Lessons Learned from Recent Startup

RefComm Rotterdam 2019

Autor: David Williams | 02.10.2019

Agenda

- Who we are?
- Where we are?
- Radiological Issues
  - Mounting Recommendations
  - Locations
- Operational Issues

Berthold Introduction

BERTHOLD

… and where we came from

70 Years of Experience


1949
Prof. Dr. Rudolf Berthold founded the company „Laboratorium Prof. Dr. Rudolf Berthold"

1950
Development of the first industrial process measurement based on γ-Transmission (Level Switch - BASF)

1955
First density systems supplied

1959
Use of Rod shaped sources for highly accurate level measurements

1960

Dr. Fritz Berthold

1973
High-sensitive scintillators replaced Geiger-Müller technology

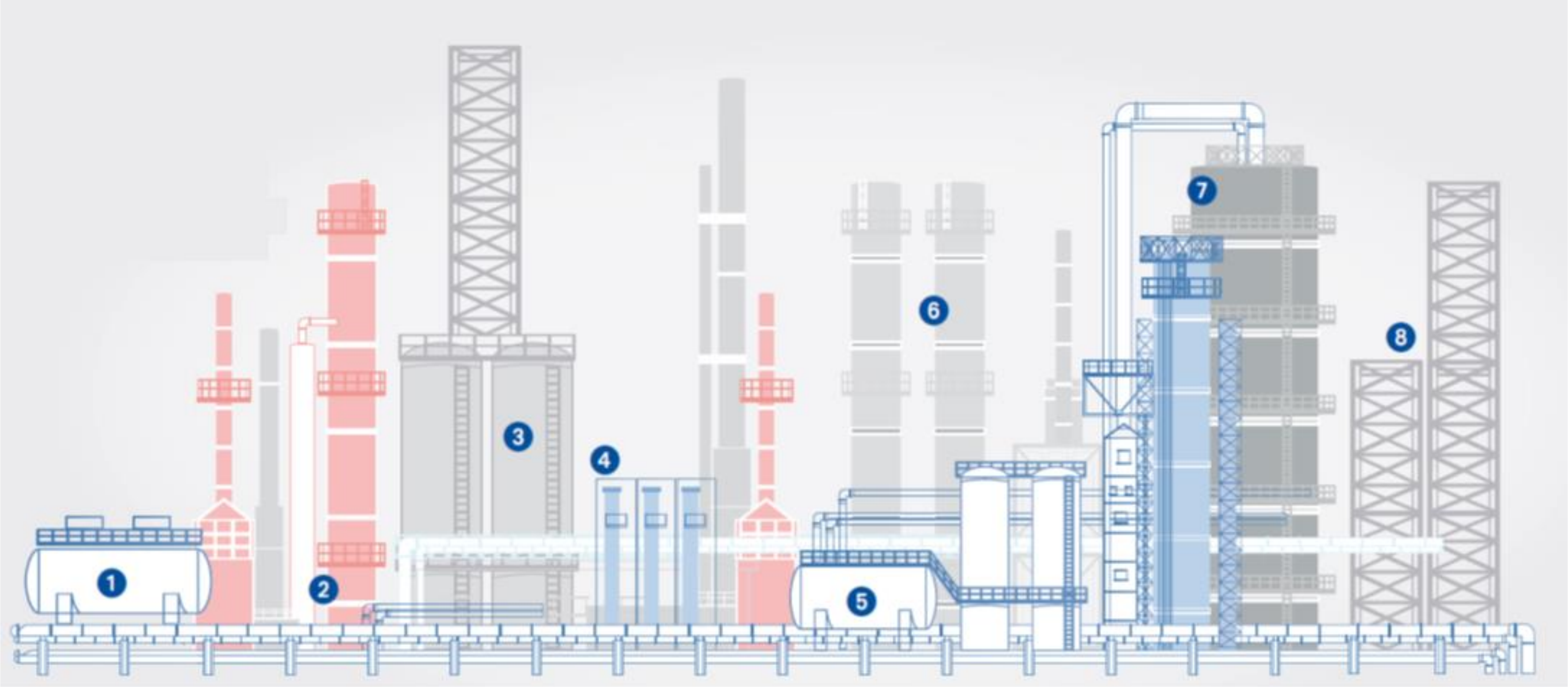
1989
Acquisition by EG&G

Re-privatization
renamed
Berthold Technologies

2003
SuperSENS most sensitive detector

2014
SIL2/3 certified detectors

Refinery Applications



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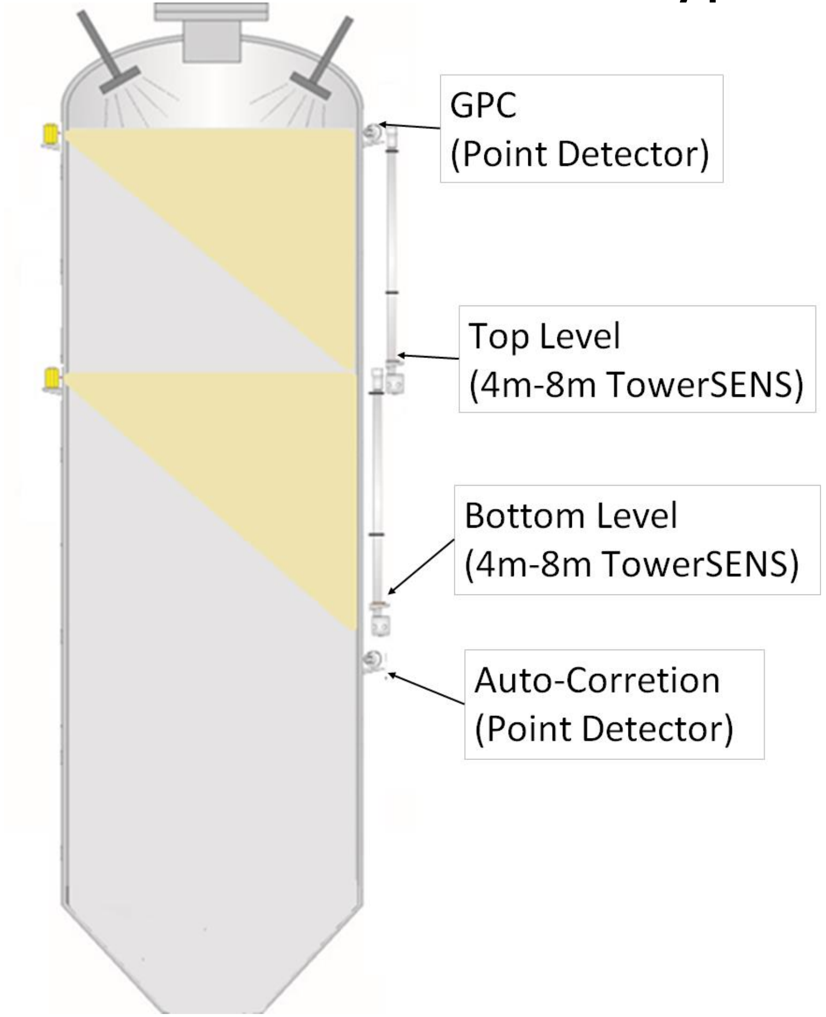
Where we are in Delayed Coking?

Coke Drum Levels

The Berthold Solution - Typical Arrangement

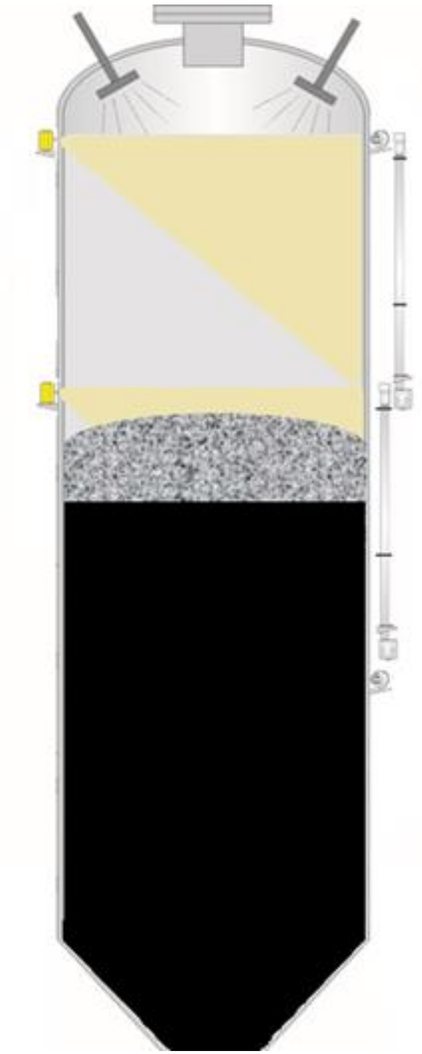


- Continuous Level measurement
  - 8m – 30m/26 – 98 ft
  - TowerSENS detector, 8m / 26 ft
  - Usually 2 or 3 fan beam point sources
- Gas Property Compensation
  - Located at or slightly above 100 % of cont. Level span is recommended
- 1 or 2 further point within the continuous level span (optional)
- Auto-SENS and Outage available

Important Aspects

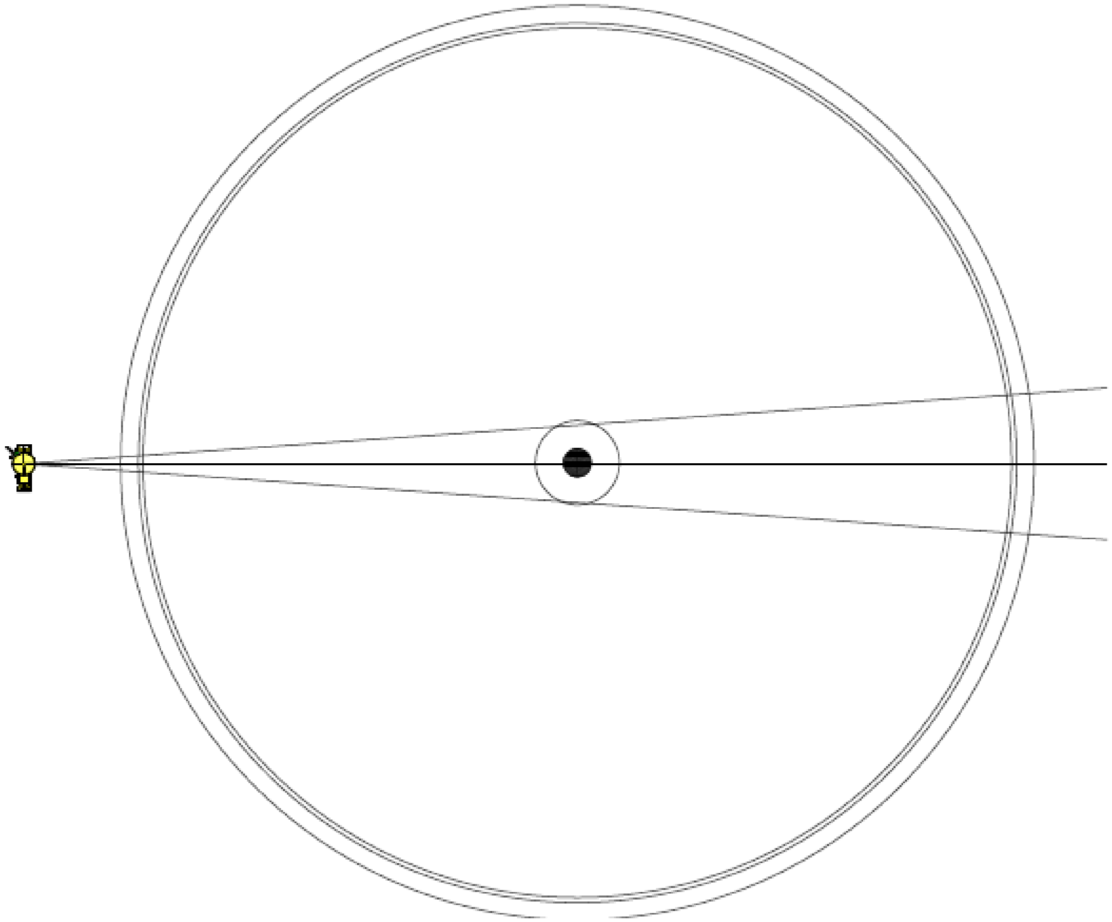
TowerSENS – One detector does it all

- Patented temperature and aging compensation
  - Gain Control
- No recalibration needed
- XIP (X-Ray Interference Protection)
- Scintillators:
  - Solid scintillation crystals
  - Diameter of 2“ / 50 mm
- 2“ Photomultiplier
  - About 10 times higher count rate



