

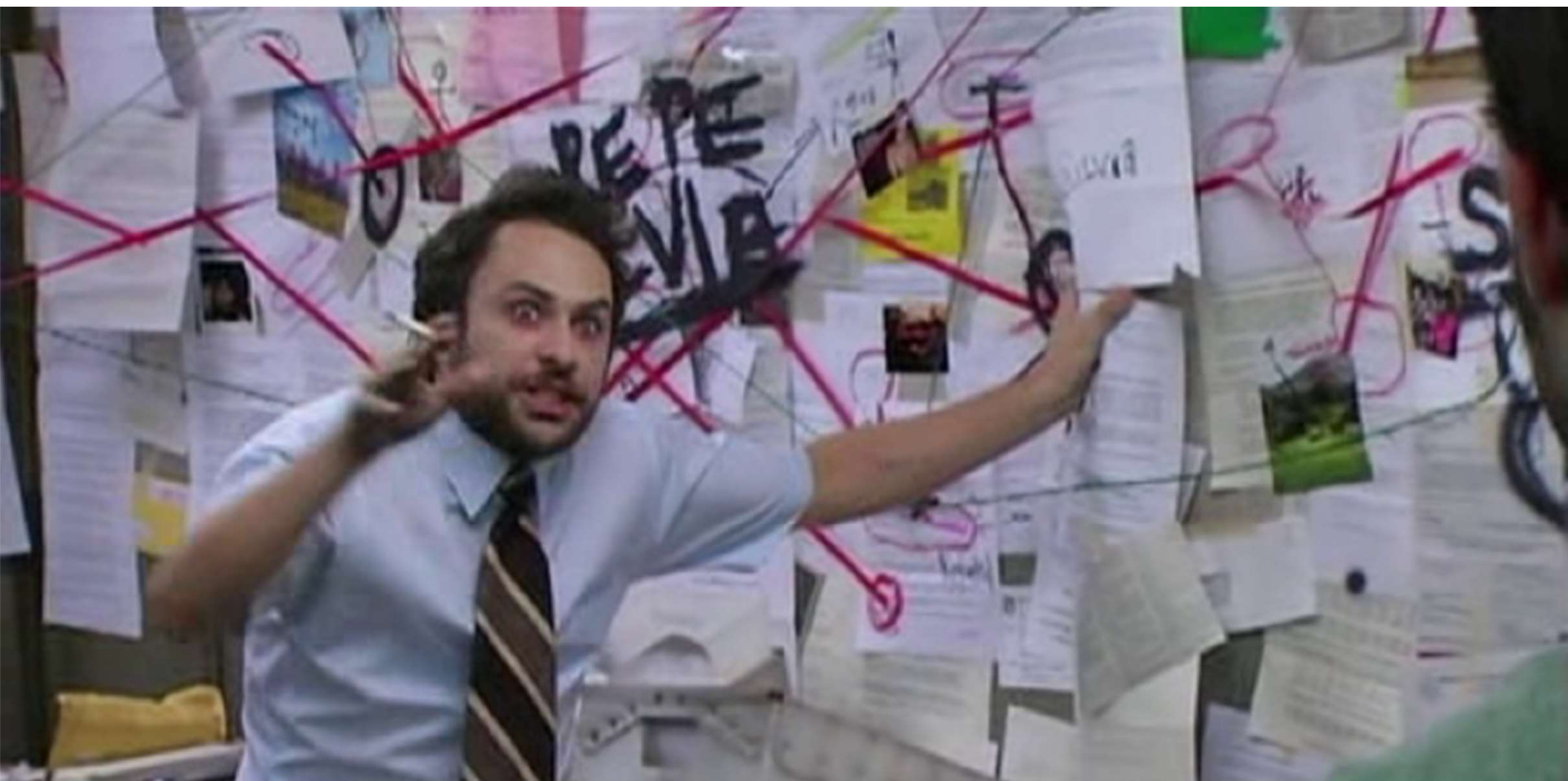
Barr Engineering Co.

