Fission Product Gas Monitoring During Fuel Drying Operations

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Fort Calhoun Nuclear Station

Groundbreaking: February 9, 1968

Initial Criticality: August 5, 1973

Plant was permanently shutdown on August 24, 2016

Final dry fuel storage campaign started October, 2019

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Project Origination

NRC Information Notice 18-01, “Noble Fission Gas Releases During Spent Fuel Cask Loading Operations” (Feb. 2018)

- FCS planned on using the same fuel storage system as described in the Information Notice. 30 casks planned – most with fuel susceptible to noble gas emission issues.
- Discussed issue with peers and vendor technical experts at a conference. A likely solution was identified.

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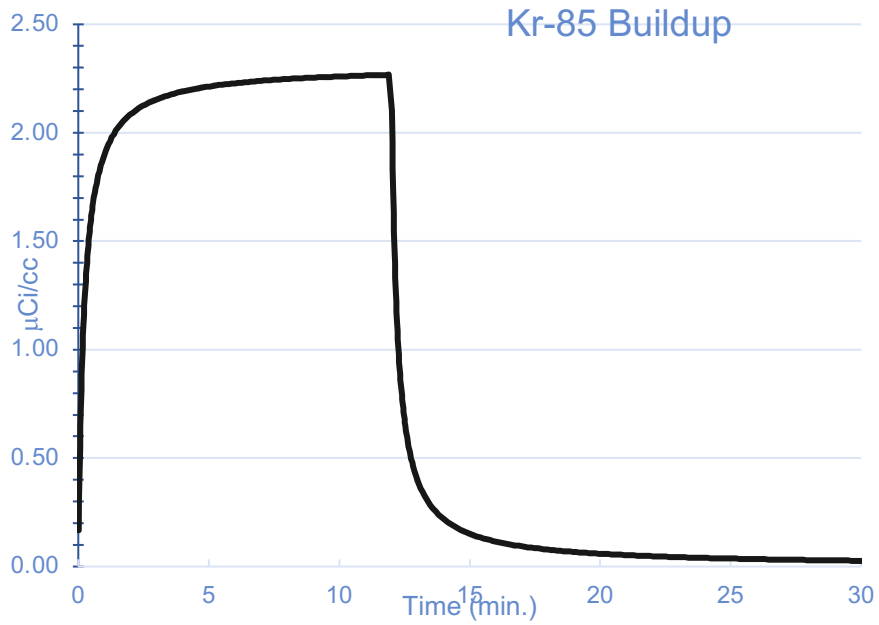
Possible Noble Gas Emission

Based on the known characteristics of the FCS spent fuel, a limiting case calculation was performed.

This calculation determined that the maximum dose to an off-site individual (the site boundary approx. 400 meters from the emission point) was well under 1 mrem.

IN 18-01 indicated that releases as great as 4 to 5 Ci over a 12-minute period were possible.