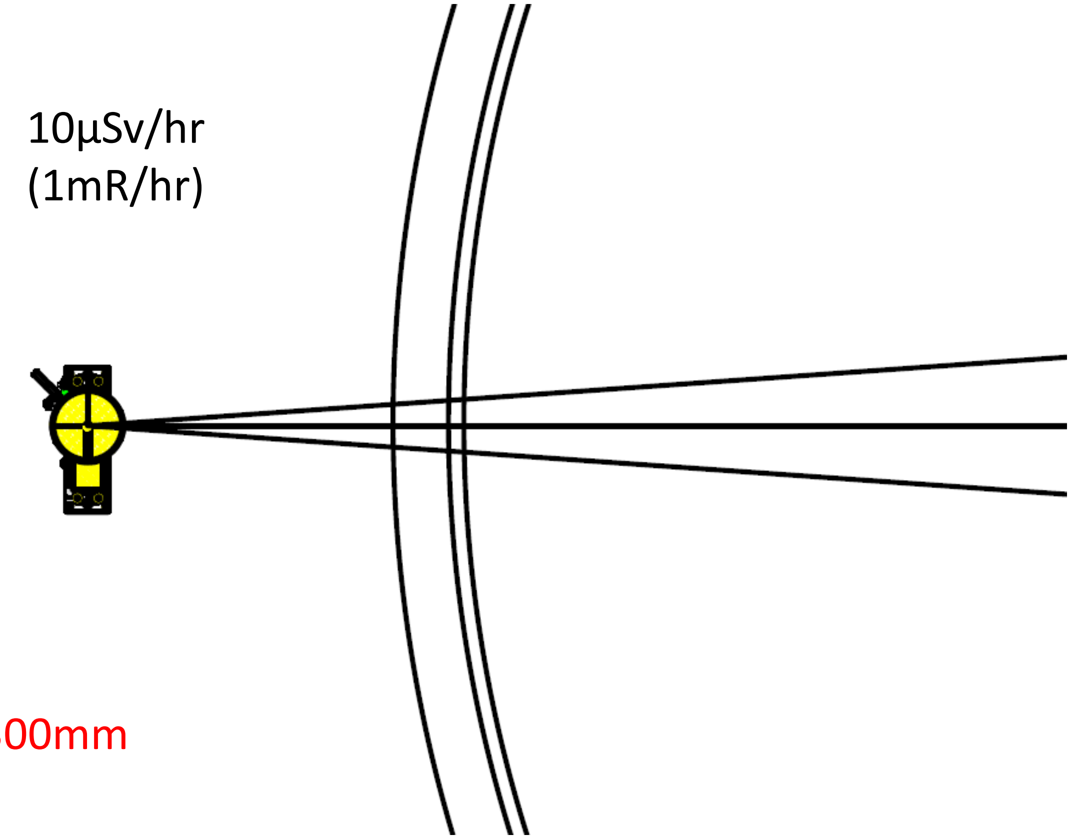
Installation Example

Radiological Issue



Radiological Issue

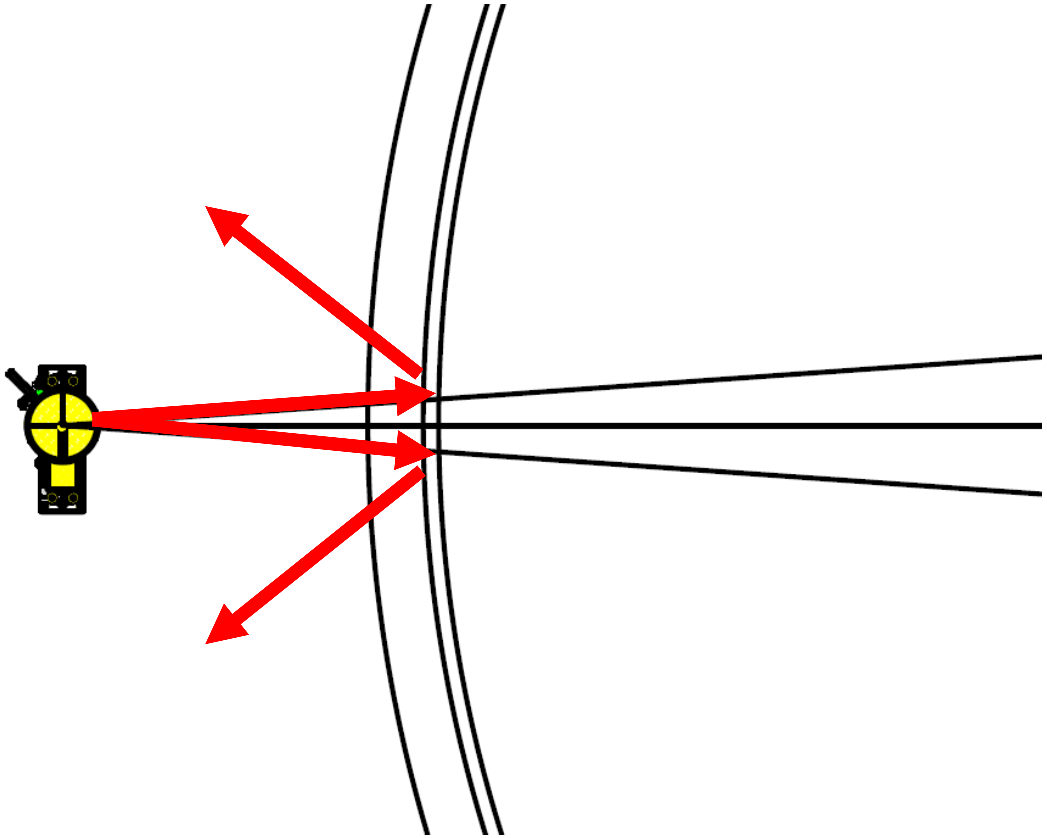
High Radiation Fields



Limit is 3µSv/hr (0.3mR/hr) @ 300mm

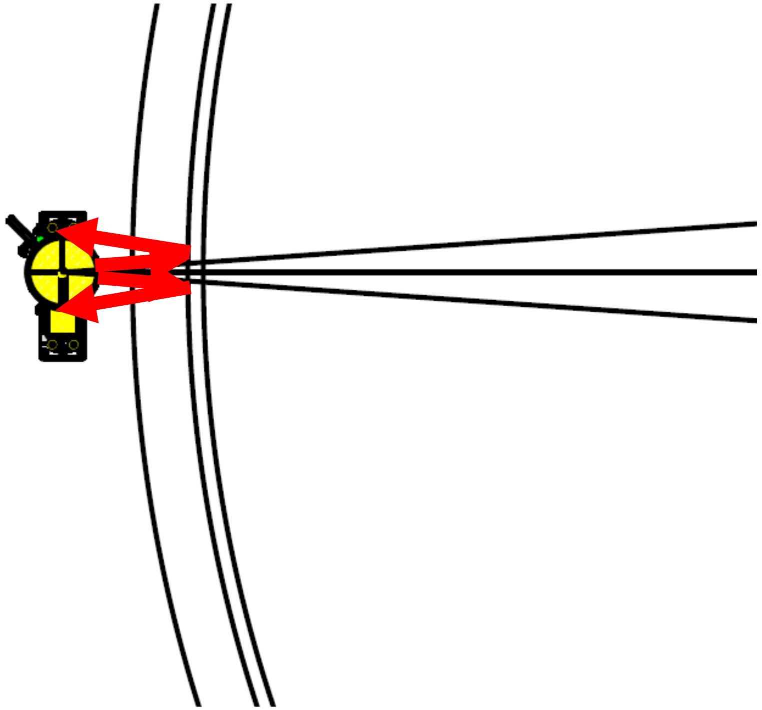
Radiological Issue

Why?



Radiological Issue

Solution!



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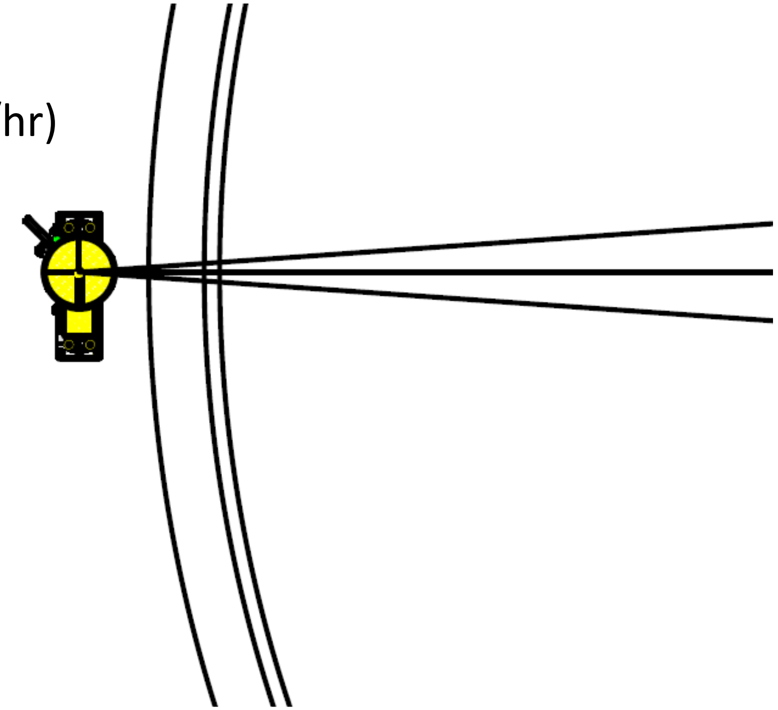
Radiological Issue