AI in Environmental Compliance

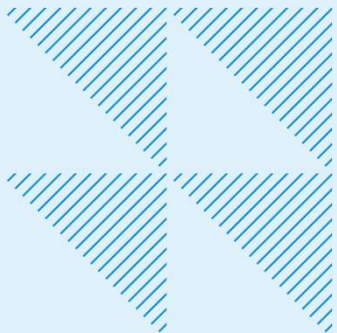


Kyong Song
Senior Data Scientist
Recovering Environmental Engineer

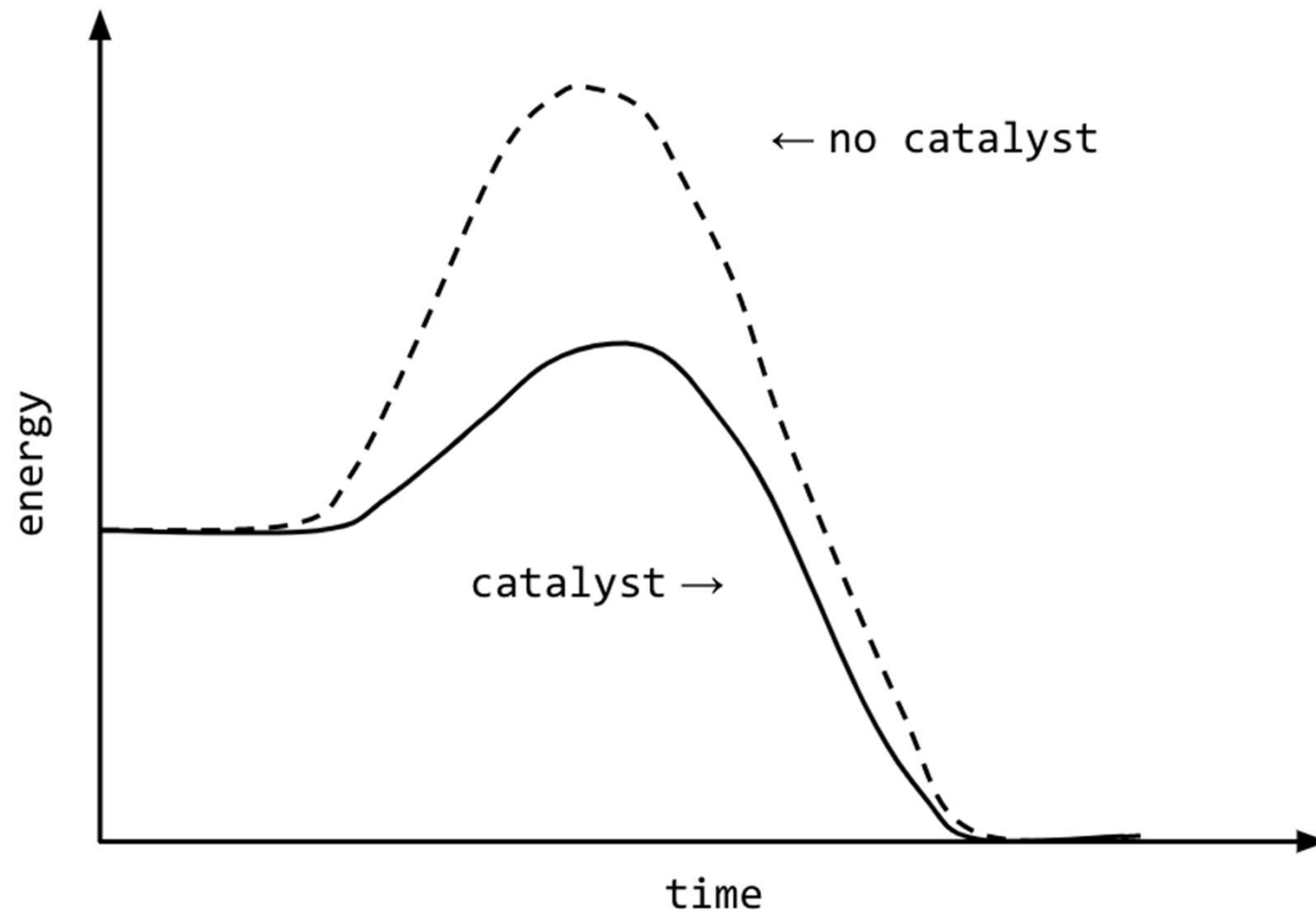








**Making the right decisions
with all the data available to us**



ENVIRONMENTAL DATA

|||||

THE LONG LIST OF DATA THAT
WE WORK WITH...
Emission factors and emissions
Modeling

Operations and process data
CEMS, instrumentation,
monitoring

Inventory data

Chemical data

Maintenance records

Incident management

Regulations, permits,
requirements, forms, reports,
memos, really really long emails

Compliance and task
management

Sustainability, decarbonization

*Proposals, budgeting, project
management*

And a lot more...

We work with a lot of data...



- Emission factors and emissions
- Modeling
- Operations and process data
- CEMS, instrumentation, monitoring
- Inventory data
- Chemical data
- Maintenance records
- Incident management
- Regulations, permits, requirements, forms, reports, memos, *really really* long emails
- Compliance and task management
- Sustainability, decarbonization
- Proposals, budgeting, project management
- And a lot more...