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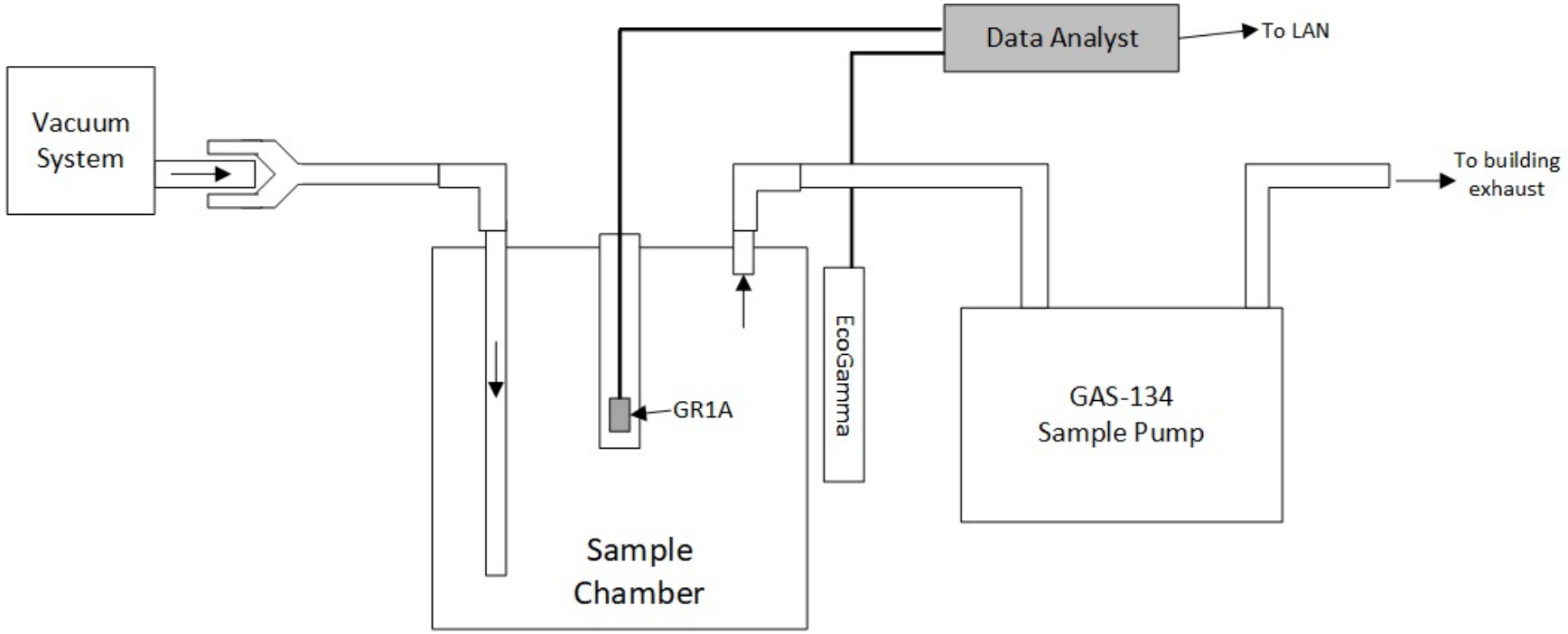
The Solution



Working with Mirion/Canberra staff, it was determined that a real-time spectroscopy system was the reasonable solution.

