MDMS *UPDATE*

~ METER DATA MANAGEMENT SYSTEM ~

US Army Corps of Engineers®

VOLUME 7, ISSUE 1 ~ OCTOBER — NOVEMBER 2021

FROM THE PROGRAM MANAGER

Welcome to our October - November 2021 issue of the *Meter Data Management System Update (MDMS),* designed to keep you informed on the growth and latest developments of the Meter Data Management System and the Army Metering Program.

As we discussed in the previous newsletter, network interruptions and outages continue to be a concern for Army Leadership, as well as local DPW and Energy Managers alike. Our "Addressing Meter Data Loss" training session continues to be well-attended, with Energy Managers asking how to get help in troubleshooting meter outages but also analyzing the quality of meter data.

To continue our efforts of assisting Energy Managers with these challenges, this newsletter focuses on addressing meter data quality. As we've discussed on many occasions, the consistency of meter data reporting is important to your energy use metrics and analysis. This newsletter will also focus on specific problem areas that affect meter data quality, as we have assessed that the impact of meter data quality to the Army's Metering Program is significant.

As always, our mission is to improve the MDMS experience for end users. Your input is valuable, and we welcome your feedback via the Army Meter Service Desk (AMSD) at: usarmy.coe-huntsville.cehnc.mbx.armymeterhelp@mail.mil

ADDRESSING METER DATA QUALITY

When assessing the quality of meter data at any installation or site, an Energy Manager should ask themselves a few questions first. Is the data quality adequate? Is the meter reporting enough to check quality? Is the data usable for your energy analysis? There are many factors that can affect the quality of the meter data, such as redundant data values, on/off fluctuations, meter multipliers, multiple readings for the same date/timestamp, and there may also be multiple issues affecting a meter making analysis more difficult.

We have found approximately ten tests that indicate specific problem areas for a meter that are an indicator for poor data quality metrics:

1. Is Baseload in Tolerance?
2. % Repeated Readings
3. % Zero Readings
4. Is Data Incrementing Upward?
5. Is there Flux Behavior?
6. Is the reading Precision Correct?
7. % Missing Data
8. % Baseload
9. % Smoothing
10. Sum of the Interval Usage vs. End-to-End Meter Readings

The overall impact of meter data quality to the Army's Metering Program is significant, as shown in the chart (right), which is an AMC Garrison point-in-time example of their meter data. *(Continued on pg. 2)*

	# Meters	% of Total
Total Meters	12461	
Connected (all but 1 week in the QTR)	6937	55.7%
Good Data Quality	3200	25.7%

% Good Data Quality of Connected Meters	46.1%	
Who can impact meters not Connected	NETCOM	DPW
Breakdown of Good Data Quality Source	Meter	Server

ADDRESSING METER DATA QUALITY (CONT. FROM PG. 1)

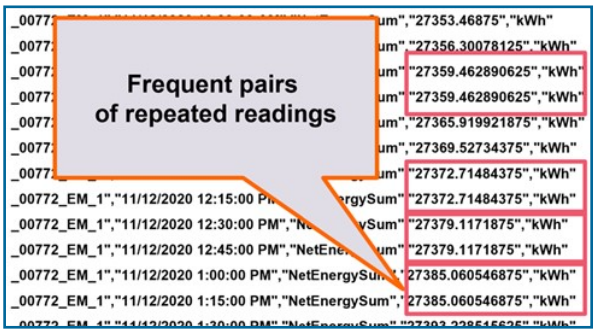
Who can troubleshoot and fix non-reporting meters? Generally, NETCOM, especially if you have zones with outages. Sometimes there are upgrades to systems on the network and the meter may need to be rebooted. In some cases, we've seen where the meters were disconnected from the network for some reason in the building.

Where is the breakdown of good data quality? Somewhere between the meter and the server but the issue can also be the network itself. In the previous example, almost half of the installations had connectivity problems, approximately a quarter of them had bad data, with the remainder having good data.