Structured Data



Unstructured Data

Structured Data Examples



SQL
databases



Excel



Digital Forms



Sensor
readings



GIS

Unstructured Data Examples



Regulations,
Permits



Reports



Emails



Images

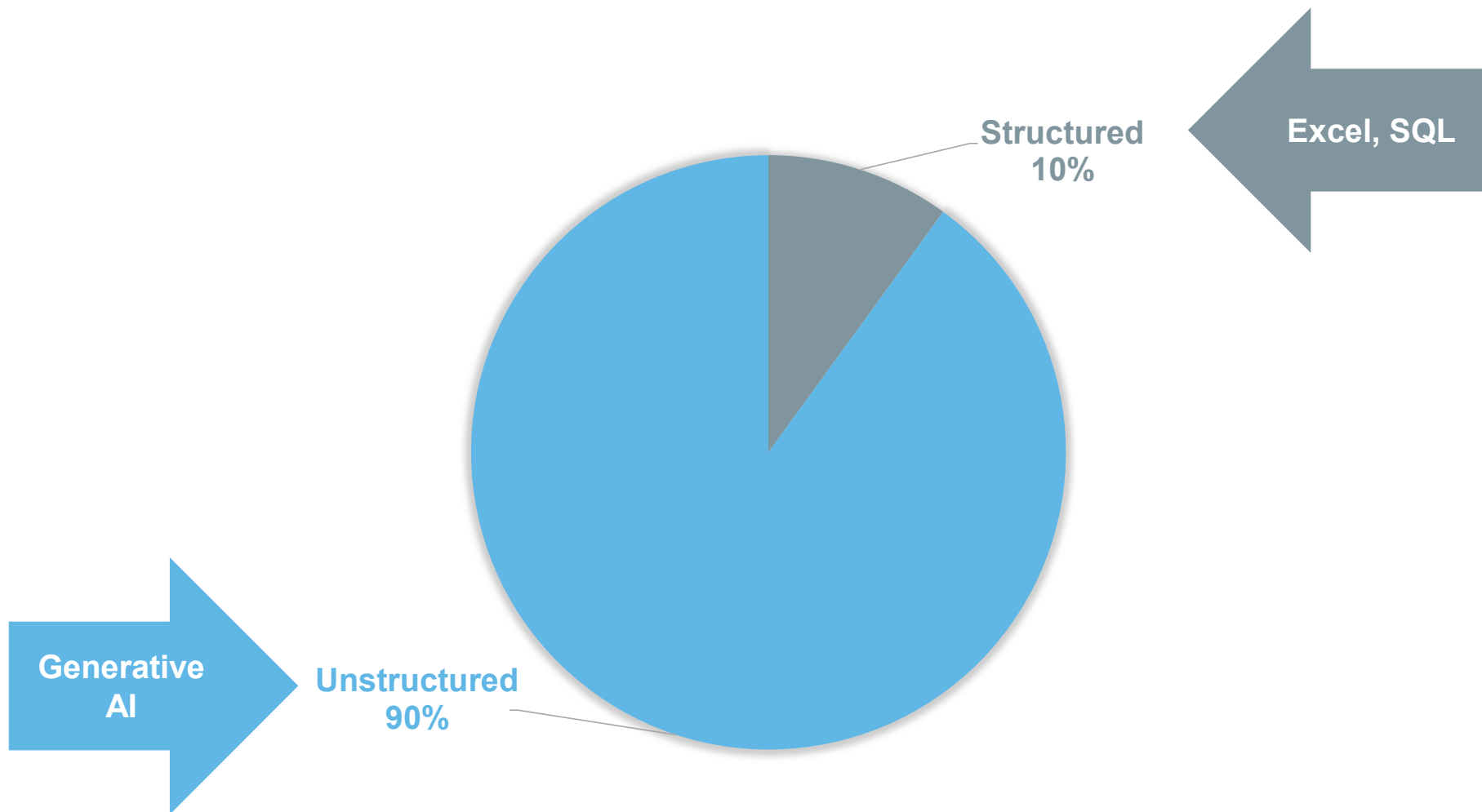


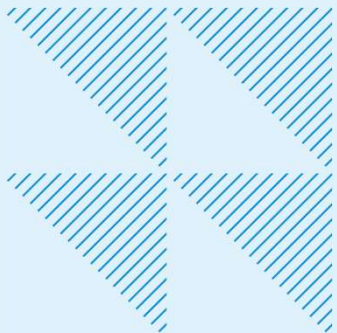
Recordings

Text as
Documents

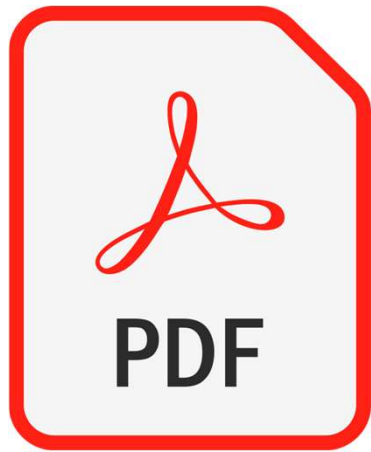


Text as
Data





How can we interact with our data?