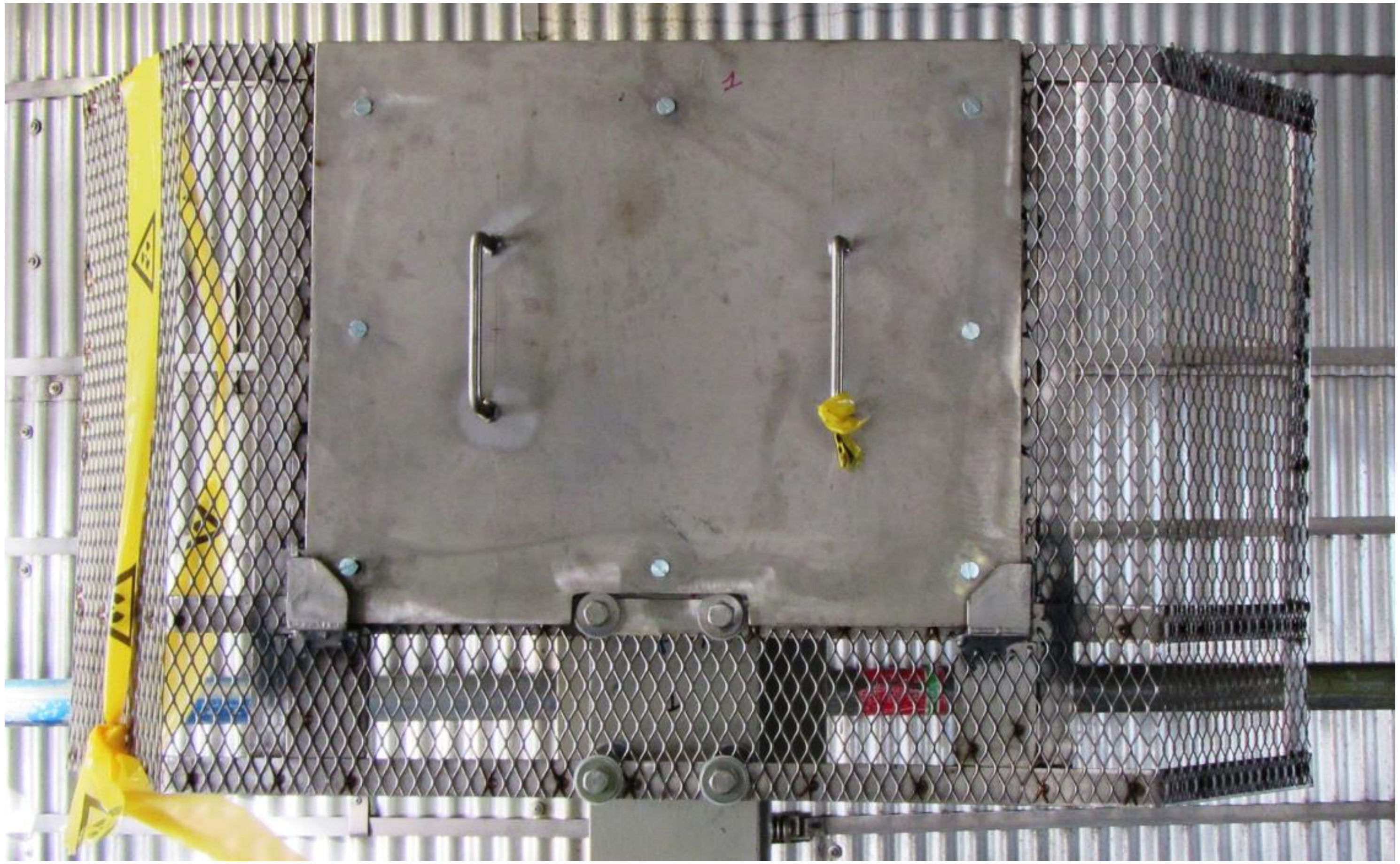
Results

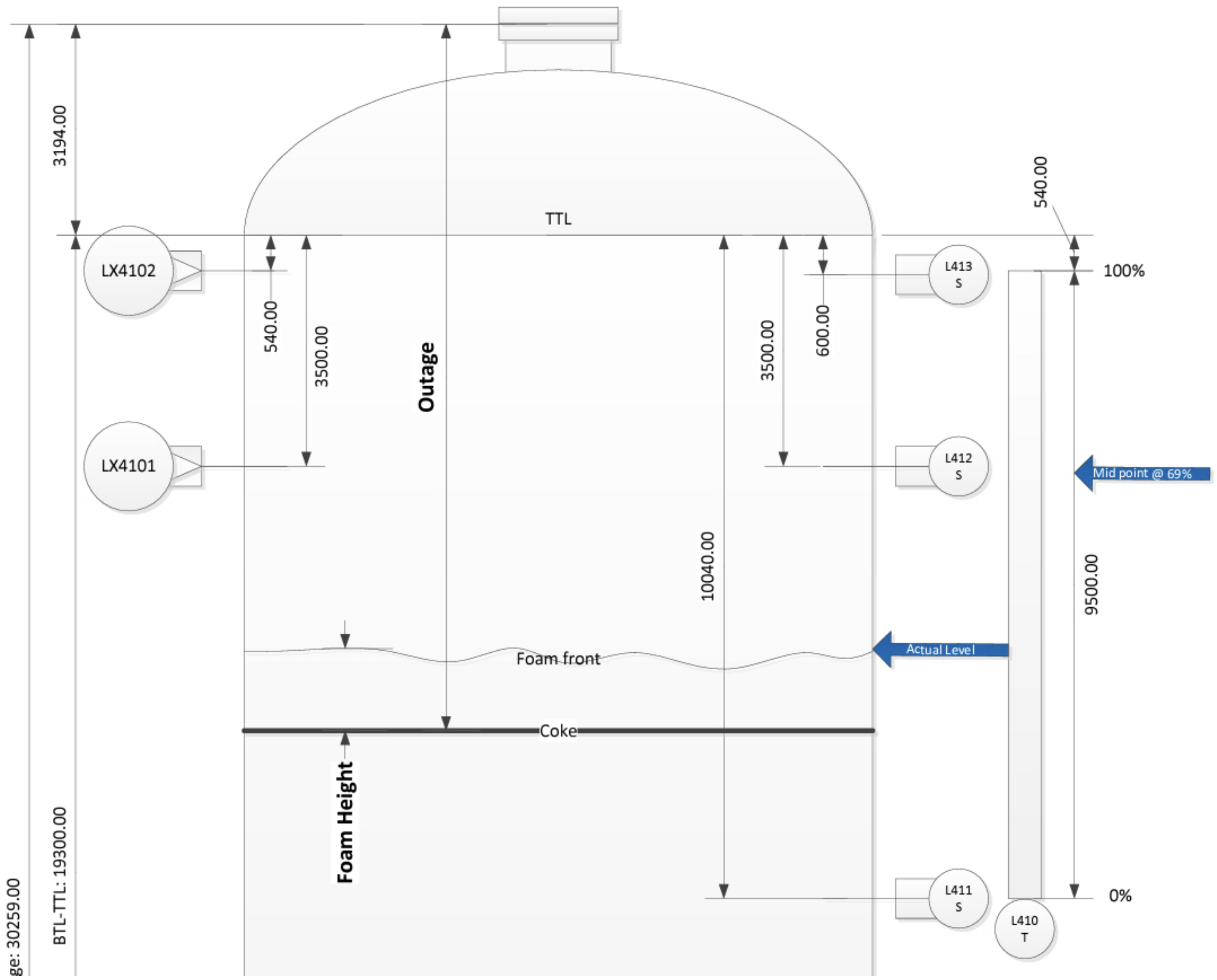
3µSv/hr
(0.3mR/hr)



Radiological Issue

Added protection




3194.00
TTL
540.00
LX4102
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3500.00
Outage
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S
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L412
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Mid point @ 69%
10040.00
9500.00
Foam front
Actual Level
Coke
Foam Height
L411
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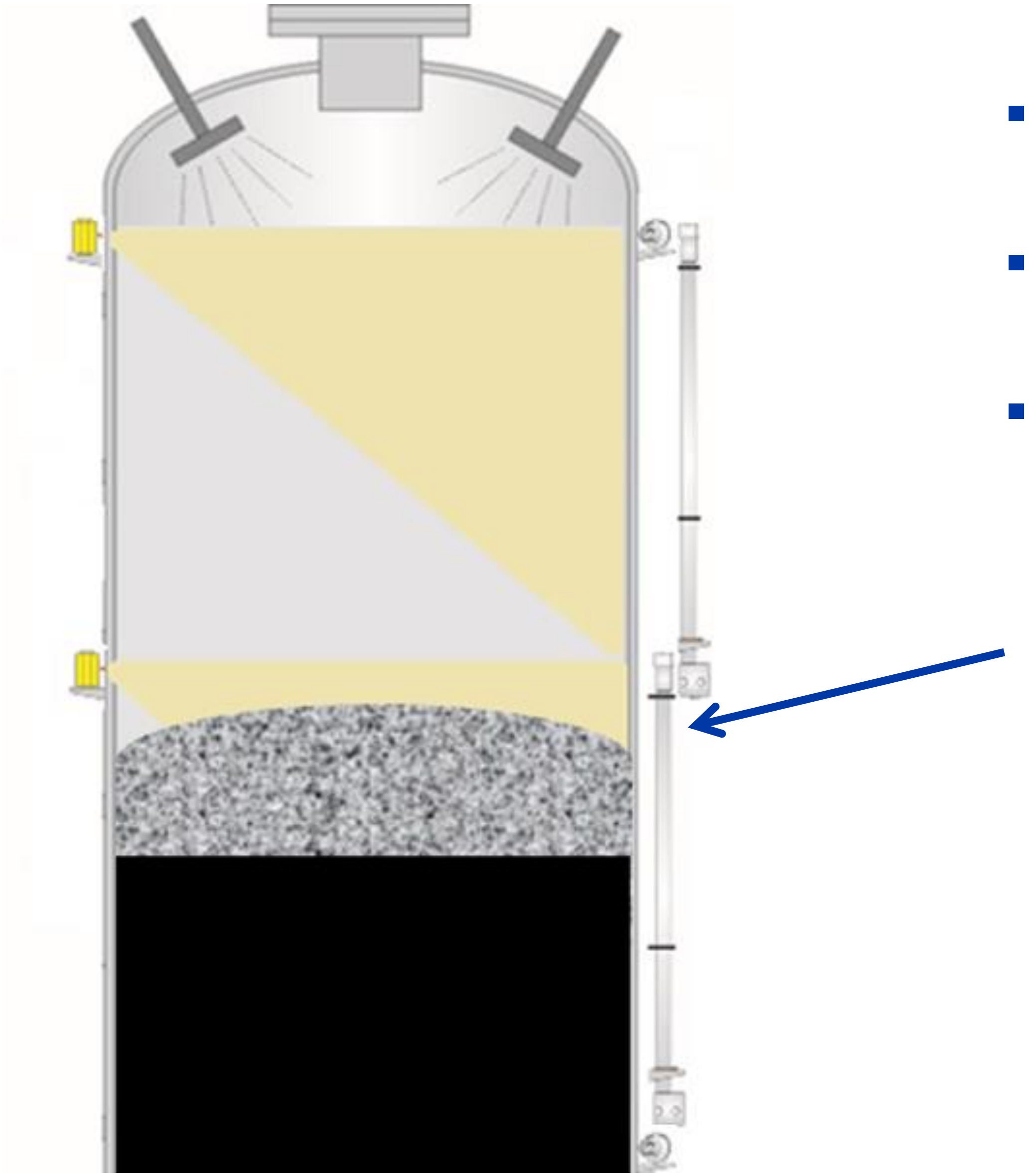
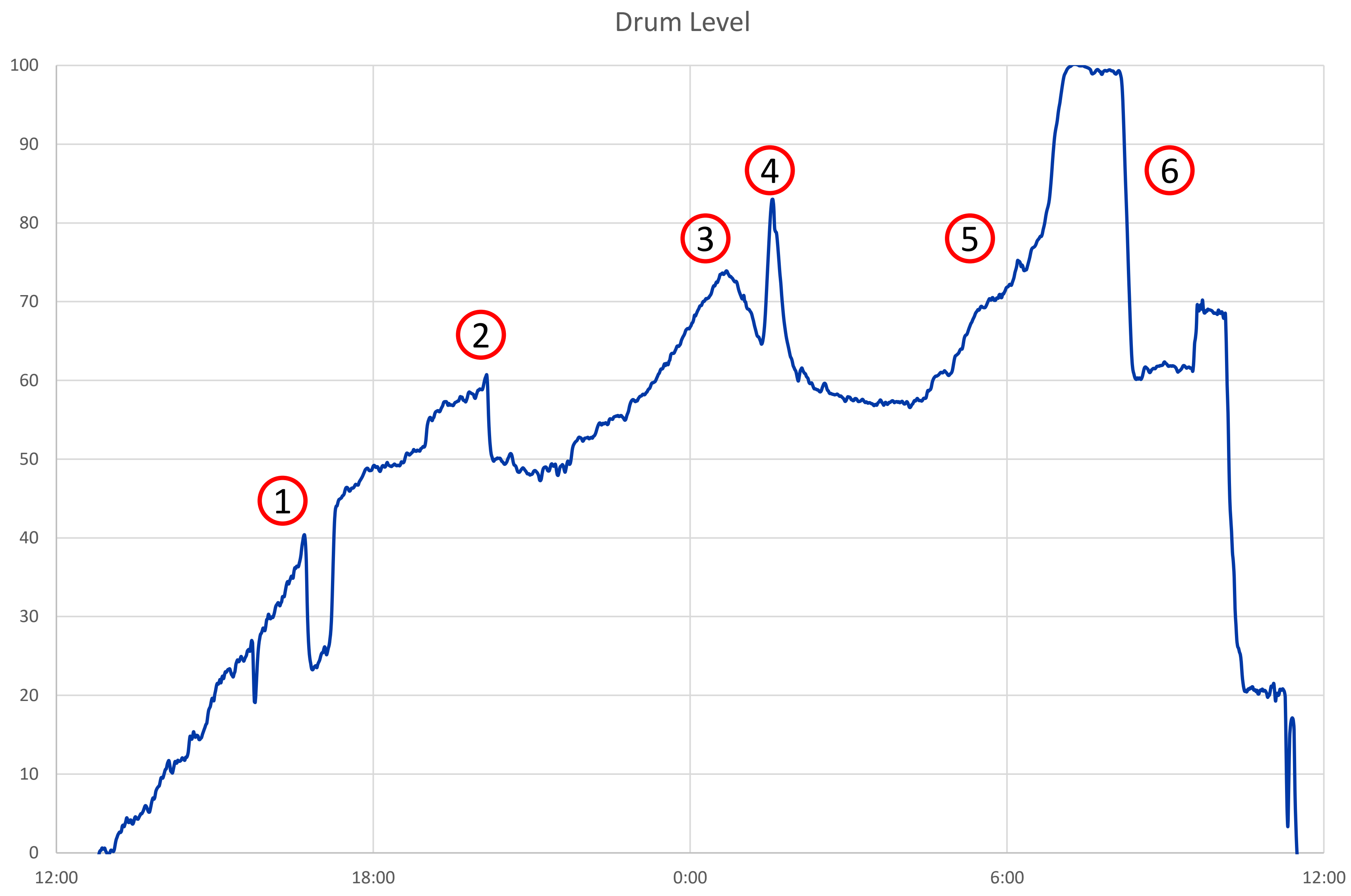
0%
ge: 30259.00
BTL-TTL: 19300.00



- Radiation over the length of the detector
- Detector average the strength of radiation over the entire length
- No spacial Resolution