% Repeated Readings

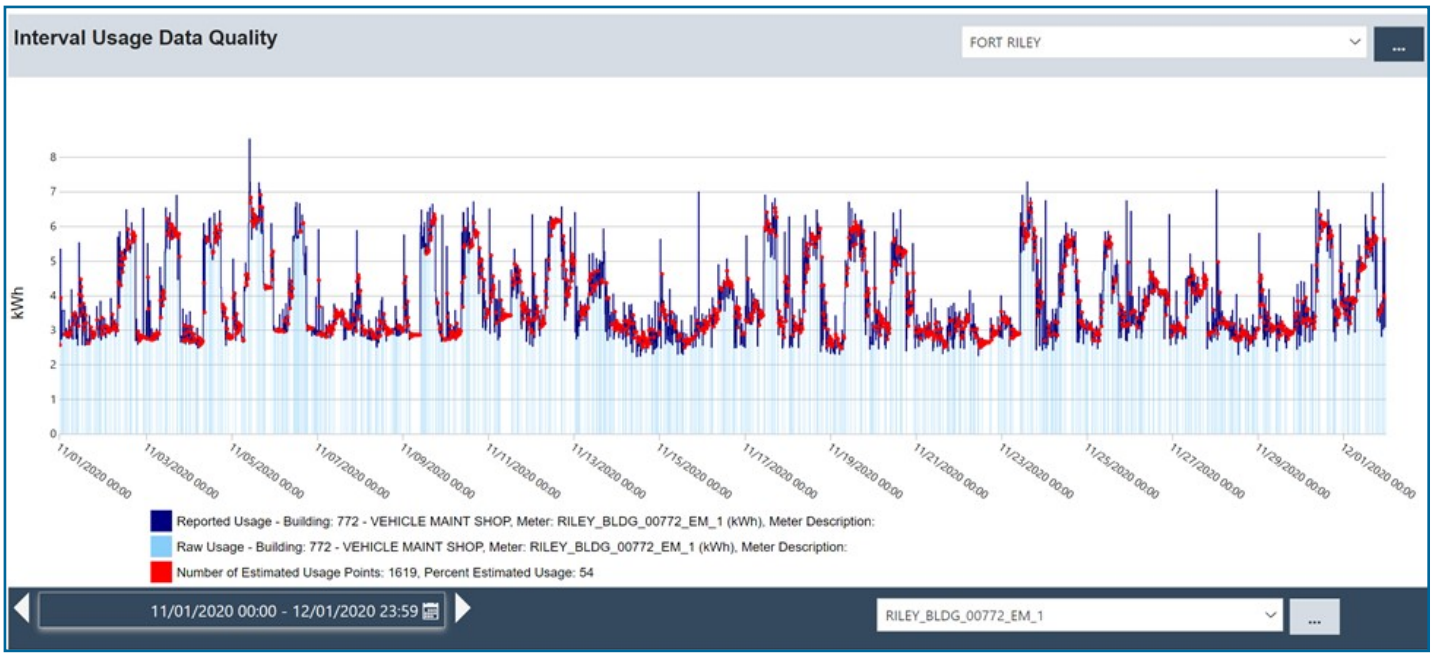
Repeated (redundant) readings are a condition where the meter reading does not increment from one interval to the next and happen most often when readings don't get through. When this happens, it overshadows other issues and factors that may also be occurring. We have found the redundant readings to be extensive. For electric meters, usage for redundant readings is smoothed (estimated), which downgrades the quality. When we see more than 20% of these redundant readings, we have a major breakdown in the quality of the meter data. Redundant data values may indicate a problem with the priority of the data transmission.

We recommend checking the meter system data identifier, which generally defaults to priority 3. We recommend setting the priority to 1 or in worst case to priority 2. This doesn't impact the overall traffic since the meter represents a minor number of points on the network.



Any additional redundant readings are because meters are not transmitting up the network. In the example file of readings to the right, we have highlighted frequent pairs of repeated readings.

The screenshot below displays what that same time period and interval readings look like in the Interval Usage Data Quality report. The red points are the redundant values that have to be estimated and as can be seen the percent of estimate usage is at 54% of the points.



% Zero Readings

Receiving a meter reading of 0 is a failure when it comes to data quality, as this means there is a lack of connection from the meter to the EEDRS. Readings should be in values greater than 0 for electric meters. Readings of 0 are also a false output, as they are generated when nothing gets through on the network. It gives the indication of a connection, but it's not really there. *(Continued on pg. 3)*

