C SCR-9
40mm vs. 20mm used in pouring. Scale up using Eq. 21 from Reference 5
Pouring is proportional to ratio of W(H^3/2), W=H= 40 mm

30	30	Public	Uncontrolled	-60	0.0001	1.02
2.5	2.5	Worker	Uncontrolled	-60	0.0001	0.08
0.17	0.17	Local W.	Uncontrolled	-60	0.0001	0.01

Single Donor Cold Trap in the Blending & Liquid Sampling Area in De-Gas Mode at 20 °C SCR-10
40mm vs. 20mm used in pouring. Scale up using Eq. 21 from Reference 5
Pouring is proportional to ratio of W(H^3/2), W=H=40 mm

30	30	Public	Uncontrolled	20	0.065	662
2.5	2.5	Worker	Uncontrolled	20	0.065	55
0.17	0.17	Local W.	Uncontrolled	20	0.065	4

Single Cylinder in the Ventilated room (TSB) for maintenance at -50 C TSB-VR-4
40mm (Reference 7) vs 20mm used. Scale up using Eq. 21 from Reference 5,
release is proportional to ratio of W(H^3/2), W=H= 40 mm

30	30	Public	Uncontrolled	-50	p. 14 of	0.0001	1.0
2.5	2.5	Worker	Uncontrolled	-50	Ref. 6	0.0001	0.1
0.17	0.17	Local W.	Uncontrolled	-50		0.001	0.01

Single cylinder in the Blending & Liquid Sampling Area at 77 F=25 °C BS-1
3/8 inch (10mm) (p. 41 of Ref. 8 1S cylinder) vs 20mm used. Scale up using Eq. 21 from Ref. 5
release is proportional to ratio of W(H^3/2), W=H=10 mm

30	30	Public	Uncontrolled	25	0.144	45.8
2.5	2.5	Worker	Uncontrolled	25	0.144	3.8
0.17	0.17	Local W.	Uncontrolled	25	0.144	0.3

Single Cylinder in Receipt & Dispatch Building at 95 F=35 C CRDB-1
8.5 in (216mm) by 1 in (25.4mm), (p. 55 of Ref. 8 48Y cylinder) vs 20mm by 20mm. Scale up using Eq.
21 from Reference 5
1*4.25= 4.25 Sq in, Equal Length for square, D=(4.25)^0.5 = 2.062 in=52.36mm
adjust area for 52.36 mm instead of 20mm using Eq 21 from Reference 5
Release is proportional to ratio of W(H^3/2), W=H=52.36 mm

30	30	Public	Uncontrolled	35	0.36	7186
2.5	2.5	Worker	Uncontrolled	35	0.36	599
0.17	0.17	Local W.	Uncontrolled	35	0.36	40

Note (1): Ambient Pressure Effect On Release Rate

The release rates used in the present Attachment were based on Eq. 21 of Reference 5. The ambient pressure used in Eq. 21 of Reference 1 was 101.35 KPa (14.7 psia). Per Reference 14, The site elevation is in the order of 3420 ft. The elevation corresponds to about 13 psia or 89.62 KPa by interpolating the elevation versus pressure of Table E.4 in Reference 15.

As a result, a sensitivity study was performed based the ambient pressure of 89.63 KPa.

The release rate in Eq. 21 of Reference 5 is repeated here. For the entire definitions of the terms please refer to Reference 5.

$$M_{UF6} = \frac{2\,(MW_{UF6}\,P_{UF6})\,[(2g\,(\rho v - \rho a)/\rho v]^{0.5}}{3\,R\,T} \times \frac{W\,H^{1.5}}{K}$$

Where K is defined as:

$$K = \{1 + [(P_{atm} - P_{UF6})/P_{atm}]^{2/3}\,(\rho a/\rho v)^{1/3}\}^{3/2}$$

In the above equation P_{atm} is the ambient pressure, P_{UF6} is partial pressure of UF6 at Temperature T, and ρa and ρv are densities of air and UF6, respectively. Since P_{atm} is only used in K term, only the sensitivity effect of P_{atm} on K was performed. Two cases of P_{atm} =101.35 KPa (K1) and P_{atm}= 89.63 KPa (K2) were compared. The density of air and UF6 were kept constant. The partial pressure of UF6 was varied. It was assumed that temperature remains constant at 100 °F.

ρa = 1.136 Kg/m^3 (Table E.3 of Ref. 15) ρv = 3300 Kg/m^3 (Ref. 5)

PUF6	ρv	ρa	Patm=101.35KPa	K1	Patm=89.63KPa	K2	%change of K1 & K2
0	3300	1.136	1.01E+05	1.10724	8.96E+04	1.10724	0.00
5000	3300	1.136	1.01E+05	1.10361	8.96E+04	1.10315	0.04
10000	3300	1.136	1.01E+05	1.09993	8.96E+04	1.09898	0.09
15000	3300	1.136	1.01E+05	1.09618	8.96E+04	1.09474	0.13
20000	3300	1.136	1.01E+05	1.09237	8.96E+04	1.09040	0.18
25000	3300	1.136	1.01E+05	1.08847	8.96E+04	1.08596	0.23
30000	3300	1.136	1.01E+05	1.08450	8.96E+04	1.08141	0.29
35000	3300	1.136	1.01E+05	1.08044	8.96E+04	1.07674	0.34
40000	3300	1.136	1.01E+05	1.07628	8.96E+04	1.07194	0.40
45000	3300	1.136	1.01E+05	1.07201	8.96E+04	1.06697	0.47
50000	3300	1.136	1.01E+05	1.06761	8.96E+04	1.06182	0.54

As seen, the percentage difference of K1 and K2 is very small and negligible. Therefore, the effect of ambient pressure on UF6 release rate is insignificant.