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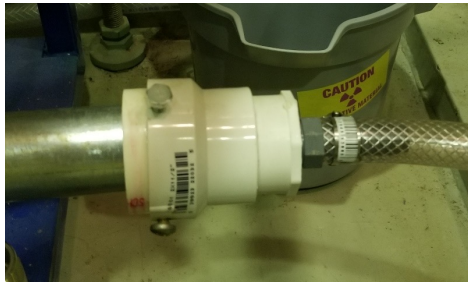
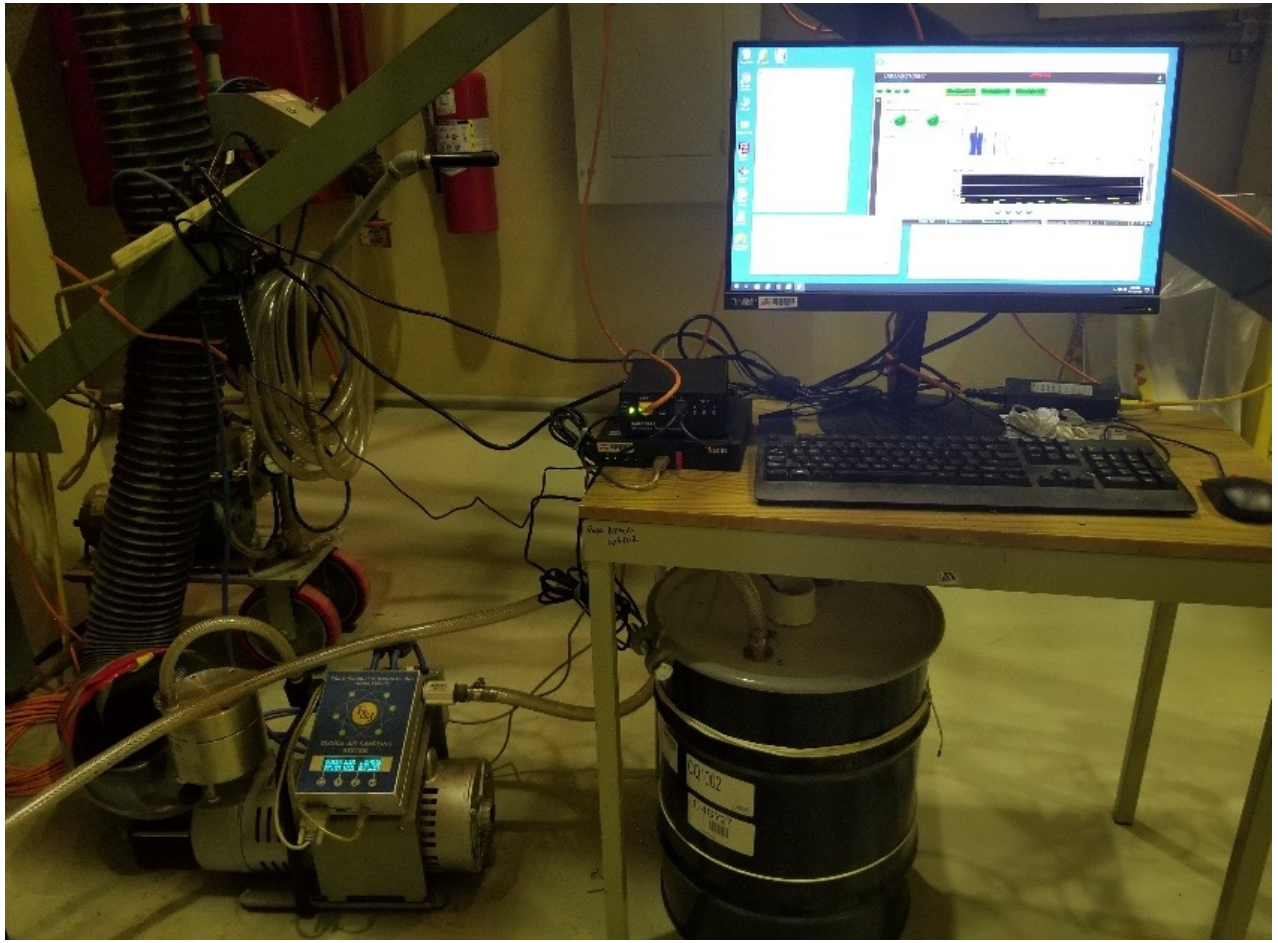
The Solution





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The Solution

Initially, the system was set to perform 1 min., 10 min., and 60 min. analysis cycles. After a few casks, it became apparent that a 10 minute spectrum integration time was optimal for the emissions measured.

The Data Analyst software was modified to accept sample flow rate, sample chamber volume, sample pressure, and sample temperature.

The resulting data in μCi/hour allowed easy determination of emission timing and magnitude.