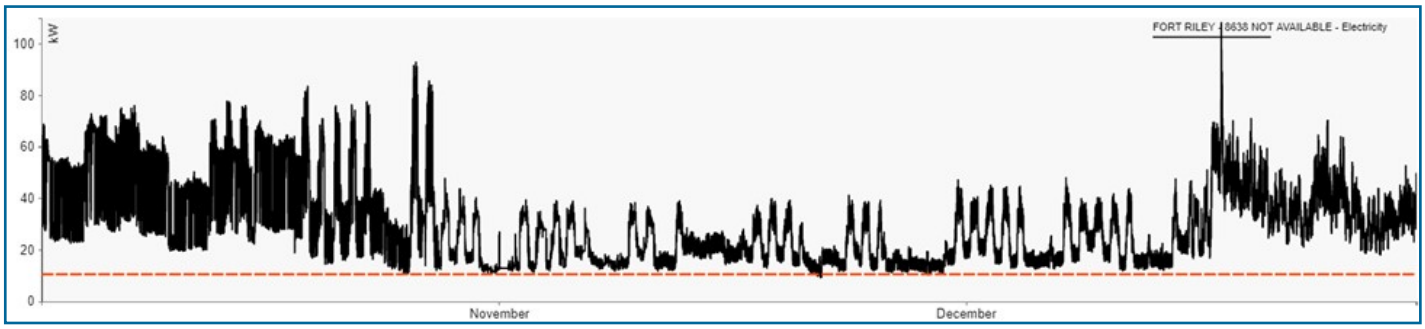
ADDRESSING METER DATA QUALITY (CONT. FROM PG. 2)

Are Data Readings Incrementing Upward?

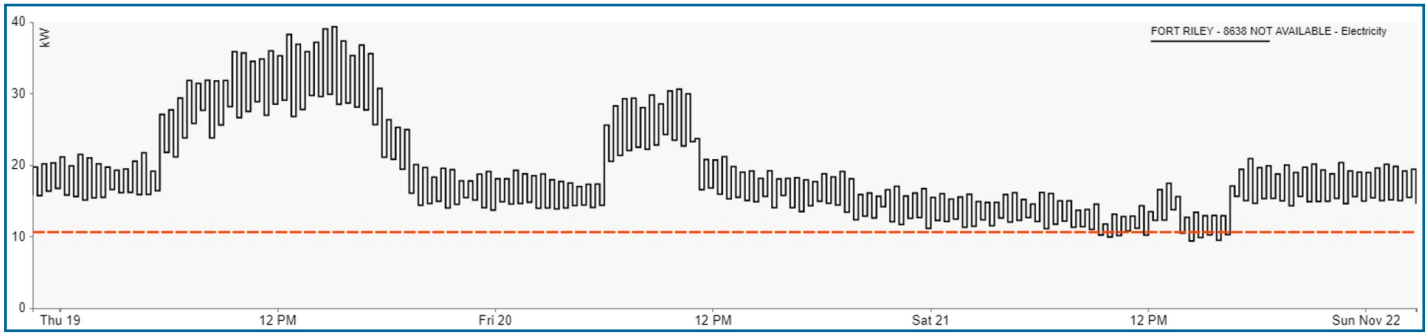
Did you get any readings? If so, are they incrementing in an upward direction (meaning that the consumption is increasing)? We should not have a reading that goes backwards. The only situation where that should occur is where you have renewables behind the meter. If there is no change in the reading, then it is a conditional failure. If we did not get a reading, there is no way to check it. Having the ability to check the readings is fundamental to showing the meter is working.

Is it Flux Behavior?

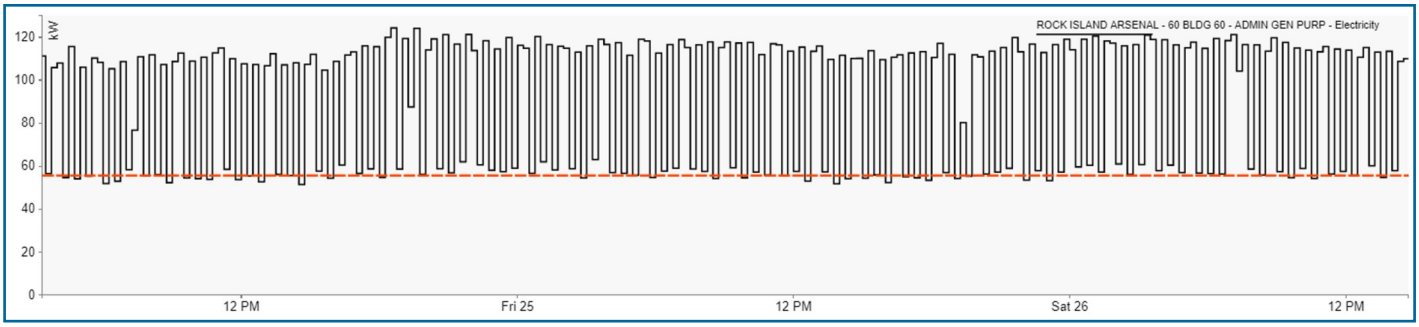
Up/down fluctuations—flux—are when the meter alternates going up and down every 15 minutes. The amplitude is approximately 20% of the load and in most cases, they are consistently a very similar amplitude change. Some intervals vary at different amplitudes every 15 minutes, but they have the same look when it comes to the blocks of up/down fluctuations. While we aren't sure of the cause, we do know that this is not normal behavior for meters. In the example below, shown in the Interval kW benchmarking tool, the intervals look normal in the November and December months where you can see the five days of the week and the weekends.