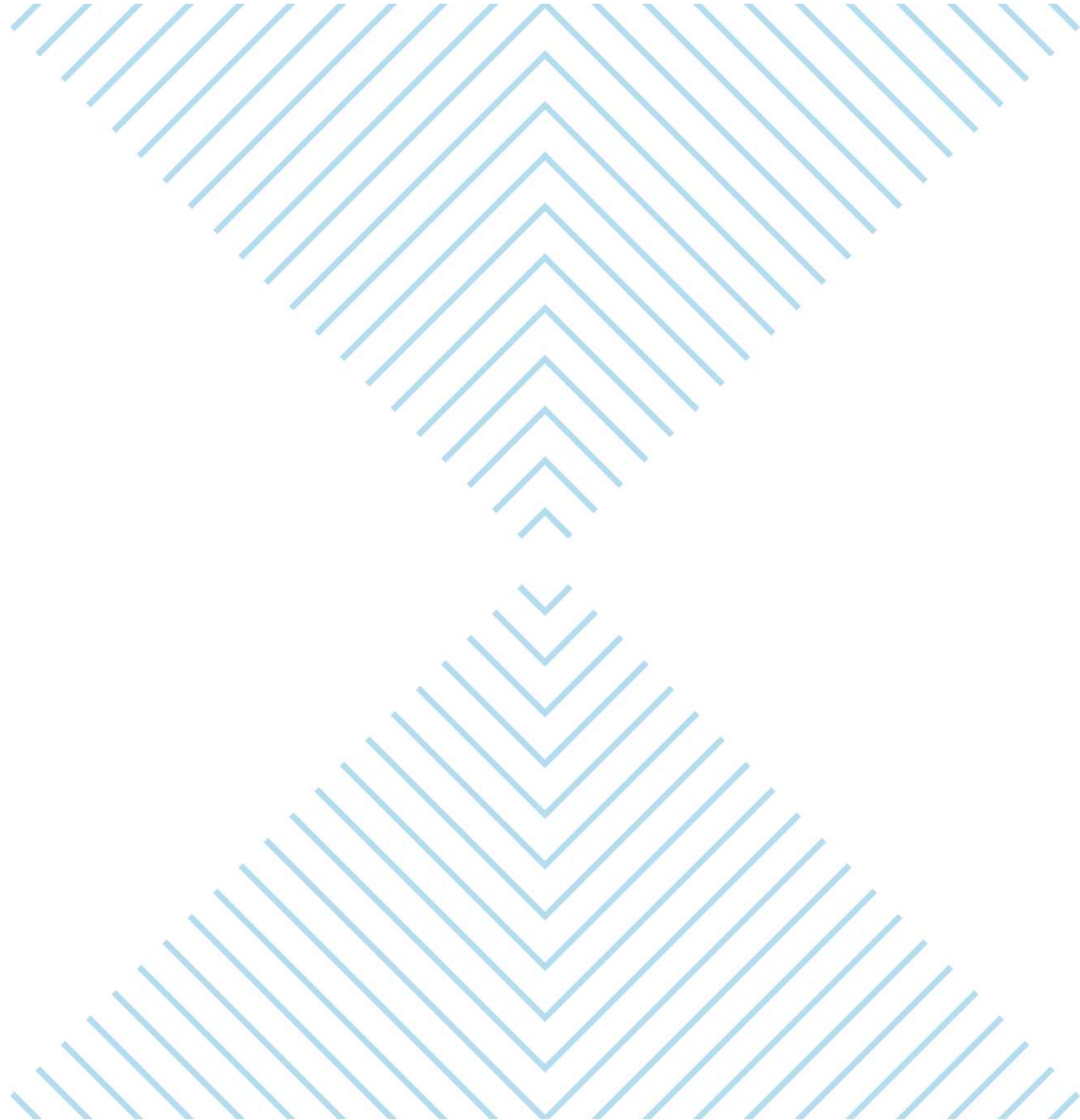


Documents
as Files



Documents
as Data

Use Cases for Environmental Professionals







Field Log Digitization

Original Image



Barr Engineering Company Field Log Data Sheet

Client:		Monitoring Point: MW 4-1						
Location: FDLF		Date: 6/16/2021						
Project #: 23/62-0884		Sample Time: 1345						
GENERAL DATA		STABILIZATION TEST						
Barr lock:	Yes							
Casing diameter:	4"	Time/ Volume	Temp. °C	Cond. @ 25	pH	Eh	D.O.	Turbidity Appearance
Total well depth:*	20.8	1258/12g	11.02	2245	8.00	-178	1.18	5.38
Static water level:*	11.01	1318/18g	10.91	2297	7.91	-152	1.03	4.08
Water depth:*	9.8	1338/24g	10.88	2345	7.86	-144	0.94	3.64
Well volume: (gal)	6.4							
Purge method:	Peristaltic							
Sample method:	"							
Start time:	1218	Odor: Yes						
Stop time:	1338	Purge Appearance: Clear						
Duration: (minutes)	80	Sample Appearance: Clear						
Rate, gpm:	.3	Comments:						
Volume, purged:	24 gal							

Extracted Data (Editable)

Form Fields

Client:	
Monitoring Point:	MW 4-1
Location:	FDLF
Date:	6/16/2021
Project Number:	23/62-0884
Sample Time:	1345
Static Water Level:	11.01

Stabilization Test Data

Time/Volume	Temp°C	Cond. @ 25	pH	Eh	D.O.	Turbidity/Appearance
1258/12g	11.02	2245	8.00	-178	1.18	5.38
1318/18g	10.91	2297	7.91	-152	1.03	4.08
1338/24g	10.88	2345	7.86	-144	0.94	3.64