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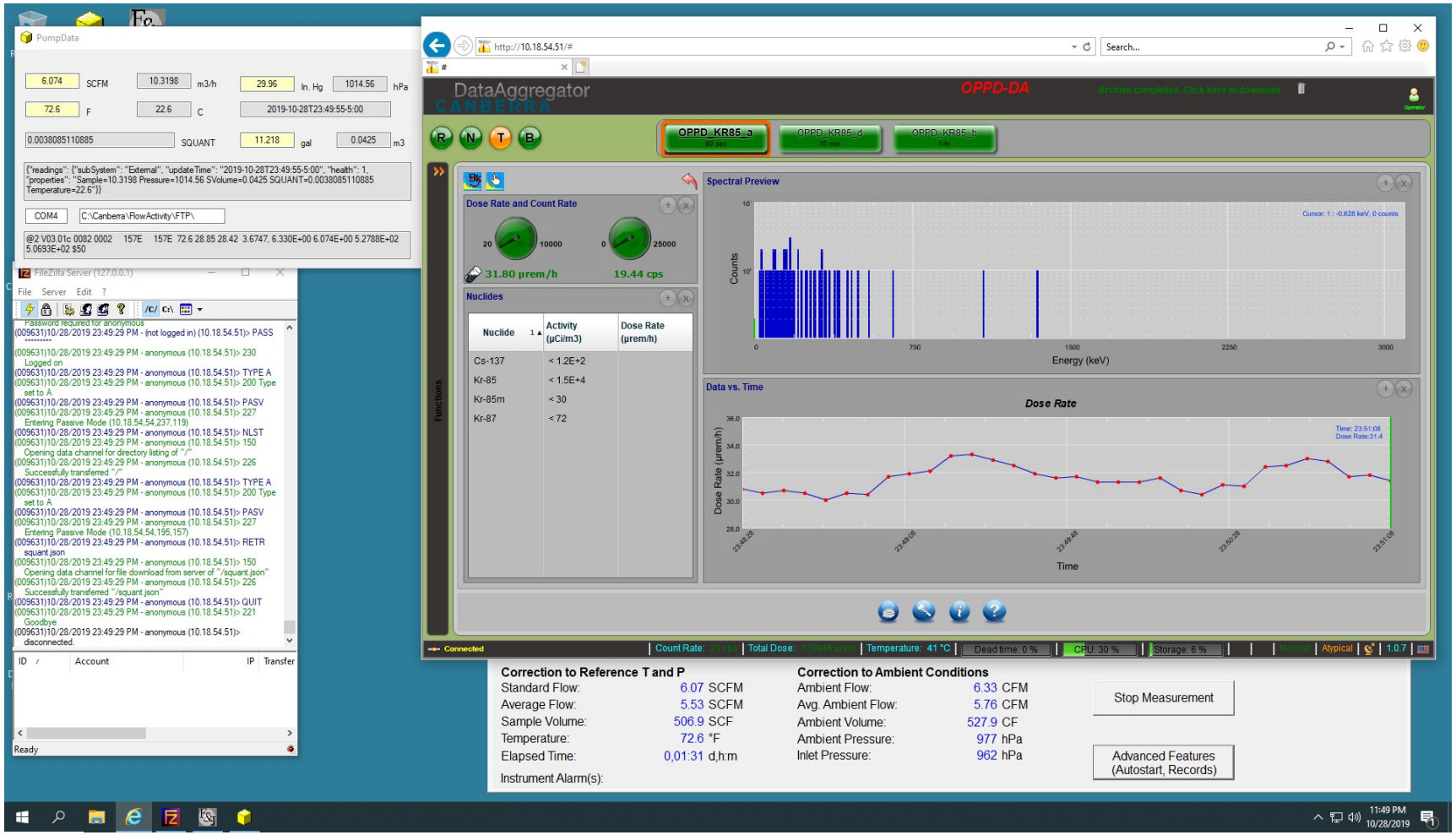
The Solution



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Early Issues Identified

- The vapor exhausting the vacuum drying machine was hotter than anticipated. This resulted in the failure of the first sample chamber. The chamber was replaced with a steel drum.

- The elevated temperature had the effect of introducing a significant false peak a the low end of the spectrum. Moving the detector and introducing cooling air flow mitigated this issue.

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Other Issues Identified

- There is another phase of the fuel drying process where a measurable Kr-85 emission occurs.

  Prior to vacuum drying, the bulk of the water is removed from the cask via a blowdown using pressurized Helium.

  It was noticed that there was a short spike in stack noble gas count rate shortly after the blowdown commenced. Samples identified the presence of Kr-85.

Other Issues Identified

- There appears to be some correlation between the levels (and duration) of Kr-85 emission and the amount of time it takes to complete the vacuum drying process.