7. Conclusion

The material at risk (UF_6 release) following a hypothetical accident is calculated at various locations in the proposed facility. A summary of these releases is tabulated in the table below.

These values will be used for U and HF exposures to the public and workers in the proposed plant.

Summary of UF_6 Releases

Release point	Material at Risk Duration 30 min UF_6 (gram)	Material at Risk Duration 2.5 min UF_6 (gram)	Material at Risk Duration 0.17 min UF_6 (gram)
UF_6 Handling Area 1&2	29,453	2,454	N/A
UF_6 Handling Area 3&4/5&6	58,905	4,909	N/A
Cascade Halls 1&2	[ ]*	[ ]*	N/A
Cascade Halls 3&4/5&6	[ ]*	[ ]*	N/A
Blending & Liquid Sampling Area	6,357	530	N/A
Centrifuge Test Facility	[ ]*	[ ]*	[ ]*

Cascade Hall Release (manifold connections)

FF9	6883.1 gram
FF11-2	13766.2 gram

** Trade Secret*

The Single Cylinder Releases are:

Summary of UF_6 (gram) Single Cylinder Releases

Case	30 minutes	2.5 minutes	0.17 minute
SCR-1	1296	108	7.2
SCR-2	3.6	0.3	0.02
SCR-3	1.02	0.08	0.01
SCR-4	662	55	4
SCR-5	774	64.5	4.3
SCR-5-a	421.2	35.1	2.34
SCR-6	259.2	21.6	1.4
SCR-6_a	4.18	0.35	0.02
SCR-6_b	0.87	0.07	0.005
SCR-7	1296	108	7.2
SCR-8	3.6	0.3	0.02
SCR-9	1.02	0.08	0.01
SCR-10	662	55	4
TSB-VR-4	1.0	0.1	0.01
BS-1	45.8	3.8	0.3
CRDB-1	7186	599	40

8. References:

1. Framatome-ANP Record Document, 32-2400505-00. Framatome ANP, "NEF UF_6 Release Estimates,", Revision 0.
2. Framatome-ANP Record Document, 38-2400142-00. Urenco, "Summary of UF_6 Pipe Volumes and UF_6 Hold up for USJV Separation Plant and Blending/Sampling System," Revision A, Calculation UPD/0200545A.
3. Framatome-ANP Record Document, 38-2400155-00. Urenco, "USJV – Confirmation of Chemicals of Concern Data,".
4. Framatome-ANP Record Document, 38-2400138-00. Urenco, Letter from P. Hale (Urenco) to D. Pepe (Framatome ANP) "LES-2 Application – Supporting Data", Rev. A, UPD/0300334A.
5. Framatome-ANP Record Document, 38-2400005-00. Urenco, "Estimation of UF_6 Release Rates Following the Accidental Opening to Atmosphere of a Vessel Containing Solid UF_6," Revision 0, Technical Report UPD/0002302A.
6. Framatome-ANP Record Document, 38-2400110-00. Urenco, "Ventilated Room," Revision C, Functional Specification and System Description UPD/0200513C.
7. Framatome-ANP Record Document, 02-2400112B-00. Urenco, "USVJ Plant, Piping and Instrument Diagram, Cylinder Pressure Test & Pump Out," Revision C, Drawing 1UC134799C.
8. American National Standards Institute, "Nuclear Materials - Uranium Hexafluoride - Packaging for Transport," American National Standard ANSI N14.1-2001.
9. Framatome-ANP Record Document, 02-2400046B-00. Urenco, "USVJ, Piping and Instrument Diagram, System 424, Product Low Temp. Take-Off Stations," Revision C, Job Number M000011, Drawing 1UC134720C.
10. Framatome-ANP Record Document, 02-2400048B-00. Urenco, "USVJ, Piping and Instrument Diagram, System 425, Project Vent System," Rev.C, #M000011, Drawing 1UC134721C.
11. Framatome-ANP Record Document, 02-2400054B-00. Urenco, "USVJ, Piping and Instrument Diagram, System 434, Tails Low Temp. Take-Off Stations," Revision B, Job Number M000011, Drawing 1UC134729B.
12. Framatome-ANP Record Document, 38-2400037-00. Urenco, "Feed & Feed Purification System (410)," Revision C, System Description UPD/0200482C.
13. Framatome-ANP Record Document, 38-2400073-00. Urenco, "Blending & Blending Vent System (460)," Revision C, System Description UPD/0201893C.
14. Framatome-ANP Record Document, 02-5034505D-03. Lockwood Greene, "NEF, Site Plan (with contours)," Revision 3.
15. "Heat, Mass, and Momentum Transfer" by W.M. Rohsenow and H.Y. Choi, Prentice-Hall.