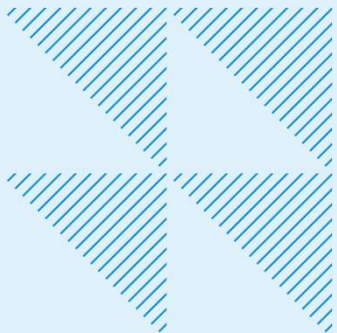
Total rows: 3

Processing Time: 20.10 seconds

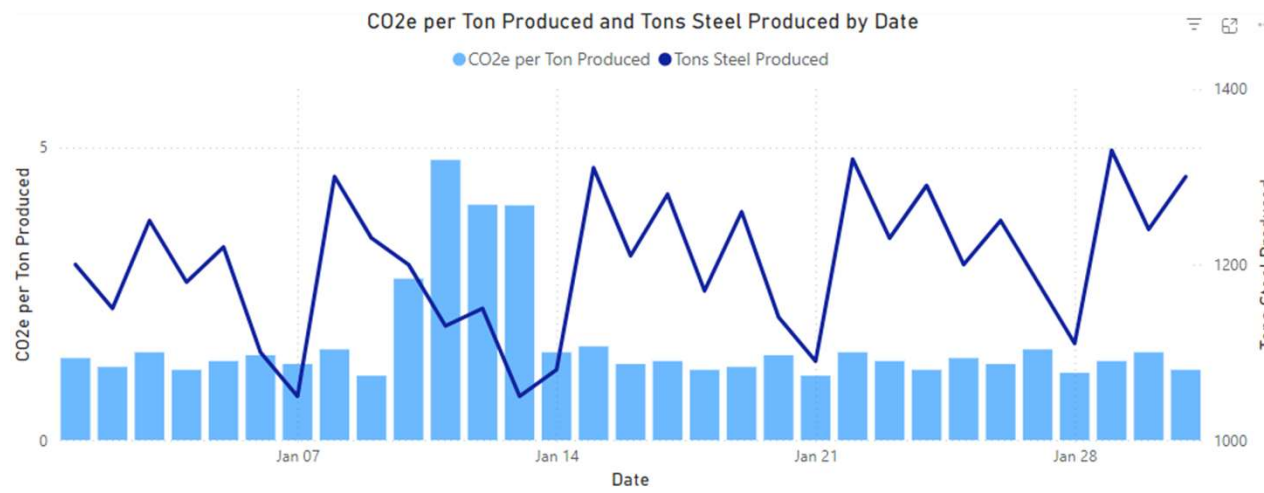
Timestamp: 2025-05-29T18:59:40.802160

Save All Data

Export to Excel



Digital Twins & Predictive Analytics



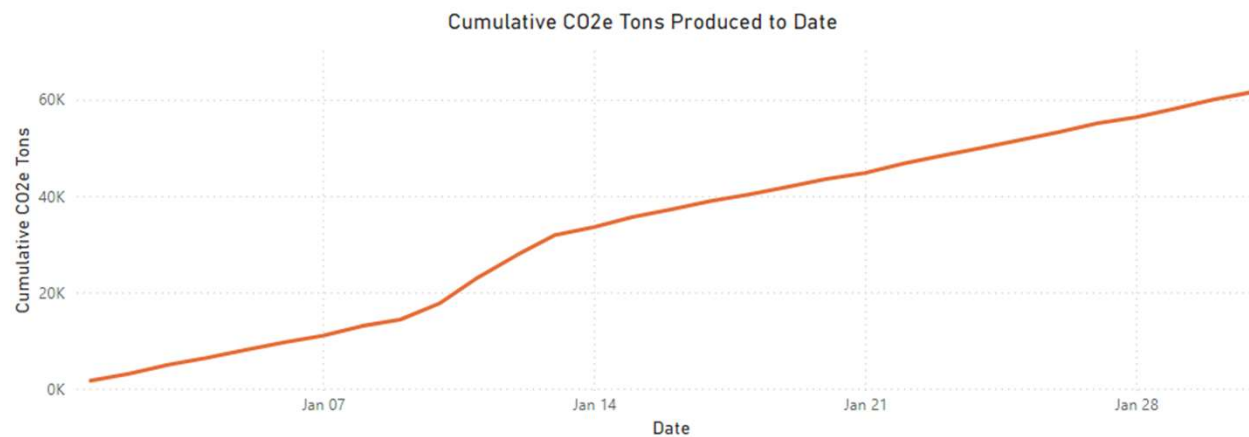
Month
January

1.68

Average CO2e per Tons Produced

1.20K

Average Daily Tons Produced



61.60K

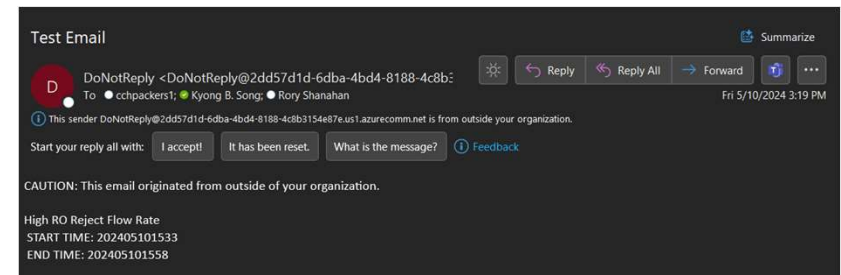
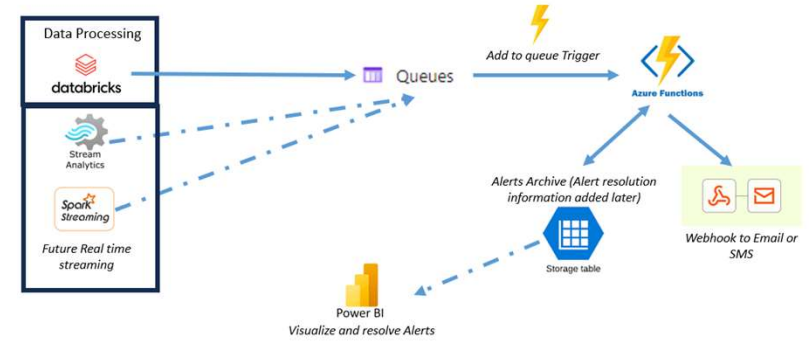
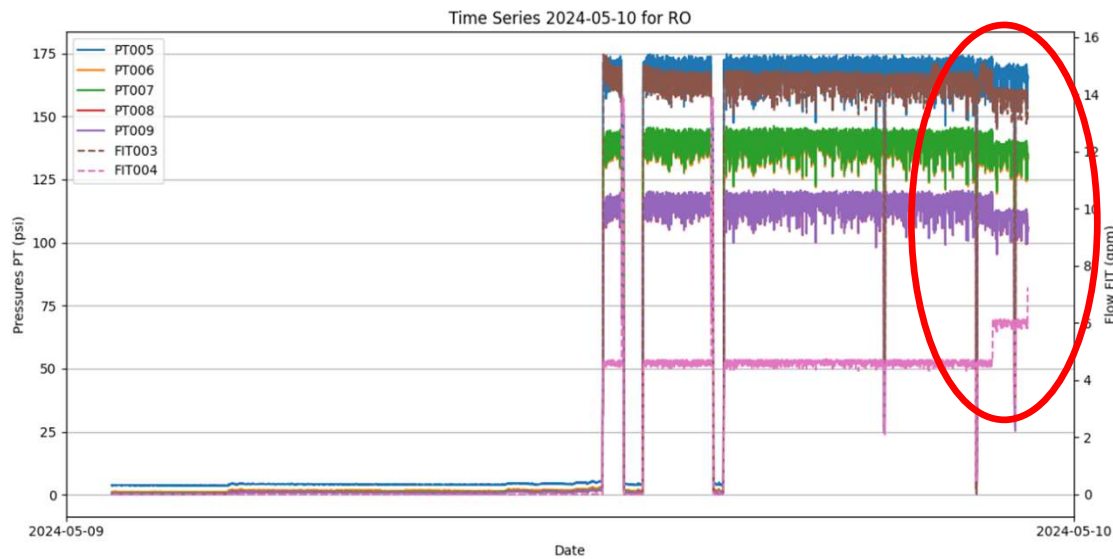
CO2e Tons Produced to Date