Drum Level
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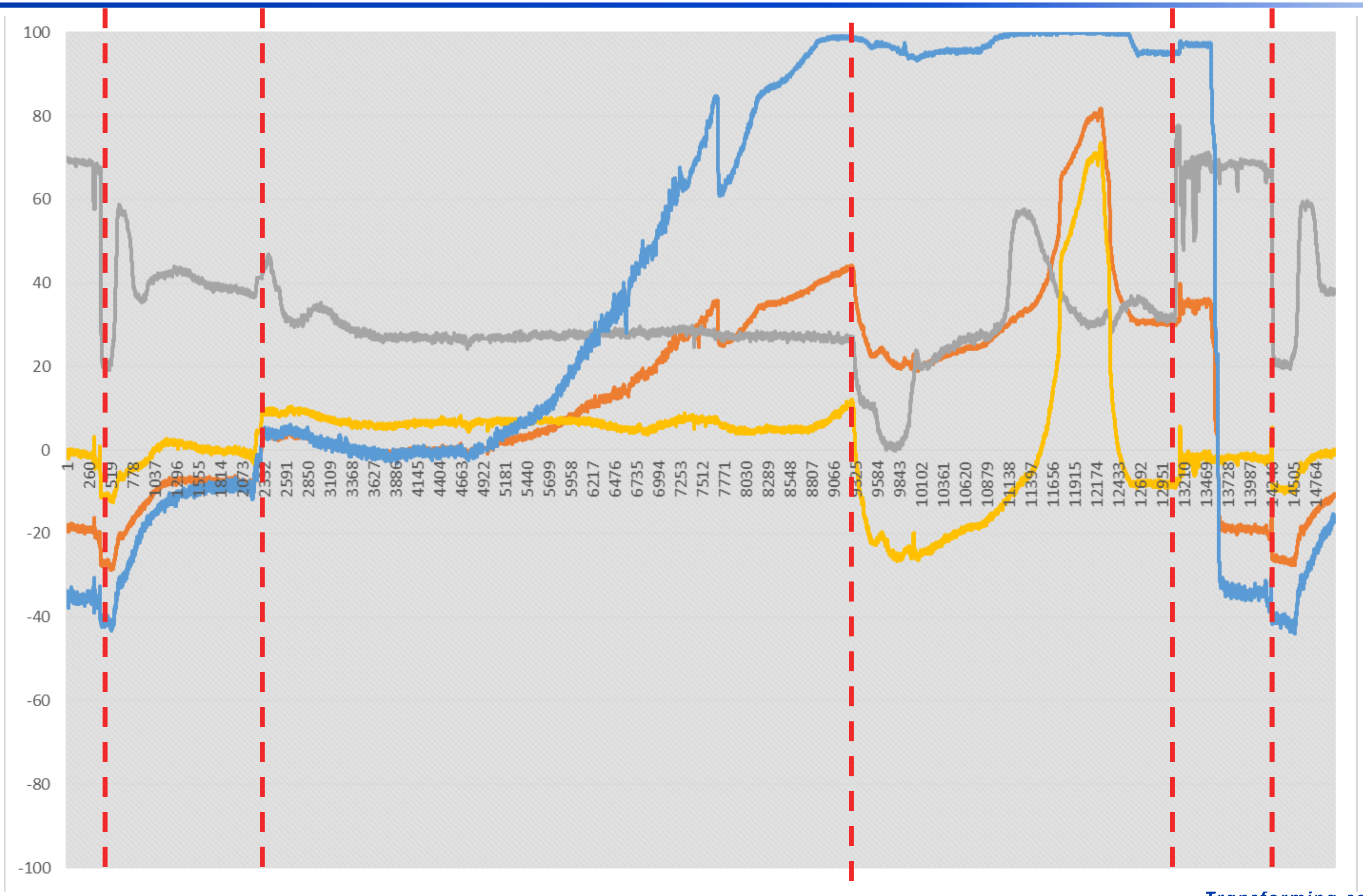
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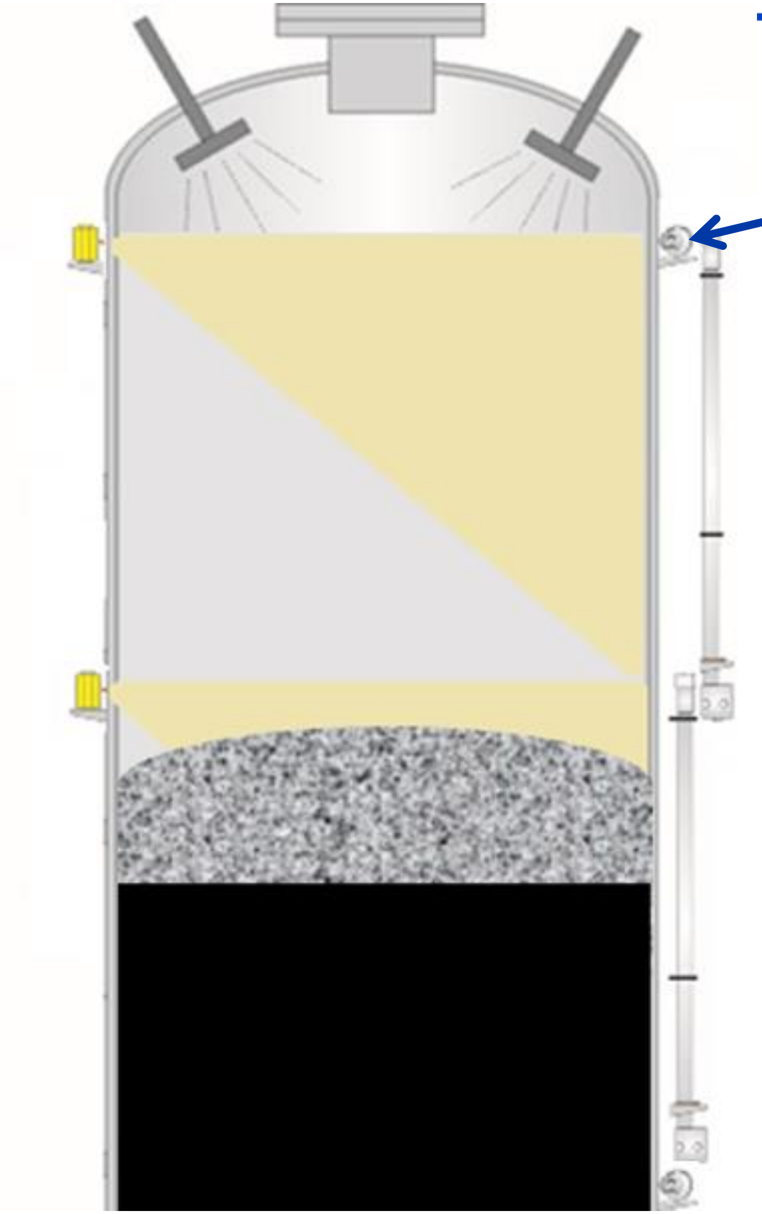

- Top Point Detector
  - Located as high as possible
  - Uses
    - Gas Property Compensation
    - High Level to shut off water
    - Monitor for Particulate Matter Carryove
    - Monitor Coke build up for dome clean outs

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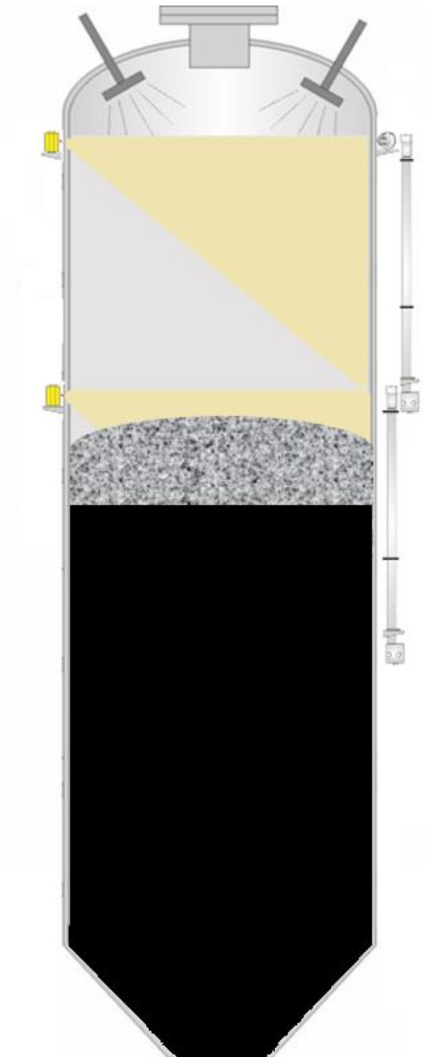
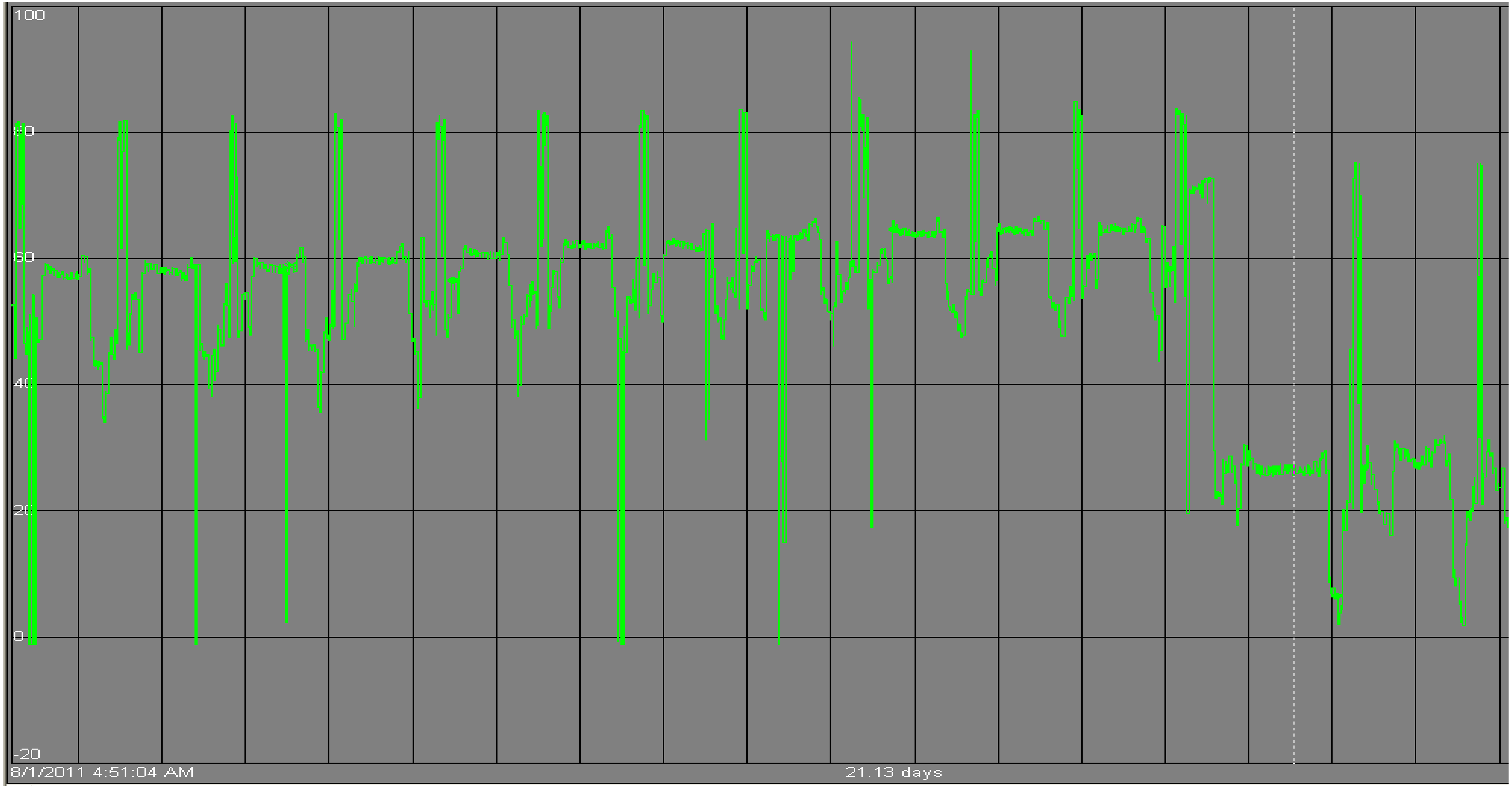
Gas Properties Compensation „GPC“

Compensate the gas density changes

- Gas properties change during the process
- High gas pressure/density results in more absorption
- Without, level will lower than actual after switching
- The solution:
  - Measuring the gas phase by using the high level switch
  - Input gas phase to the level detector
  - Correction takes place in the level detector
  - Level is recalculated according to gas conditions during measurement