But upon drilling/zooming in on the intervals, the 15 minute up/down fluctuations become apparent.



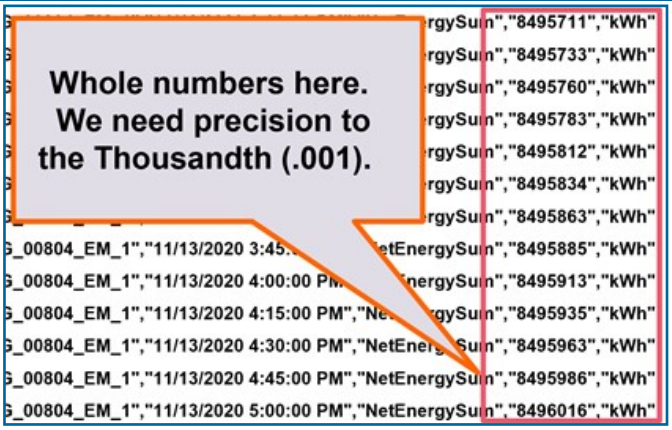
Below is another example of the 15 minute up/down flux, but the amplitudes are much larger.



Are We Getting the Correct Precision?

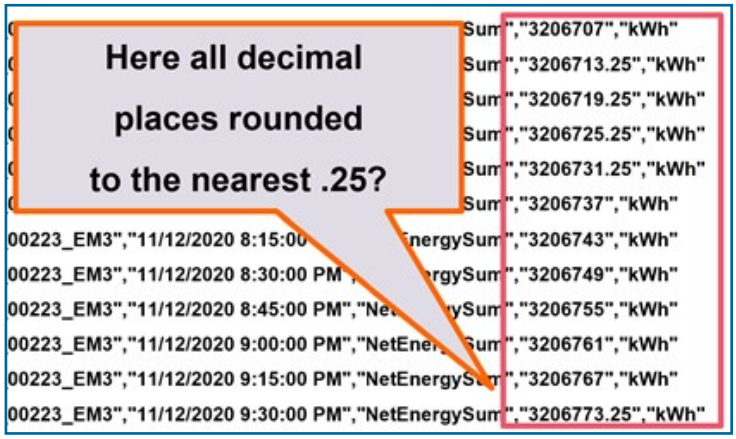
The following examples show multiple cases of various precision issues. Precision issues could cause data metrics to be off on midsize buildings by 3% and by as much as 25% on a small building. On a large building, it may not be as noticeable. *(Continued on pg. 4)*

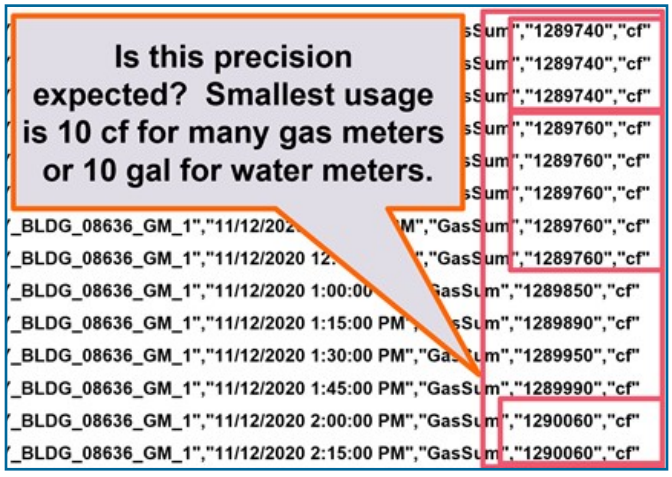
ADDRESSING METER DATA QUALITY (CONT. FROM PG. 3)