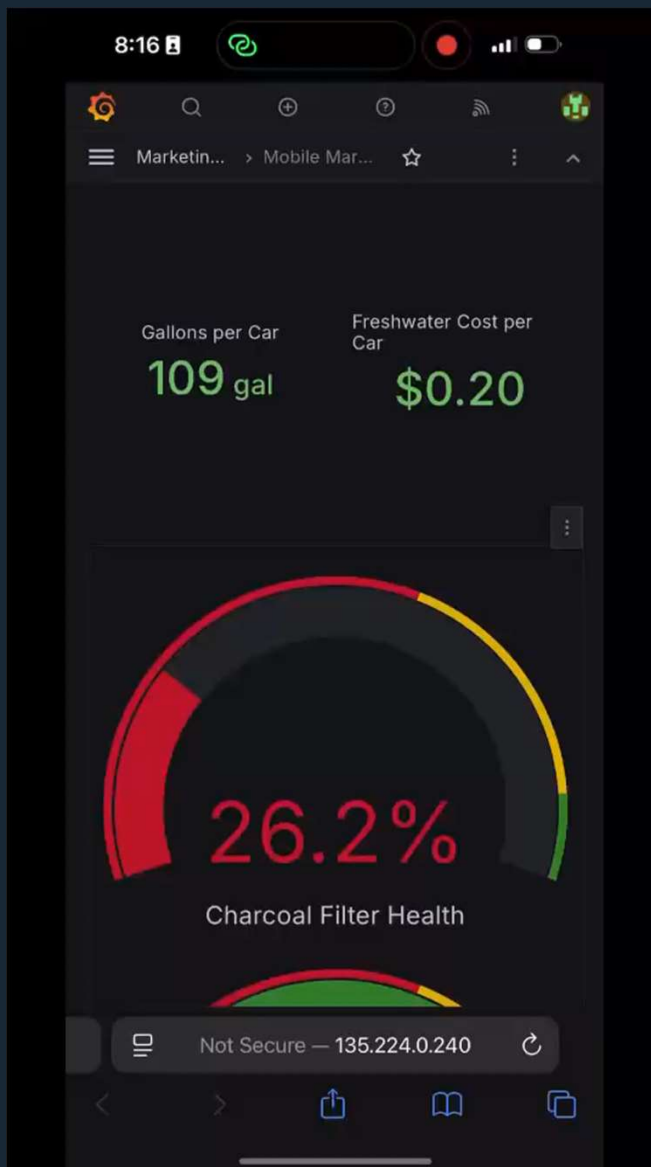
725.29K

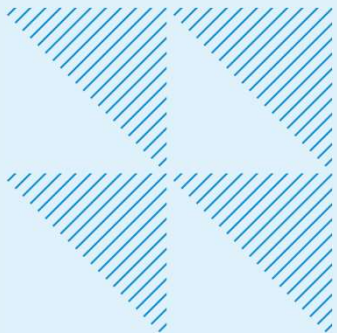
Projected Year-End CO2e Tons

Anomalies

|||||||





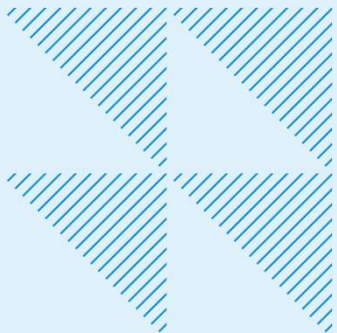


How can we scale analysis and expertise?

What would emissions calculations
look like without spreadsheets?

Previous Requirement	Future Requirement	Redline by Character
The Permittee must comply with all applicable requirements of 40 CFR pt. 63, subp. A as follows:	The Permittee must comply with all applicable requirements of 40 CFR pt. 63, subp. A as follows:	The Permittee must comply with all applicable requirements of 40 CFR pt. 63, subp. A as follows:
40 CFR 63.1(a)(1)-(4);	40 CFR 63.1(a)(1)-(a)(4);	40 CFR 63.1(a)(1)-(4);
40 CFR 63.1(a)(6)-(8);	40 CFR 63.1(a)(6)-(a)(8);	40 CFR 63.1(a)(6)-(a)(4);
40 CFR 63.1(a)(10)-(14);	40 CFR 63.1(a)(10)-(a)(14);	40 CFR 63.1(a)(6)-(a)(8);
40 CFR 63.1(b)(2);	40 CFR 63.1(b)(2);	40 CFR 63.1(a)(10)-(a)(14);
40 CFR 63.1(c)(1);	40 CFR 63.1(c)(1)-(c)(2);	40 CFR 63.1(b)(2);
40 CFR 63.1(c)(2);	40 CFR 63.1(c)(4)-(c)(6);	40 CFR 63.1(c)(1);
40 CFR 63.1(c)(4);	40 CFR 63.1(e);	40 CFR 63.1(c)(2);
40 CFR 63.1(c)(5);	40 CFR 63.2;	40 CFR 63.1(c)(4);
40 CFR 63.1(c)(6);	40 CFR 63.3(a)-(c);	40 CFR 63.1(c)(6);
40 CFR 63.1(e);	40 CFR 63.4(a)(1)-(a)(3);	40 CFR 63.1(e);
40 CFR 63.2;	40 CFR 63.4(a)(5)	40 CFR 63.2;
40 CFR 63.3(a)-(c);	40 CFR 63.4(b)-(c);	40 CFR 63.3(a)-(c);
40 CFR 63.4(a)(1)-(3);	40 CFR 63.5(a)(1)-(a)(2);	40 CFR 63.4(a)(1)-(a)(3);
40 CFR 63.4(a)(5)	40 CFR 63.5(b)(1);	40 CFR 63.4(a)(5);
40 CFR 63.4(b);	40 CFR 63.5(b)(3)-(b)(6);	40 CFR 63.1(c)(6);
40 CFR 63.4(c);	40 CFR 63.5(d)(1)-(d)(4);	40 CFR 63.1(e);
40 CFR 63.5(a)(1)-(2);	40 CFR 63.5(e);	40 CFR 63.1(e);
40 CFR 63.5(b)(1);	40 CFR 63.5(f)(1)-(f)(2);	40 CFR 63.1(e);
40 CFR 63.5(b)(3)-(6);	40 CFR 63.6(a);	40 CFR 63.1(e);
40 CFR 63.5(d)(1)-(4);	40 CFR 63.6(b)(1)-(b)(5);	40 CFR 63.1(e);
40 CFR 63.5(e);	40 CFR 63.6(b)(7);	40 CFR 63.1(e);
40 CFR 63.5(f)(1)-(2);	40 CFR 63.6(c)(2);	40 CFR 63.1(e);
40 CFR 63.6(a);	40 CFR 63.6(c)(5);	40 CFR 63.1(e);
40 CFR 63.6(b)(1);	40 CFR 63.6(e);	40 CFR 63.1(e);
40 CFR 63.6(b)(2);	40 CFR 63.6(f)(1)-(f)(3);	40 CFR 63.1(e);
40 CFR 63.6(b)(3);	40 CFR 63.6(g);	40 CFR 63.1(e);
40 CFR 63.6(b)(4);	40 CFR 63.6(i)(1)-(i)(14);	40 CFR 63.1(e);
40 CFR 63.6(b)(5);	40 CFR 63.6(i)(16);	40 CFR 63.1(e);
40 CFR 63.6(b)(7);	40 CFR 63.6(j);	40 CFR 63.1(e);
40 CFR 63.6(c)(2);	40 CFR 63.7(a)(1)-(a)(3);	40 CFR 63.1(e);
40 CFR 63.6(c)(5);	40 CFR 63.7(b)-(d);	40 CFR 63.1(e);
40 CFR 63.6(e);	40 CFR 63.7(e)(1)-(e)(4);	40 CFR 63.1(e);
40 CFR 63.6(f)(1)-(3);	40 CFR 63.7(f)-(h);	40 CFR 63.1(e);
40 CFR 63.6(g);	40 CFR 63.8(a)(1)-(a)(2);	40 CFR 63.1(e);
40 CFR 63.6(i)(1)-(14);	40 CFR 63.8(a)(4);	40 CFR 63.1(e);
40 CFR 63.6(i)(16);	40 CFR 63.8(b)(1)-(b)(3);	40 CFR 63.1(e);
40 CFR 63.6(j);	40 CFR 63.8(c)(1)-(c)(4);	40 CFR 63.1(e);
40 CFR 63.7(a)(1);	40 CFR 63.8(c)(6)-(c)(8);	40 CFR 63.1(e);
40 CFR 63.7(a)(2);	40 CFR 63.8(d)-(e);	40 CFR 63.1(e);
40 CFR 63.7(a)(3);	40 CFR 63.8(f)(1)-(f)(3);	40 CFR 63.1(e);