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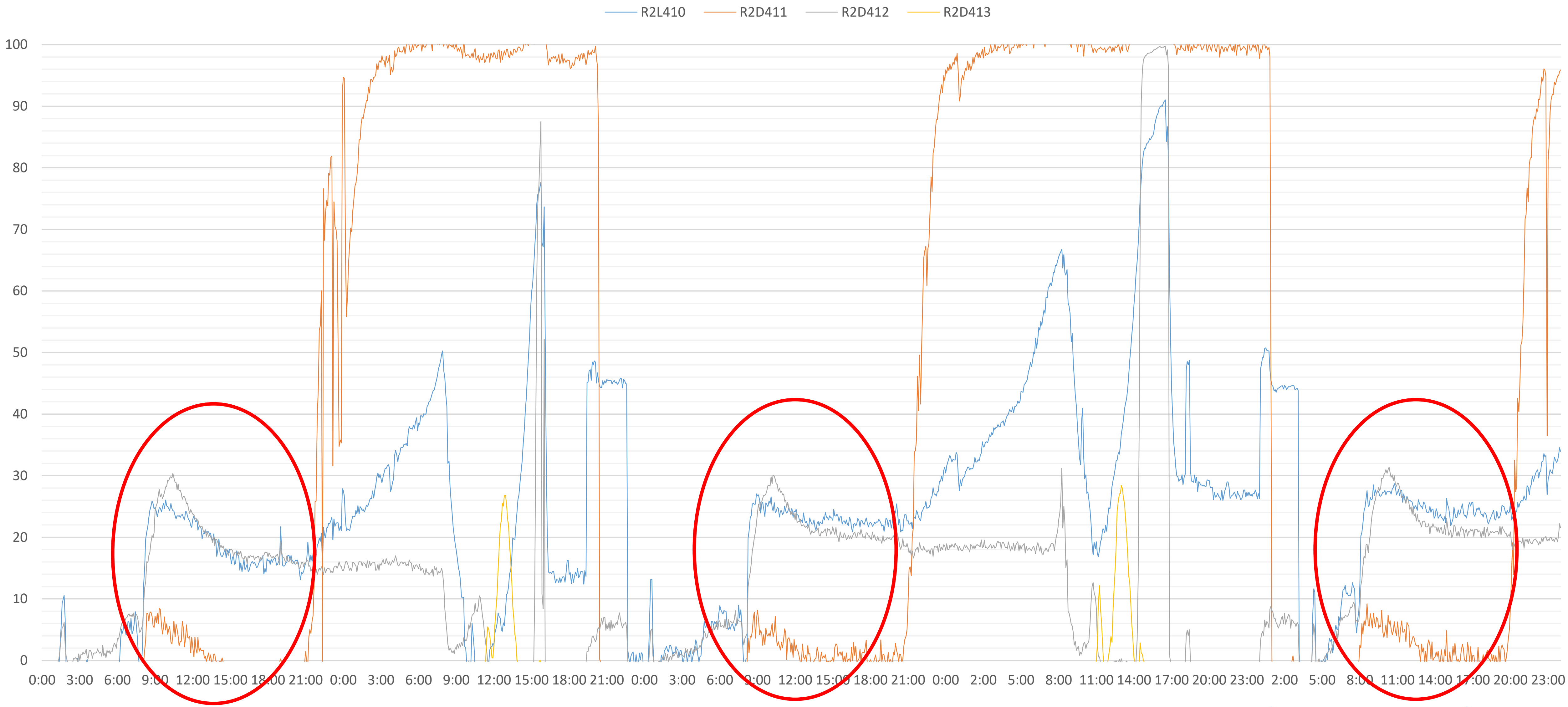
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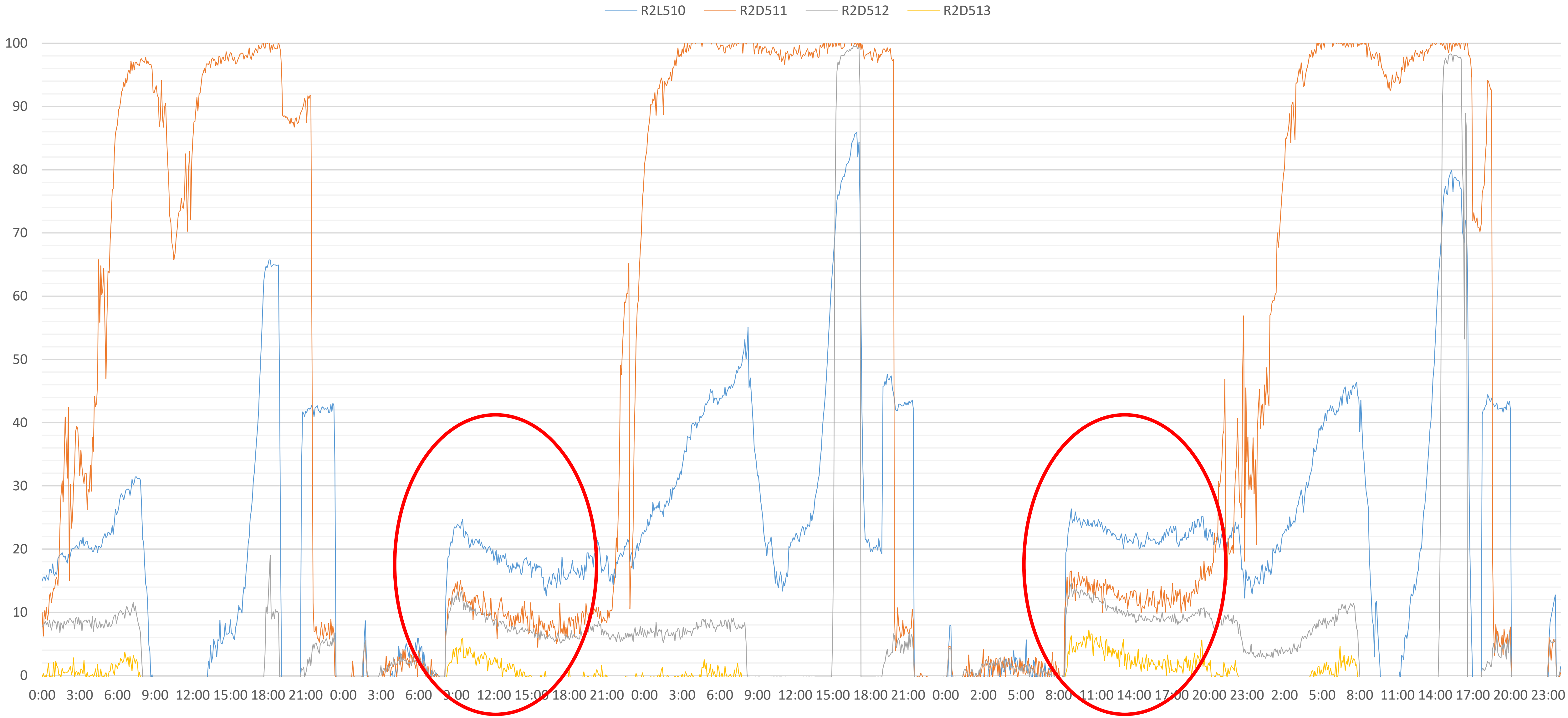
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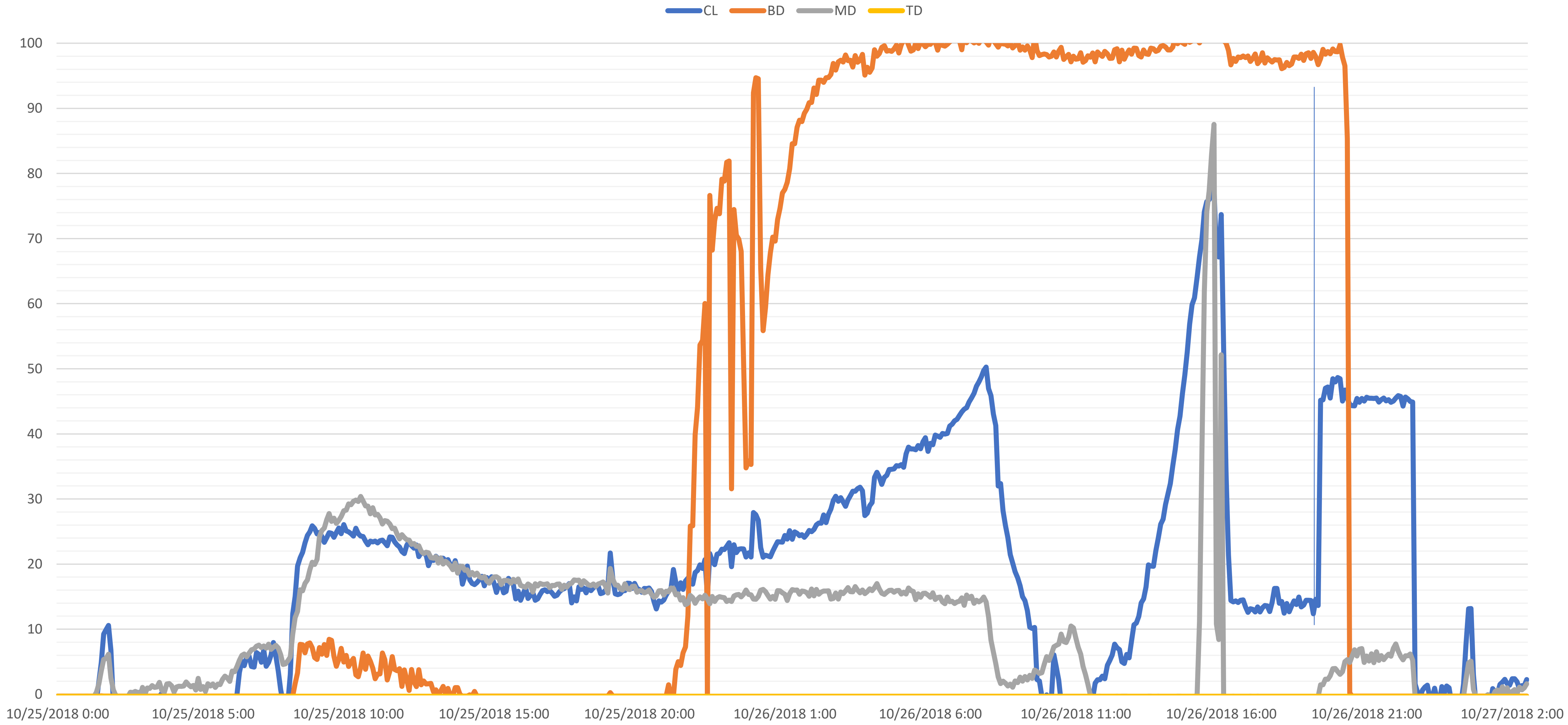

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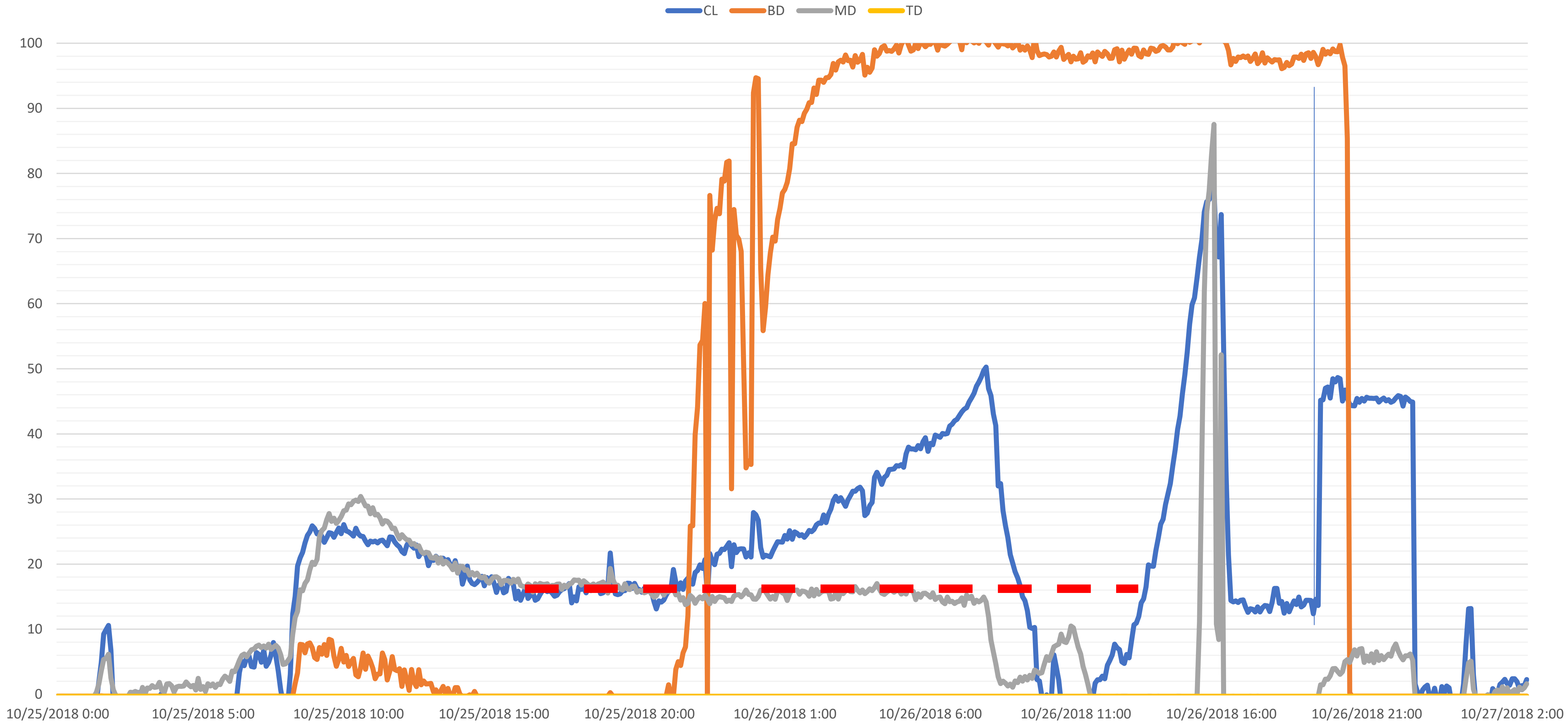