Results

DSC	Noble Gas Emission	DSC	Noble Gas Emission	DSC	Noble Gas Emission
11	None identified	21	906 MBq (24.5 mCi)	31	210 MBq (5.7 mCi)
12	None identified	22	5,392 MBq (145.7 mCi)	32	30,735 MBq (830.1 mCi)
13	32 MBq (0.88 mCi)	23	3,127 MBq (84.5 mCi)	33	3,181 MBq (86.0 mCi)
14	None identified	24	9,041 MBq (244.4 mCi)	34	830 MBq (22.4 mCi)
15	12,110 MBq (327.3 mCi)	25	18,568 MBq (501.8 mCi)	35	3,809 MBq (102.9 mCi)
16	3,703 MBq (100.1 mCi)	26	4,882 MBq (131.9 mCi)	36	6,023 MBq (162.8 mCi)
17	10,845 MBq (293.1 mCi)	27	171 MBq (4.6 mCi)	37	2,3608 MBq (638.0 mCi)
18	6,692 MBq (180.9 mCi)	28	569 MBq (15.4 mCi)	38	296 MBq (8.0 mCi)
19	4,725 MBq (127.7 mCi)	29	4,784 MBq (129.3 mCi)	39	66 MBq (1.8 mCi)
20	5350 MBq (144.6 mCi)	30	13,471 MBq (364.1 mCi)	40	116 MBq (3.1 mCi)

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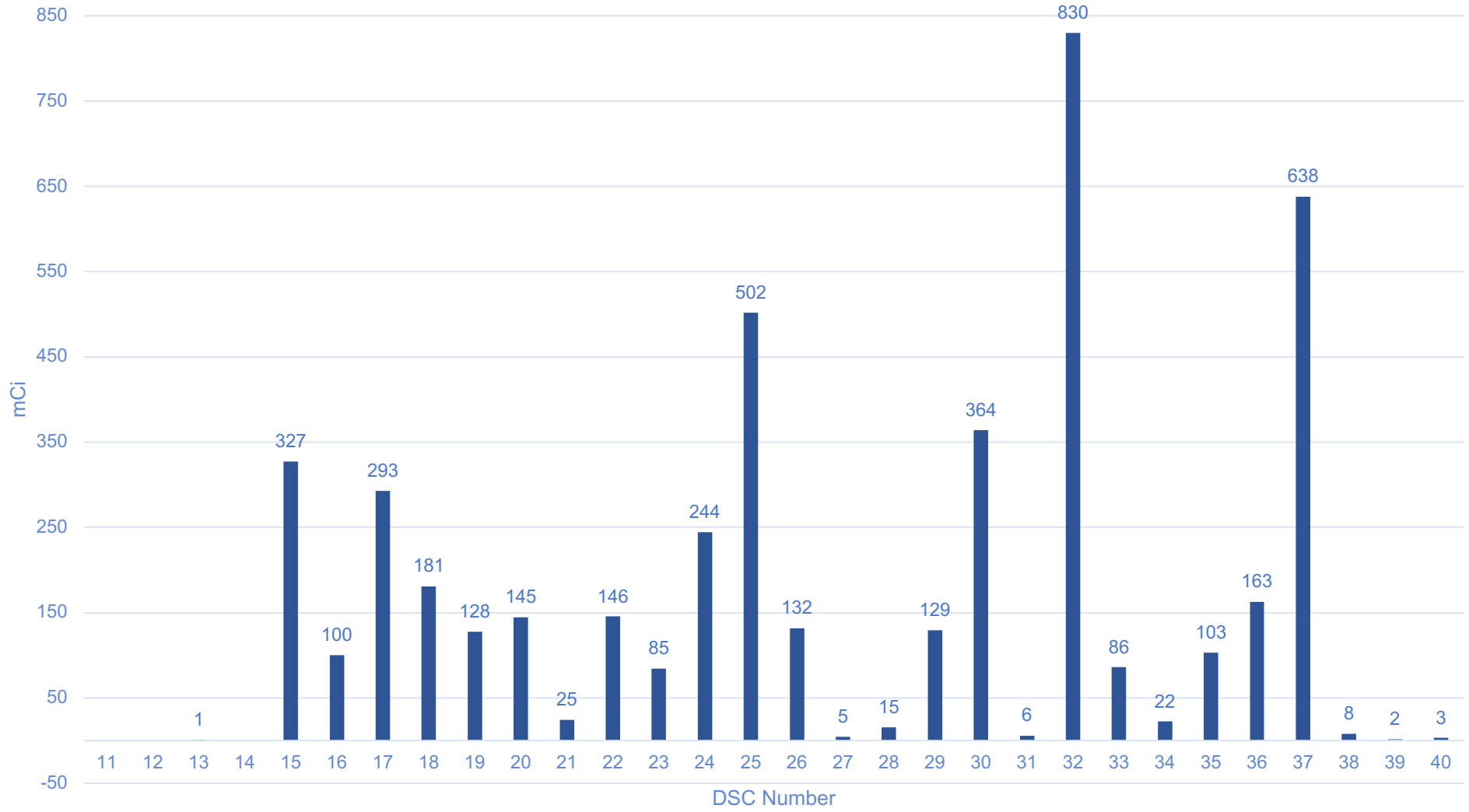
Results