Redline by Character	Substantive Changes	Editorial Changes	Summary	Compliance Impact	Change Category
<p>The Permittee shall limit Volatile Organic Compounds <= 35.0 tons per year 12-month rolling sum. For the first 11 months after the limit becomes effective, VOC emissions are limited as determined by the following equation:</p> $E = 35.0 \times (0.15 + 0.85 (M/12))$ <p>Where: E = VOC emissions in total tons M = number of months after limit is effective. [Title I Condition: Avoid major modification under 40 CFR 52.21(b)(2) & Minn. R. 7007.3000]</p>	<p>The 2025 version removes the phased initial compliance period calculation for the first 11 months after the limit becomes effective. In the 2024 version, a specific formula was provided to determine allowable VOC emissions during the ramp-up period, but this phased approach is no longer present in the 2025 version. Now, the 35.0 tpy 12-month rolling sum limit applies immediately upon the limit becoming effective, with no transitional calculation.</p>	<p>Minor formatting changes, such as the removal of the equation and explanatory text, but these are directly tied to the substantive change.</p>	<p>The 2025 version eliminates the phased-in compliance period and requires immediate compliance with the 35.0 tpy VOC limit upon effectiveness.</p>	<p>This change makes compliance more strict, as it removes the initial ramp-up period and requires the full limit to be met immediately.</p>	<p>Change that required review but likely acceptable</p>
<p>Monitoring of emissions and operations: Follow monitoring requirements of 40 CFR pt. 60, subp. RRR as alternative means of demonstrating compliance with 40 CFR pt. 60, subp. NNN in accordance with Alternative Monitoring Plan (AMP) approval s. (USEPA approved the AMPs dated December 21, 2009 <u>and April 19, 2023</u>).</p> <p>(1) Any potential bypass lines must be car sealed/lock and key; (2) Visually inspect monthly any car seals that have been installed; (3) Introduce vent stream into boiler/process heater with the primary fuel. [40 CFR 60.663(b)(2), 40 CFR 60.663(c)(1)-(3), 40 CFR 60.703(c)(1)(i)-(ii), Minn. R. 7011.2900(C), Minn. R. 7011.3430]</p>	<p>The 2025 version updates the reference to the Alternative Monitoring Plan (AMP) approvals to include a new USEPA-approved AMP dated April 19, 2023, in addition to the previously referenced December 21, 2009 approval. This means that compliance can now be demonstrated under the terms of either AMP, potentially introducing new or revised monitoring requirements or flexibilities as specified in the 2023 AMP. The specific requirements of the new AMP are not detailed here, so the substantive impact depends on the content of the 2023 AMP.</p>	<p>Minor editorial change: 'approval' is changed to 'approvals' to reflect multiple AMPs. Parentheses are also adjusted for clarity.</p>	<p>The 2025 version adds reference to a new USEPA-approved Alternative Monitoring Plan dated April 19, 2023, allowing compliance under either AMP.</p>	<p>The compliance impact depends on the content of the new 2023 AMP; it could introduce new requirements or flexibilities. Review of the 2023 AMP is necessary to determine if compliance is more or less strict.</p>	<p>Significant Change; Requires review</p>



End-to-end example

Section 4 - Engine Information

Engine Function: ☐ Primary and/or Peaking Power ☐ Emergency (max. 500 hrs/year) ☒ Compression
☐ Pump Jack ☐ Water Pump ☐ Other: _____

What is the maximum number of hours this engine will be used for emergency back-up power? N/A hours/year

Engine Make: Caterpillar Engine Model: G3306NA Serial Number⁷: _____

What is the maximum designed horsepower rating? 145 hp

What is the maximum manufacturer's site-rating? 145 hp 108 kW

What is the engine Brake Specific Fuel Consumption at 100% Load? 7,775 BTU/hp-hr

Is this APEN reporting an AOS replacement engine? ☐ Yes ☒ No

If yes, provide the make, model, and serial number of the *old* engine below:

Engine Make: _____ Engine Model: _____ Serial Number: _____

Engine Features:

Cycle Type: ☐ 2-Stroke ☒ 4-Stroke Combustion: ☐ Lean Burn ☒ Rich Burn

Aspiration: ☒ Natural ☐ Turbocharged

Is this engine equipped with an Air/Fuel ratio controller (AFRC)? ☒ Yes ☐ No

If yes, what type of AFRC is in use? ☒ O₂ Sensor (mV) ☐ NO_x Sensor (ppm) ☐ Other: _____