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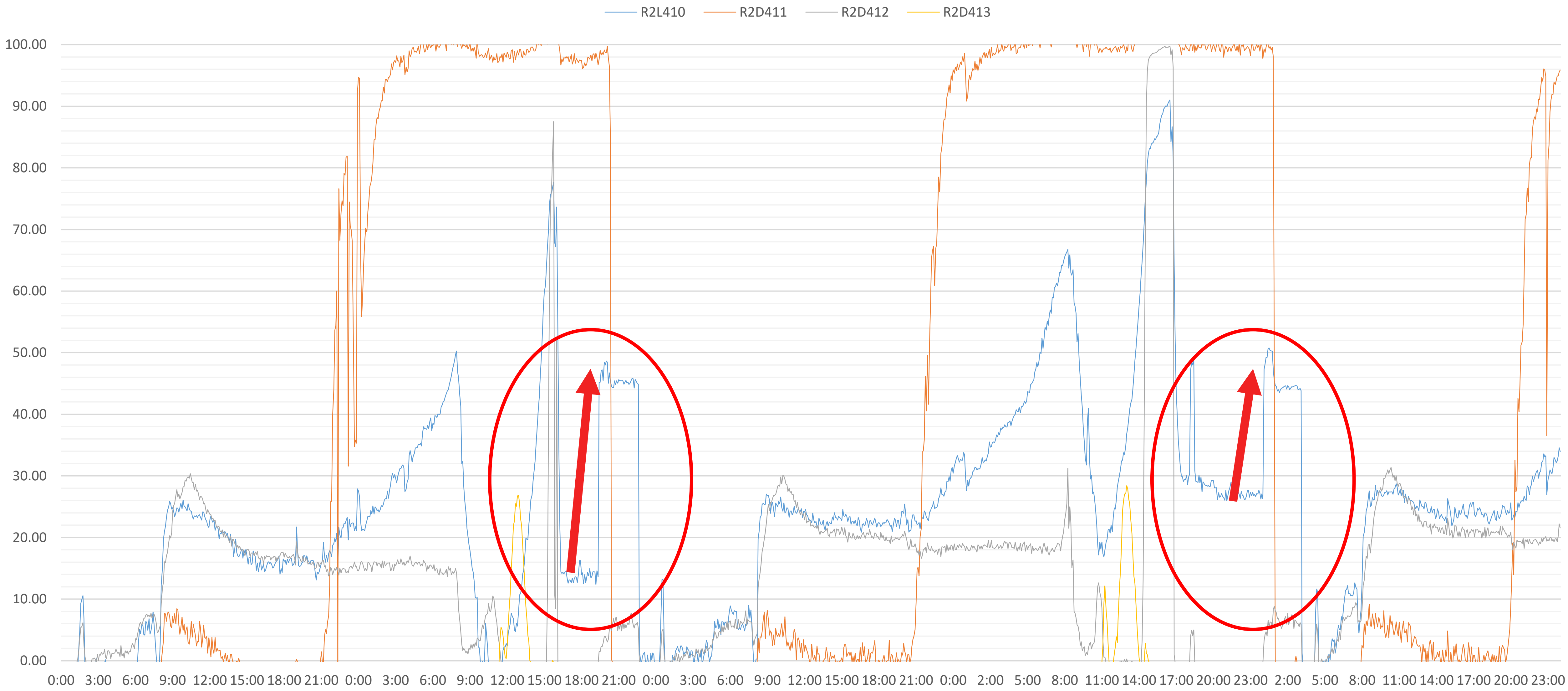
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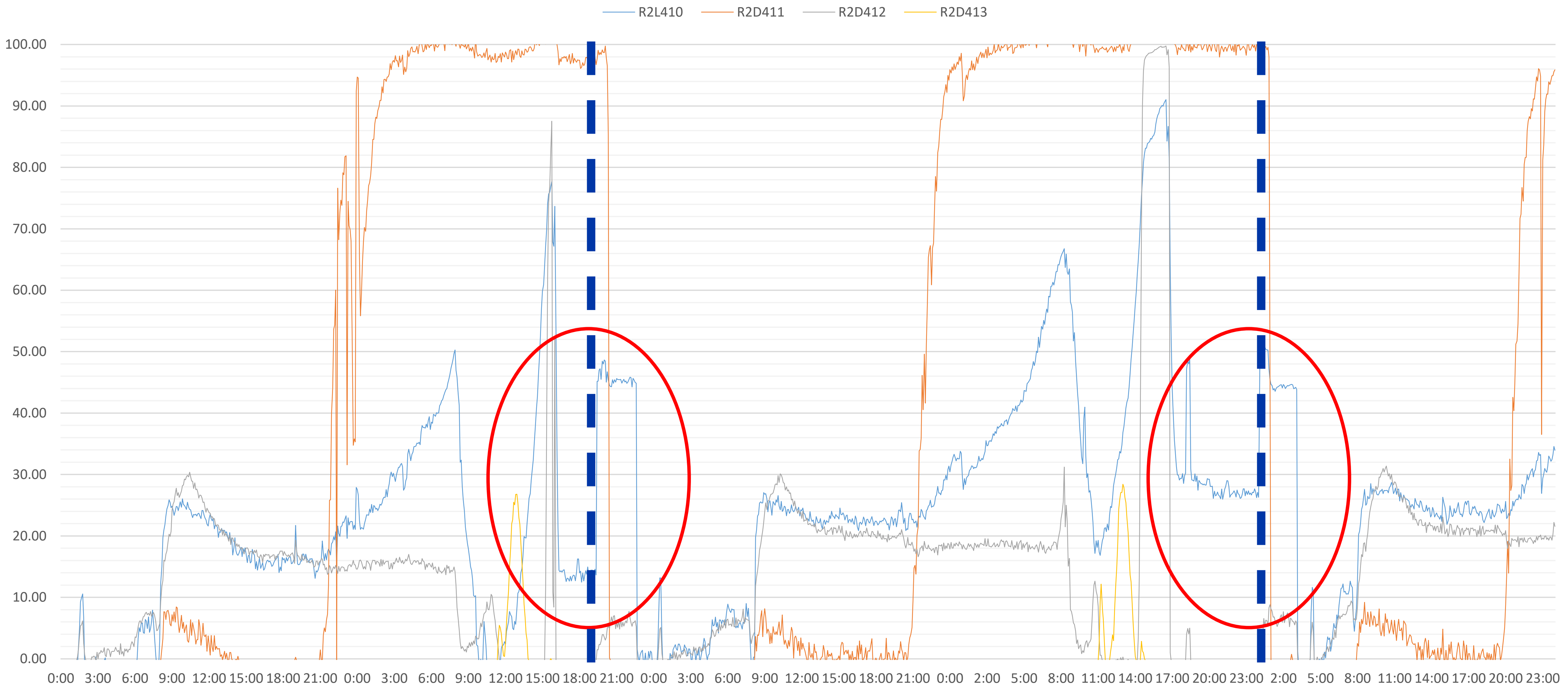
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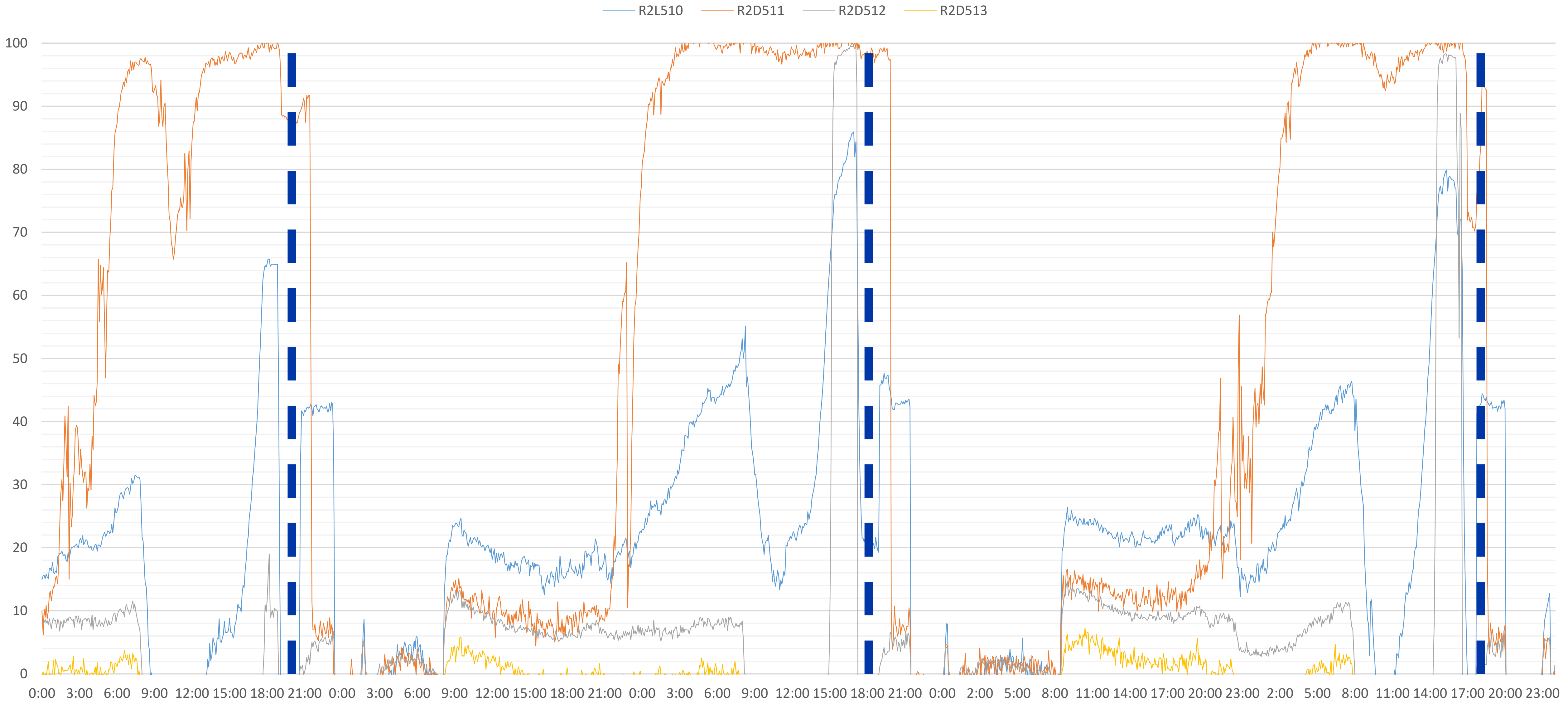
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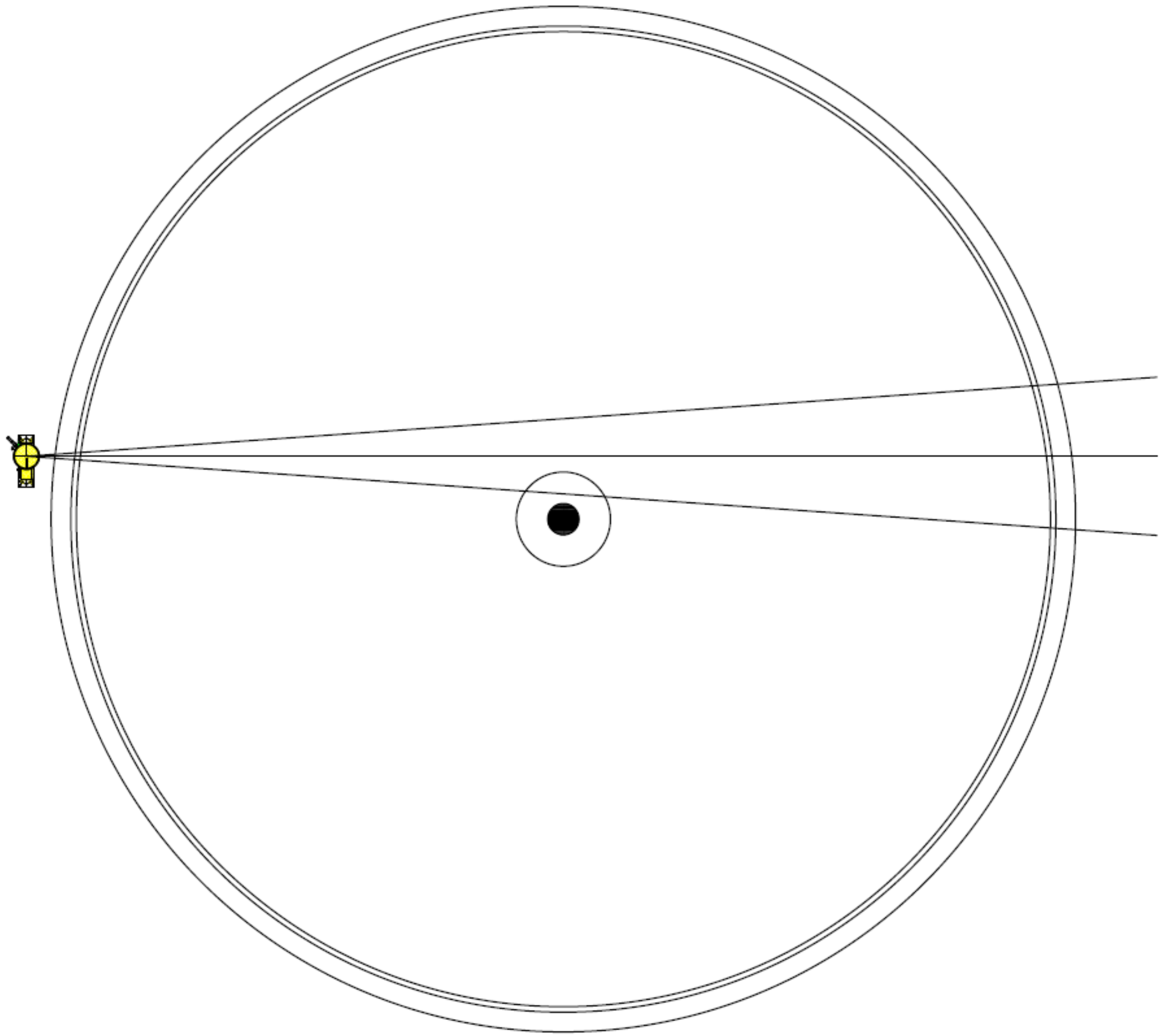