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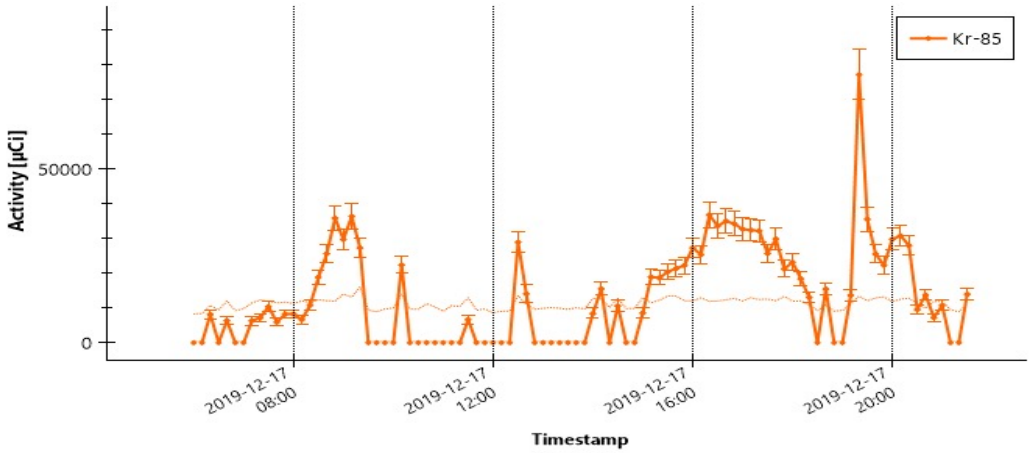
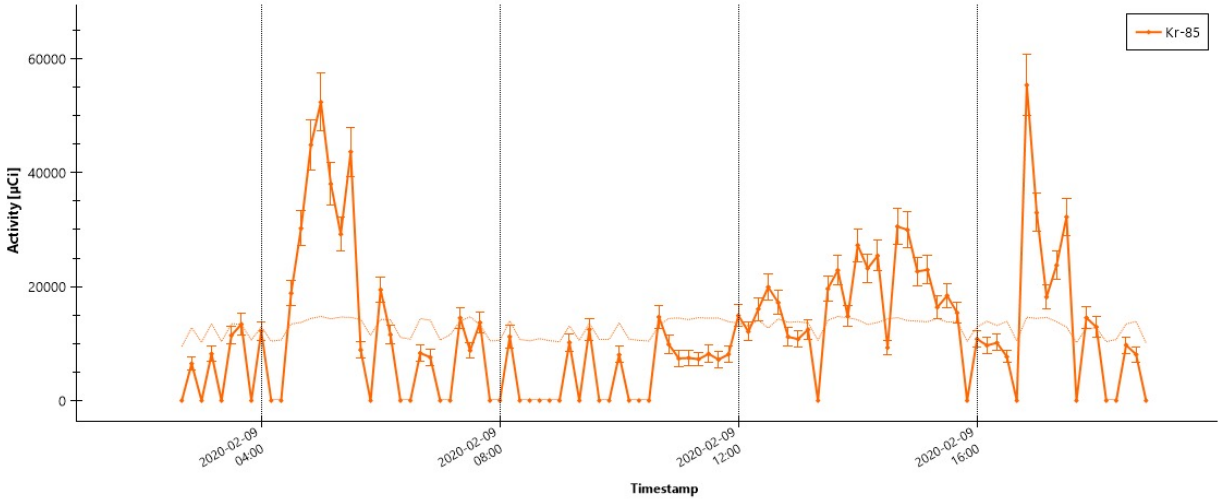
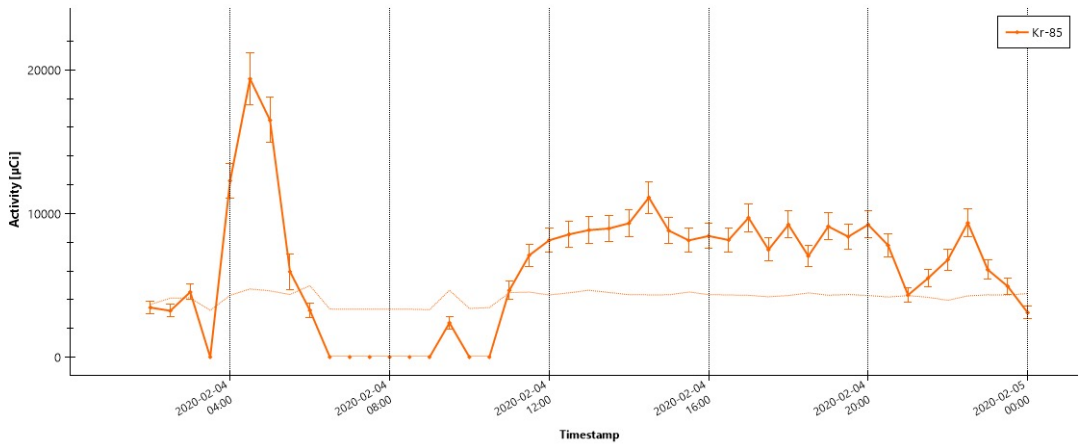