Is this engine equipped with a Low-NO_x design? ☐ Yes ☒ No

```

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  "page_numbers": [
    3,
    4
  ],
  "pages": [
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      "page_number": 3,
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            ":unselected: Emergency (max. 500 hrs/year)",
            "\u2714 :selected: Compression",
            ":unselected: Pump Jack",
            ":unselected: Water Pump",
            ":unselected: Other:",
            "What is the maximum number of hours this engine will be used for emergency back-up?",
            "N/A",
            "hours/year",
            "Engine Make:",
            "Caterpillar",
            "Engine Model:",
            "G3306NA",
            "Serial Number7:",

```

model_output	{ "engine_function": "Compression", "engine_make": "Caterpillar", "engine_model": "G3306NA", "serial_number": "#####", "max_designed_hp": "145", "max_manufacturer_hp": "145", "engine_bsfc": "7,775", "engine_features_cycle": "4-Stroke", "engine_features_aspiration": "Natural", "combustion": "Rich Burn", "afrc_present": "Yes", }
engine_function	Compression
engine_make	Caterpillar
engine_model	G3306NA
serial_number	#####
max_designed_hp	145
max_manufacturer_hp	145
engine_bsfc	7,775
engine_features_cycle	4-Stroke
engine_features_aspiration	Natural
combustion	Rich Burn
afrc_present	Yes

06/29/25 07:25 PM

Section 4 – Engine Information

Field	Value
Engine Function	Compression
Engine Make	Caterpillar
Engine Model	G3306NA
Serial Number	
Maximum Designed Horsepower Rating	145 hp
Maximum Manufacturer's Site-Rating	145 hp
Engine Brake Specific Fuel Consumption at 100% Load	7,775 BTU/hp-hr
Is this APEN reporting an AOS replacement engine?	No
Cycle Type	4-Stroke
Combustion	Rich Burn
Aspiration	Natural
Equipped with Air/Fuel Ratio Controller (AFRC)?	Yes
Type of AFRC	O2 Sensor (mV)
Equipped with Low-NOx Design?	No
Manufactured Date	
Maximum Hours for Emergency Back-up Power	N/A

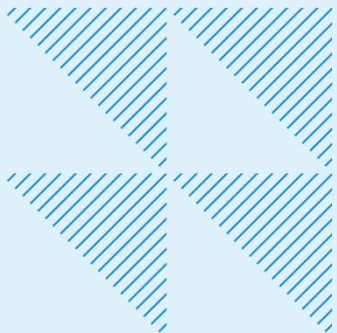
Notes:

- Some fields such as dates for order, first located to Colorado, first placed in service, commenced construction, and last reconstructed/modified were not provided.

Type your prompt here



Review Changes



Democratize Access to Data



SQL Query Assistant

1:17 PM ▲

Write me a SQL query so that I can see a list of all active engines in the DJ basin in 2024

1:17 PM

Plain-language summary:

This query returns a list of all active engines (`equipment_type_id = 4`) located in the DJ Basin (`area_id` in the DJ Basin `area_children` hierarchy) that were active at any point in 2024. It includes key identifying fields and filters out engines that are not currently active or not in the DJ Basin.

Key design decisions and logic:

- Uses `all_facility_equipment` as the main table for engine and facility data.
- Filters for **active engines** using `equipment_type_id = 4` and `equipment_status_id = 1`.
- Restricts to the **DJ Basin** using `area_id IN (SELECT area_id FROM area_children WHERE parent_area_id = 1)` is commonly used for DJ Basin in ACTS).
- Ensures the engine was active at any point in 2024 by checking `active_date` and `inactive_date` overlap with 2024.
- Returns key fields: area, facility, engine name, serial, manufacturer, model, and dates.

Data governance/trade-offs:

- Assumes `equipment_type_id = 4` is the canonical value for engines (see many engine queries, e.g., "Active Engines in ZZZZ portfolios").
- Uses `equipment_status_id = 1` for active status, which is standard across engine and equipment queries.
- Area filtering for DJ Basin is inferred from multiple queries using `parent_area_id = 1` (see "Active Engines in ZZZZ portfolios", "DJ Basin Active Engines Report").
- Date overlap logic ensures engines that were active at any point in 2024 are included, not just those still active at query time.

References:

- Query: "Active Engines in ZZZZ portfolios" (Engine Ops)

Type your prompt here



SQL Query Assistant

```
SELECT
    afe.area_list,
    afe.facility_id,
    afe.facility_name,
    afe.equipment_id,
    afe.equipment_name,
    afe.source_name,
    afe.alternate_name,
    afe.manufacturer_name,
    afe.model_name,
    afe.serial_number,
    afe.active_date,
    afe.inactive_date
FROM
    all_facility_equipment afe
WHERE
    afe.equipment_type_id = 4 -- Engine
    AND afe.equipment_status_id = 1 -- Active
    AND afe.area_id IN (
        SELECT area_id
        FROM area_children
        WHERE parent_area_id = 1 -- DJ Basin
    )
    -- Engine was active at any point in 2024
    AND afe.active_date <= TO_DATE('12/31/2024', 'MM/DD/YYYY')
```

Type your prompt here





Wrapping Up

Documents
as Files



Documents
as Data

ctrl + f



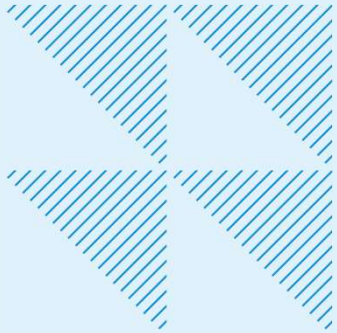
Interaction &
Integration



Wrapping up



1. Paradigm shift from regulations and permits as documents to data
2. Generative AI scales the synthesis of text, just like Excel and SQL did for tabular data
3. Reimagine how permits and regulations integrate with other data sources
4. How do you want to interact with your permits and regulations?



**Making the right decisions
with all the data available to us**

Can AI be Used in Regulatory Compliance? 7 Layers to Reduce Risk & Fail Gracefully

Thank you



ksong@barr.com



Nashville, TN



952-893-5233



Kyong Song