Common Questions

Non-Destructive Testing – Radiography

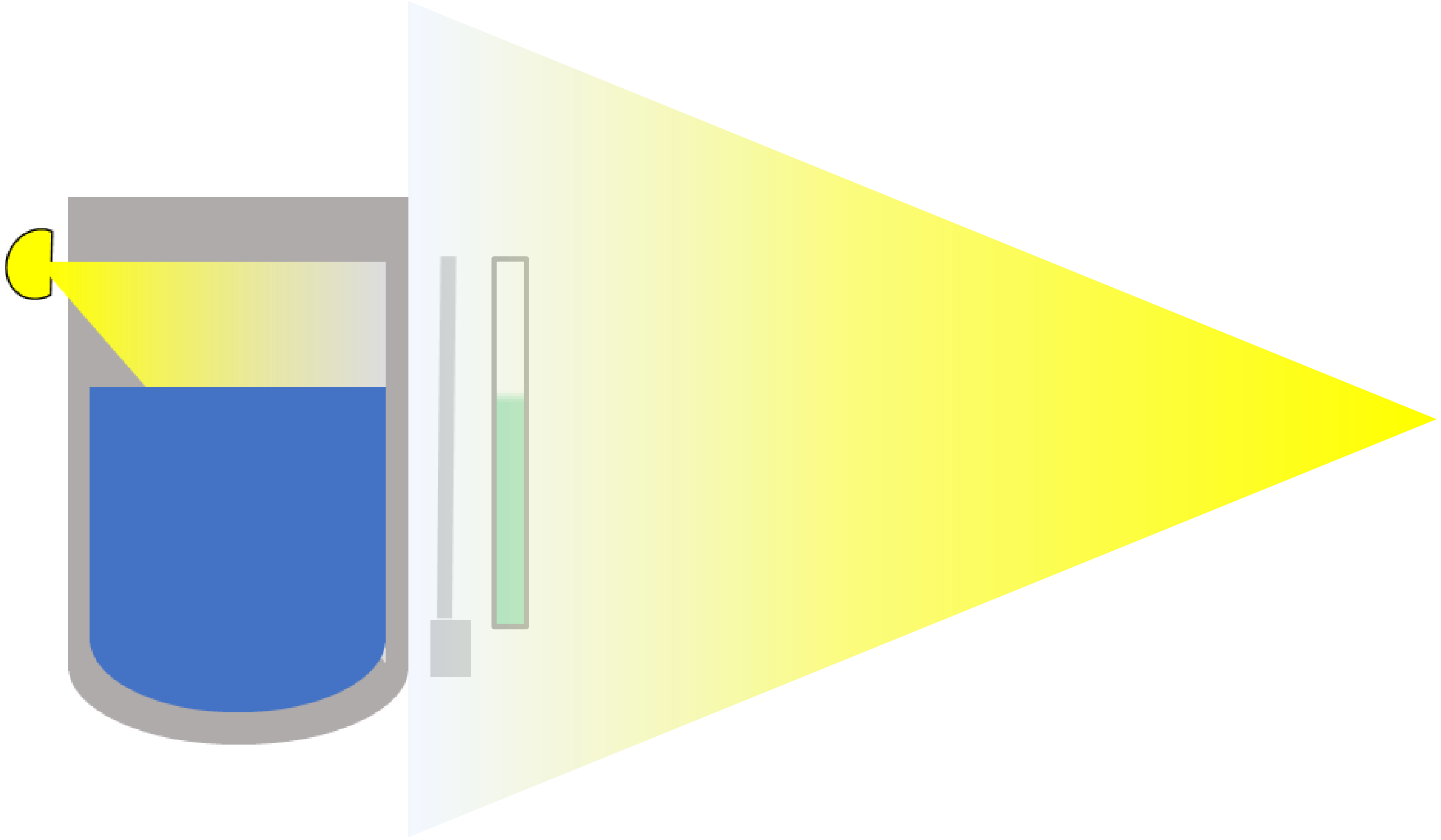
- Radioactive source is used
  - Co-60 gamma energy ≈ 1.25MeV
    - 1.8 – 3.7 TBq (50 – 100 Ci)
  - Ir-192 gamma energy ≈ 0.45MeV
    - 3.7 TBq (100 Ci)
  - Se-75 gamma energy ≈ 0.32MeV
    - 1.48 TBq (40 Ci)

Non-Destructive Testing – Radiography

Typical 3m level

- Calibration on 2m level device
  - Average field of $.5\mu Sv/hr$
  - $\text{Detector sensitivity 10000 cps per meter of length per } 1\mu Sv/hr$
  - $2m * 10000cps \ * .5\mu Sv/hr \ = 10000 \text{ cps}$

Radiography



Non-Destructive Testing – Radiography

Calculating Radiation Field

- To calculate the field of a point source

$$I = \frac{\Gamma \ * A}{d^2}$$

- Where:
- Γ = gamma constant (µSv$h^{-1}MBq^{-1}$)
- A = Activity of Source in MBq
- d = distance

$$d = \sqrt{\frac{\Gamma * A}{I}}$$

Non-Destructive Testing – Radiography

Calculating Radiation Field

$$d = \sqrt{\frac{\Gamma * A}{I}}$$

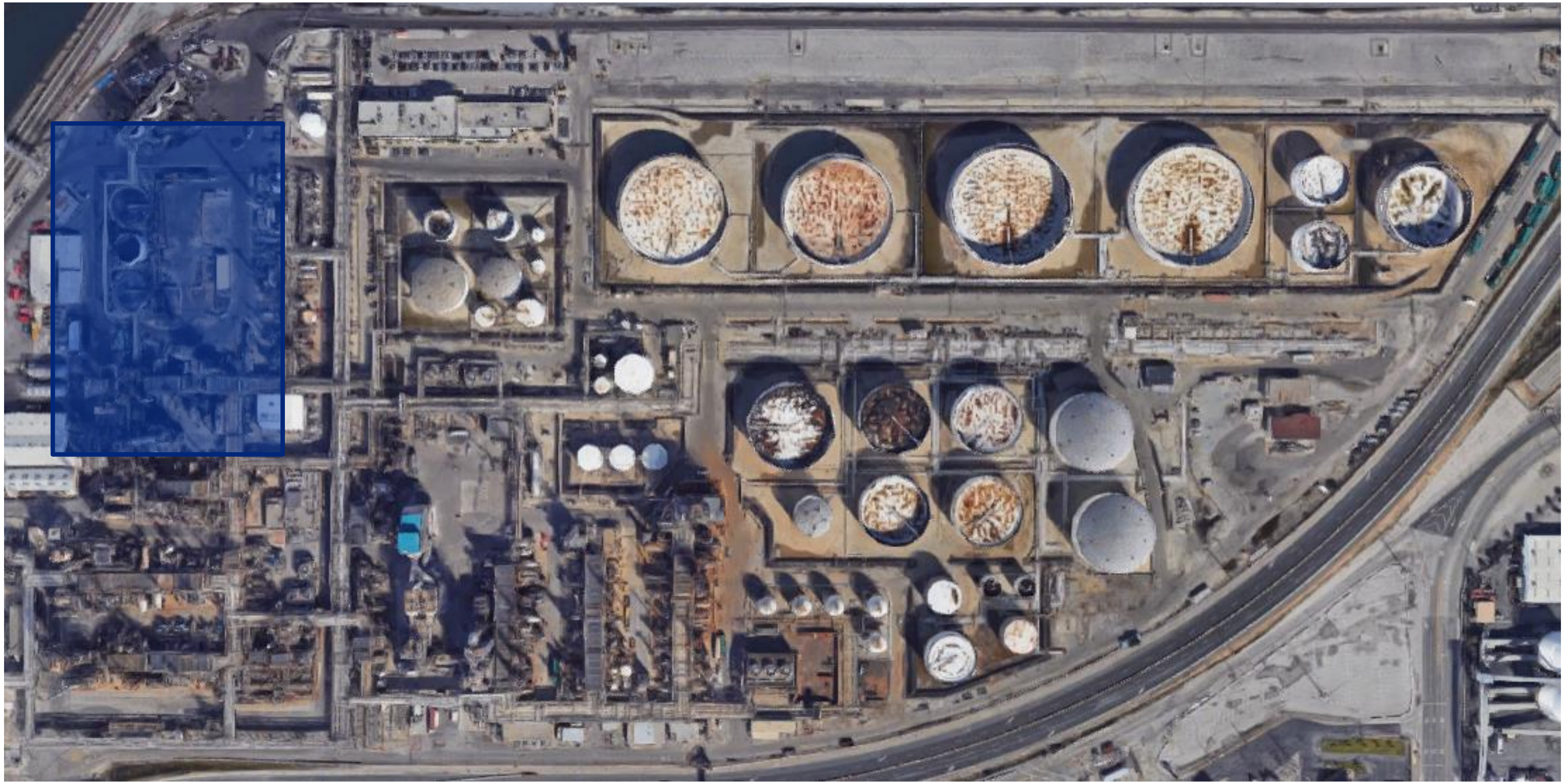
- For Co-60
- $\Gamma = .369\ \mu Sv h^{-1}\ MBq^{-1}$
- $A = 3.7\ \ TBq$ or $3700000\ MBq\ (100\ Ci)$
- $I = 0.5 \mu Sv/hr$
- **$d = 1652$ meters**
- **$d = 2337$ meters for a field of $0.25 \mu Sv/hr$**

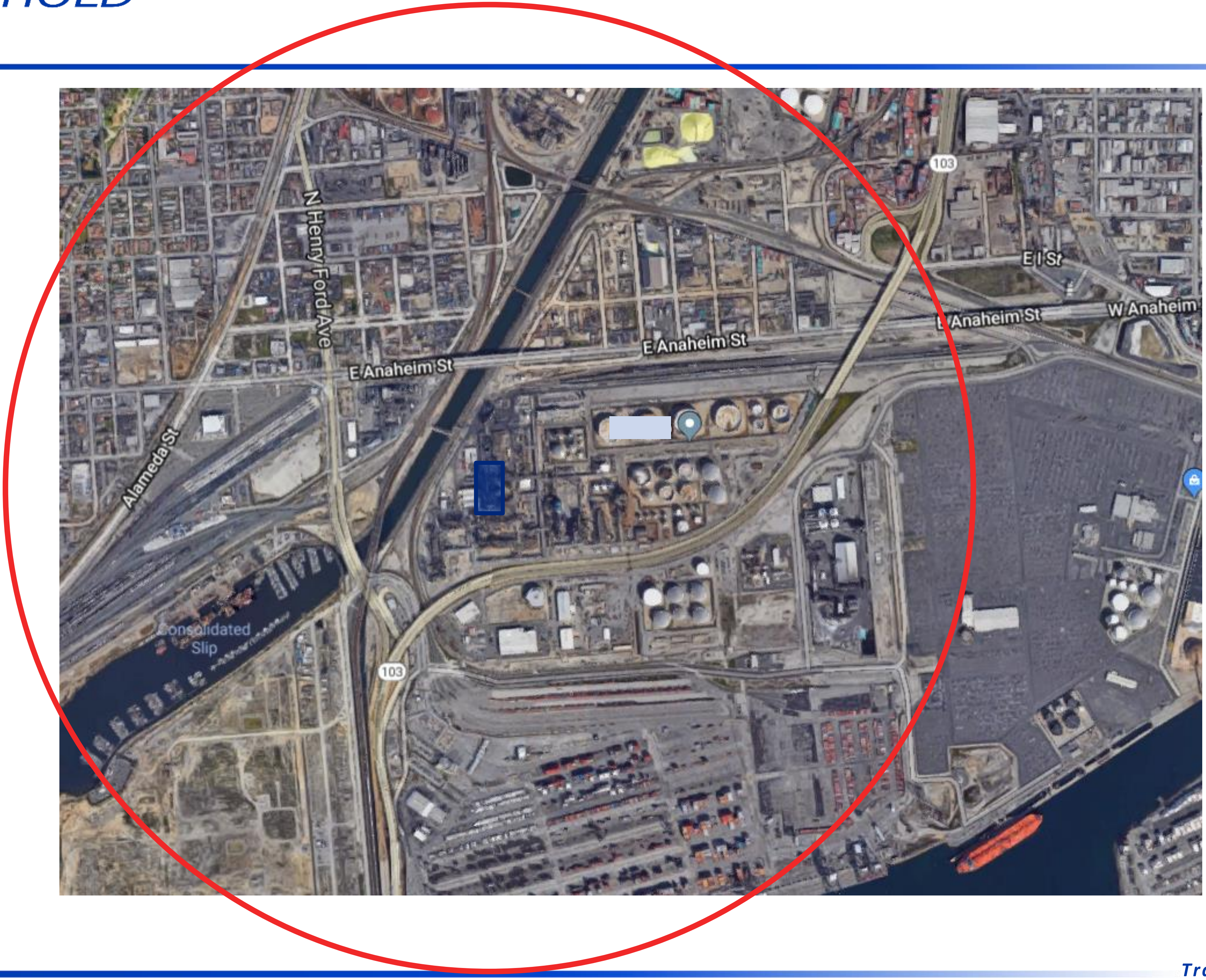
Non-Destructive Testing – Radiography

Calculating Radiation Field

$$d = \sqrt{\frac{\Gamma * A}{I}}$$

- For Ir-192
- $\Gamma = .163\ \mu Svh^{-1}\ MBq^{-1}$
- $A = 3.7$ TBq or 3700000 MBq (100 Ci)
- $I = 0.5\mu Sv/hr$
- **d = 1098 meters**
- **d = 1553 meters for a field of 0.25µSv/hr**




N Henry Ford Ave
E Anaheim St
E Anaheim St
E Anaheim St
W Anaheim
E I St
103
103
Alameda St
Consolidated
Slip

Non-Destructive Testing – Radiography

- Radioactive source is used
  - Co-60 gamma energy ≈ 1.25MeV
    - 3.7 TBq (100 Ci) has a field of .5μSv/hr (.05mR/hr) at 1652 meters
  - Ir-192 gamma energy ≈ 0.45MeV
    - 3.7 TBq (100 Ci) has a field of .5μSv/hr (.05mR/hr) at 320 meters
  - Se-75 gamma energy ≈ 0.32MeV
    - 1.48 TBq (40 Ci) has a field of .5μSv/hr (.05mR/hr) at 242 meters

Non-Destructive Testing – Radiography

Typical 2m level

- Calibration on 2m level device
  - Average field of .5μSv/hr
  - Detector sensitivity 10000 cps per meter of length per 1μSv/hr
  - $2\text{m} * 10000\text{cps} \; * .5\mu\text{Sv/hr} \; = 10000 \text{ cps}$
- Level @ 50% ≈ 5000cps
- 10000cps from NDT source, drives PV to -50% (15000cps, 10000cps from NDT, 5000cps from installed source)

Non-Destructive Testing – Radiography

Shielding

- Radioactive source is used
  - Co-60 gamma energy ≈ 1.25MeV
    - HVL of lead = 12.5mm (0.49”)
  - Ir-192 gamma energy ≈ 0.45MeV
    - HVL of lead = 4.8mm (0.19”)