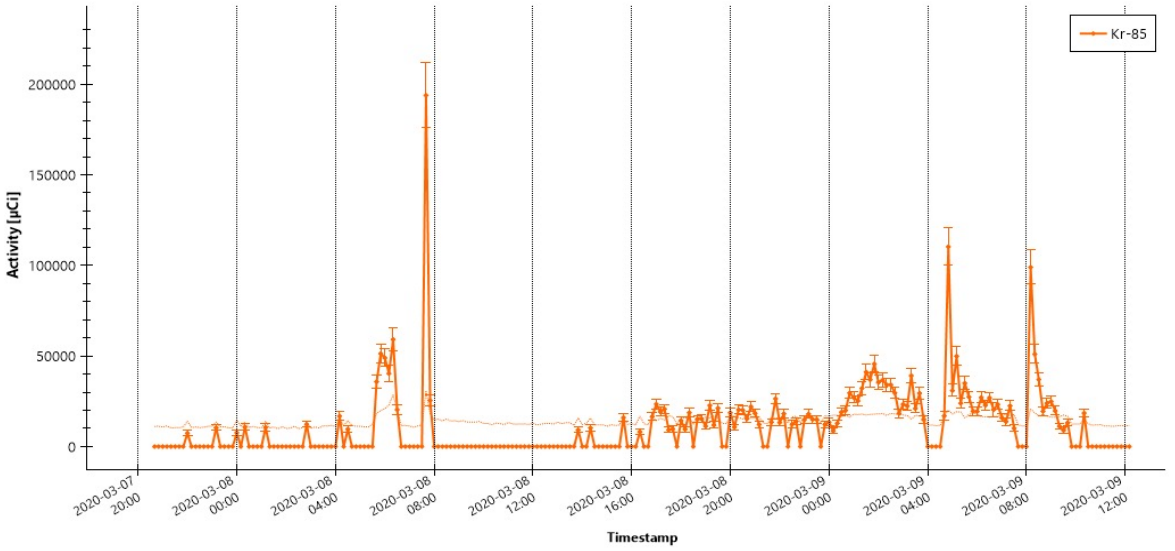
Results









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Questions?

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