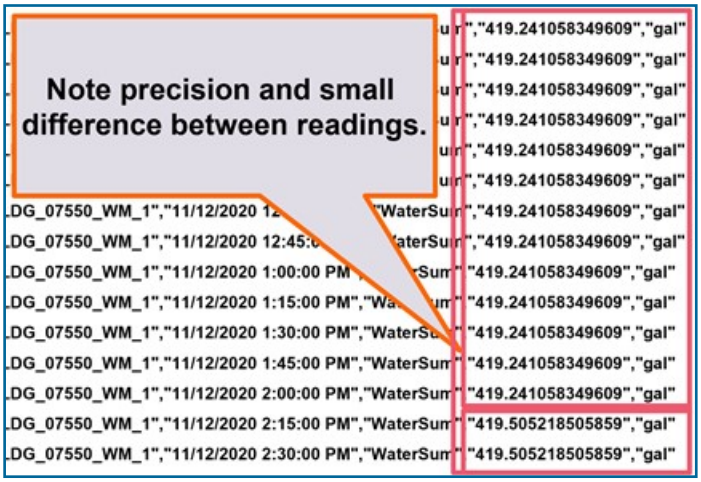
Our first example to the left, shows readings of all whole numbers. For our meter data analysis to be more accurate, we need the precision to be to the thousandth (.001).

This next example (right) shows the decimal places are rounded to the nearest .25, so you see we have readings with .25, .50, .75 and whole numbers.





This next example (left) begs the question “is this precision expected?” The smallest usage is generally 10 cubic feet (cf) for gas meters and 10 gallons (gal) for water meters. These could be pulse kits but set to not roll over until they reach a particular increment.



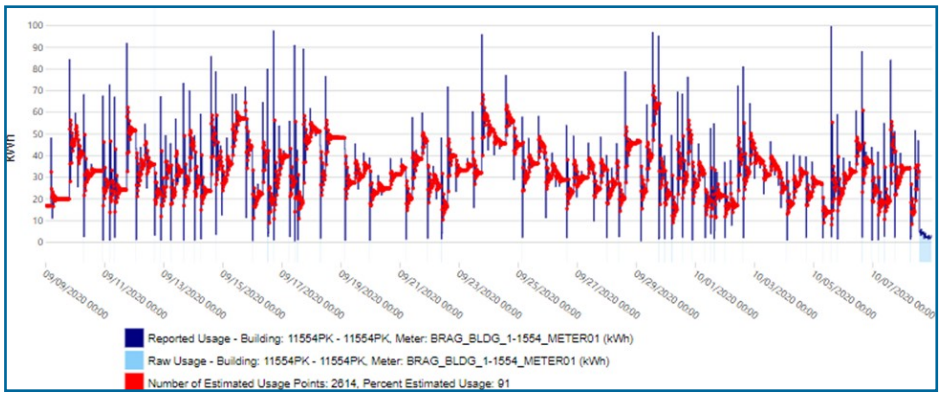
In this example (right), note the precision and the fact that there is very little difference between readings. This is a good indicator that it is probably a meter multiplier issue.

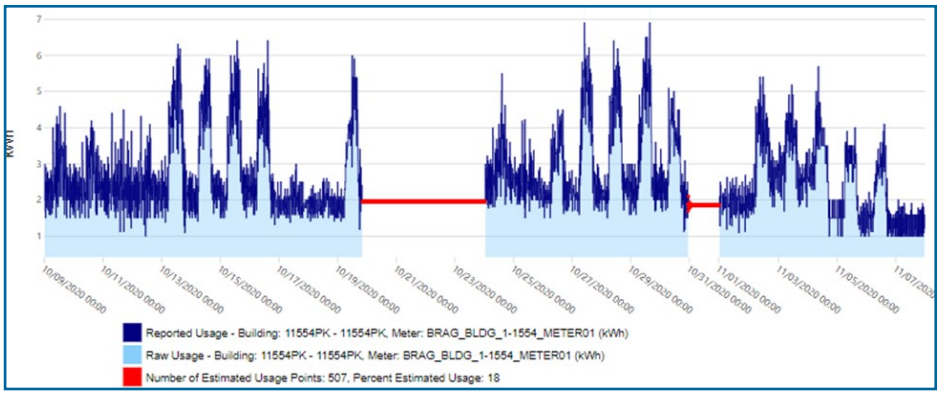
(Continued on pg. 5)

ADDRESSING METER DATA QUALITY (CONT. FROM PG. 4)

% Missing Data

Any meter with greater than 35% smoothed (estimated) data indicates too much missing data to be reliable/usable. It could be one period or every other reading that is missing. Below is an example where there is high estimated usage at 91% and then the second graph shows the results after the meter and/or network was restored where the estimated usage is down to 18% with two short network outage durations.