Non-Destructive Testing – Radiography

Calculating Shielding reduction

- To calculate the reduction

$$I = I_o e^{-\mu\rho t}$$

- Where:
- I = field after shielding
- I_o = Initial field strength
- μ = attenuation coefficient
- P = density of material
- t = thickness of material

Non-Destructive Testing – Radiography

Calculating Shielding reduction

- To calculate the reduction

$$I = I_o e^{-\mu\rho t}$$

- Where:
- I = field after shielding
- I_o = Initial field strength
- µ = .0493 cm2/g
- P = 11.25 g/cm3
- t = 1.25cm
- Reduction is 50%, if the initial field was $0.5\ \mu Sv/hr$ then the resulting field is $0.25 \mu Sv/hr$

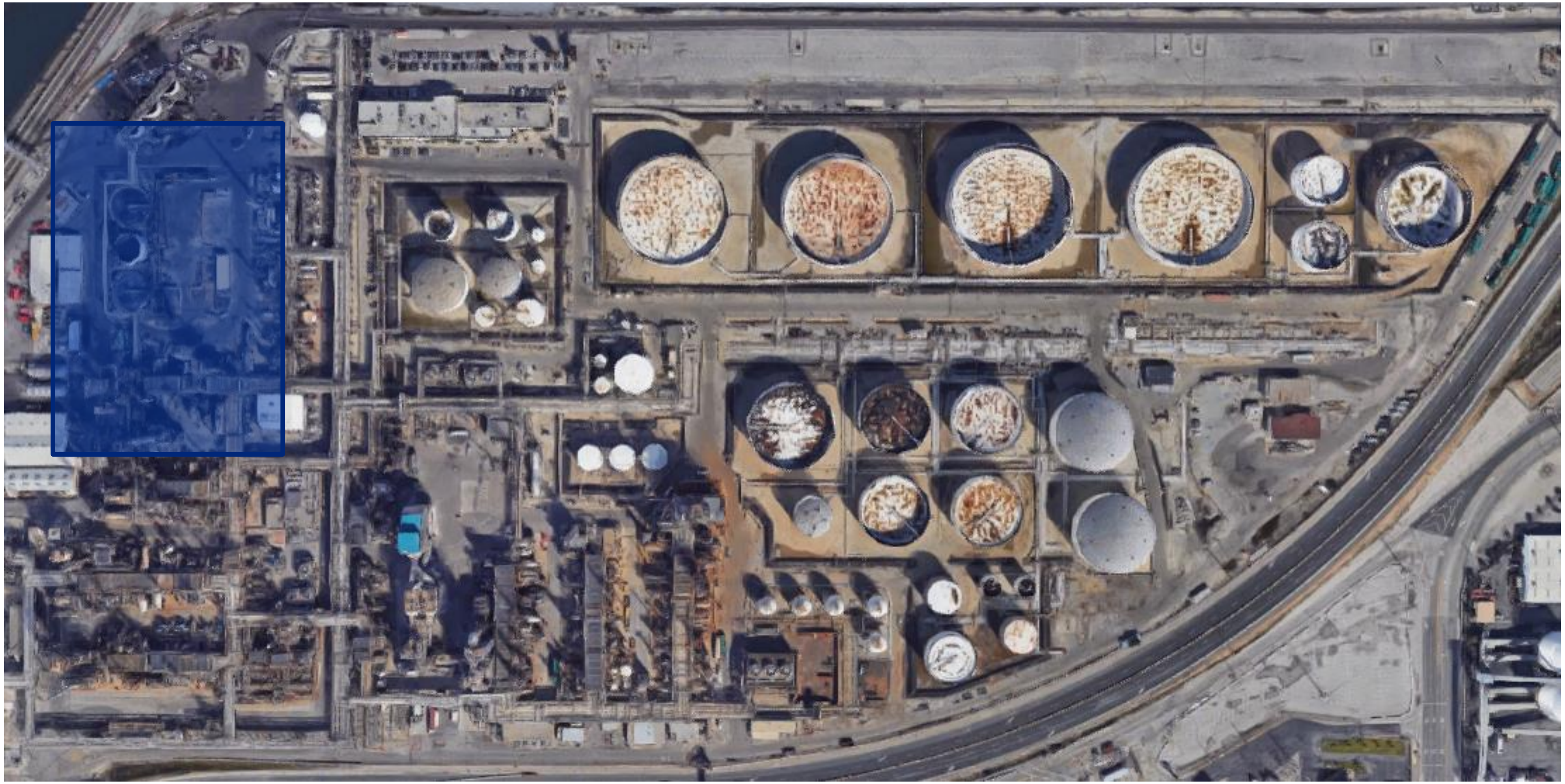
Non-Destructive Testing – Radiography

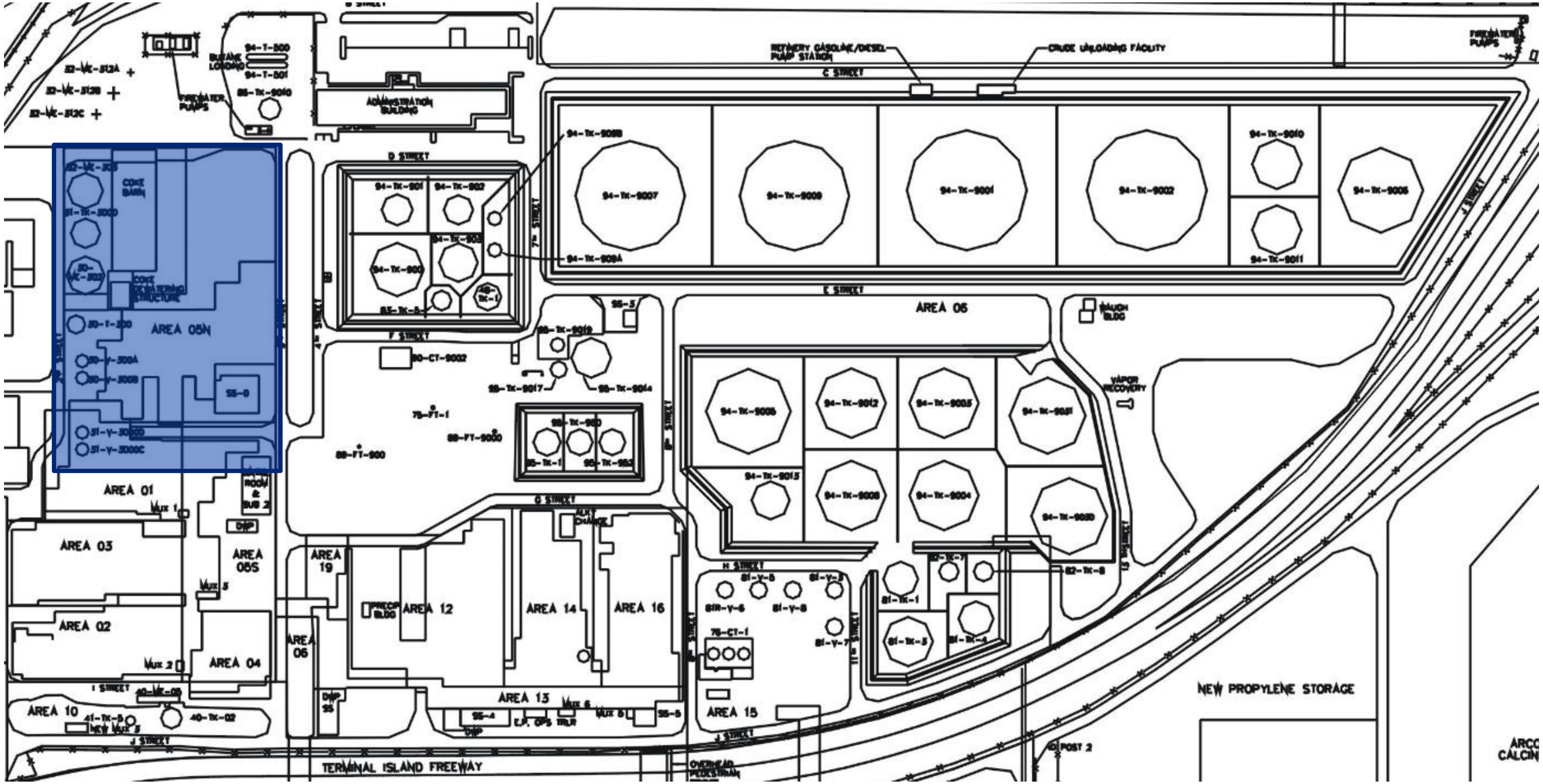
Calculating Shielding reduction

- To calculate the reduction

$$I = I_o e^{-\mu\rho t}$$

- Reduction is 50%, if the initial field was $0.5\ \mu\mathrm{Sv/hr}$ then the resulting field is $0.25\mu\mathrm{Sv/hr}$
- $1.25\mathrm{cm} = 50\%$ (still getting 5000cps) $= 50\%$ of span
- $2.5\mathrm{cm} = 75\%$ (still getting 2500cps) $= 25\%$ of span
- $3.75\mathrm{cm} = 87.5\%$ (still getting 1250cps) $= 12.5\%$ of span
- $5\mathrm{cm} = 93.75\%$ (still getting 625 cps) $= 6.25\%$ of span

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AREA 15
AREA 06
NEW PROPYLENE STORAGE
TERMINAL ISLAND FREEWAY
ADMINISTRATION BUILDING
CRUDE UNLOADING FACILITY
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D STREET
E STREET
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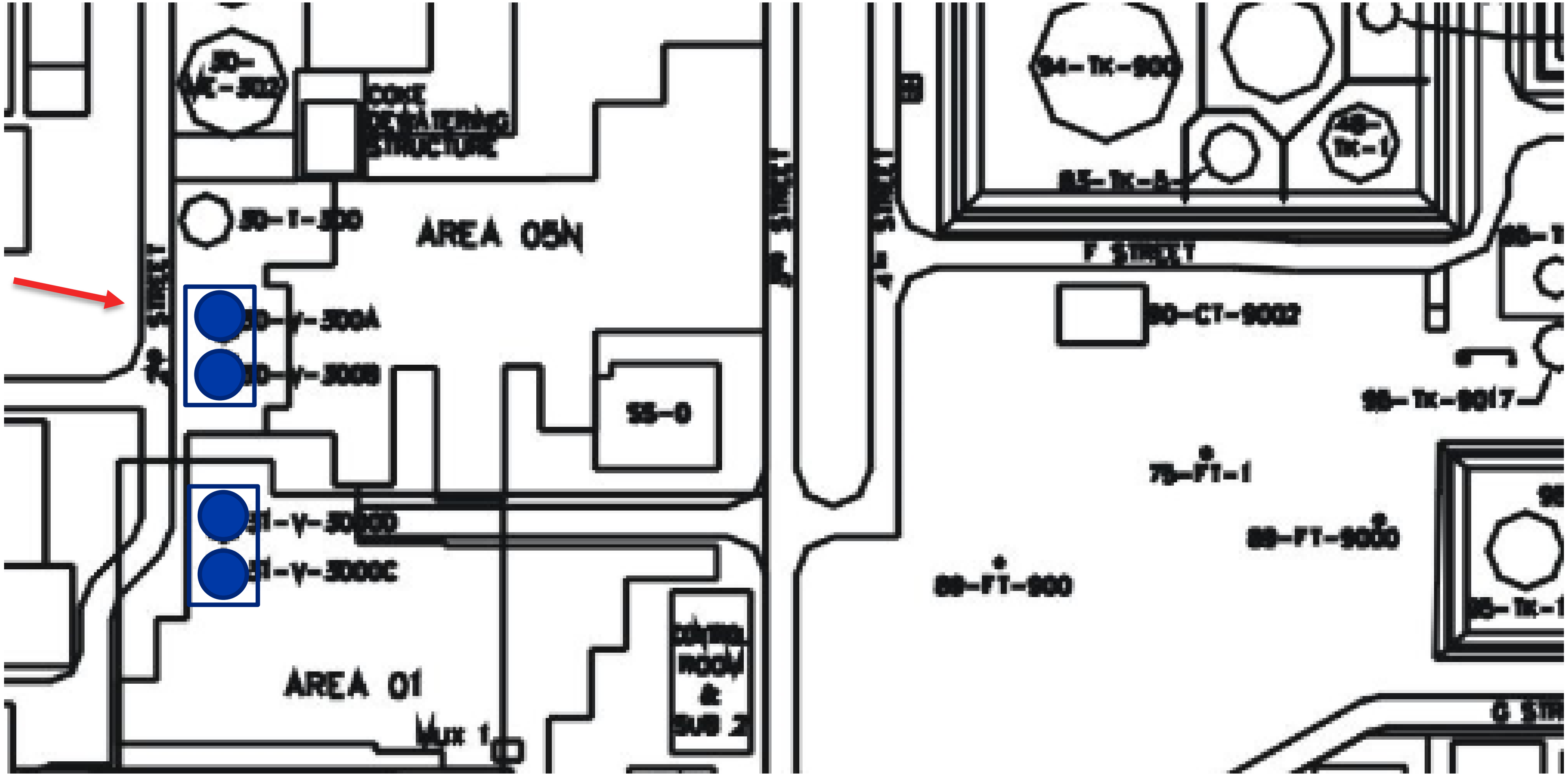
AREA 05N
AREA 01
F STREET
55-0

BERTHOLD

Thank you for your attention!!!!

Refining COMMUNITY

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Berthold Technologies

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