% Of Baseload

In our Advanced Metrics for Systems training webinar, we utilize stop light charts like the one shown below, which is generated from the Base Load Comparison report located on the Energy Management page under the Benchmarking sub-menu. The “Baseload as % of Consumption” column values we highlight are surrounded with the purple box. For one shift operation buildings, we advise that 75% is the top-end maximum and 15% is the bottom-end minimum theoretical maximums for a good, metered building.

In the chart (right), those buildings with % of baseload above 75% are highlighted in red. These buildings are wasting a considerable amount of energy. They could potentially have a baseline set incorrectly, which is easy to check using the Benchmarking Interval kW module. We believe these have an 85% probability that they have a bad meter, as the only technically feasible buildings that might be this high are pumping stations or Communications Centers where you have a load that runs continuously.

			120	bad		110		98		
			371	good		371		371		
			32.3%			29.6%		26.4%		
		median	0.257		0.10	29.33		27.337	10.93	
Square	Cat Code	Base Load	Watts/Sf	12 Months C		Baseload	12 Months	12 Months	% of Da	Climate
11857	CO HQ BLDG (14185)	29.004	2.446	9,215.99		105.743	2.652	69.144	3.836	5A
11909	CO HQ BLDG (14185)	19.873	1.669	28,338.97		100.982	8.12	49.394	16.438	5A
10775.12	CO HQ BLDG (14185)	8.154	0.757	22,220.46		100.404	7.037	22.529	31.233	5A
11909	CO HQ BLDG (14185)	27.93	2.345	127,771.34		100.202	36.609	69.959	52.329	5A
10775.12	CO HQ BLDG (14185)	5.957	0.553	49,388.26		100.159	15.639	16.498	94.795	5A
7821	CO HQ BLDG (14185)	5.83	0.745	18,652.50		97.517	8.138	22.848	35.616	3A
38736	CO HQ BLDG (14185)	56.611	1.461	204,420.14		92.386	18.007	47.284	38.082	3A
13595	CO HQ BLDG (14185)	30.179	2.22	289,566.73		85.296	72.677	77.792	93.425	2A
15295	CO HQ BLDG (14185)	3.997	0.261	40,186.84		81.406	8.965	9.596	93.425	2A
48006	CO HQ BLDG (14185)	43.012	0.896	114,557.23		81.101	8.142	33.022	24.658	4A
16317	CO HQ BLDG (14185)	21.744	1.333	67,123.20		79.299	14.036	50.229	27.945	4C
25164	CO HQ BLDG (14185)	0.098	0.004	1,039.45		76.55	0.141	8.152	92.877	2A
14314	CO HQ BLDG (14185)	10.898	0.761	125,855.63		75.643	30.001	30.083	99.726	4A
1520	CO HQ BLDG (14185)	0.004	0.002	24.80		75.552	0.056	0.096	57.808	5A
24000	CO HQ BLDG (14185)	32	1.333	382,523.97		73.282	54.384	54.384	100	5B
83253	CO HQ BLDG (14185)	51.213	0.615	174,608.05		71.801	7.156	25.608	27.945	4C
25168	CO HQ BLDG (14185)	14.413	0.573	168,403.49		69.634	22.831	24.582	92.877	2A
41925	CO HQ BLDG (14185)	55.683	1.328	710,998.57		68.605	57.865	57.865	100	3A
2418	CO HQ BLDG (14185)	1.976	0.817	26,324.13		65.77	37.147	37.147	100	3A
3591	CO HQ BLDG (14185)	1.965	0.547	27,260.41		63.131	25.902	25.902	100	3A
44063	CO HQ BLDG (14185)	18.241	0.414	71,095.30		62.808	5.505	19.701	27.945	4C
14308	CO HQ BLDG (14185)	2.4	0.168	31,958.18		61.448	7.621	8.158	93.425	2A
52135	CO HQ BLDG (14185)	13.447	0.258	54,275.25		60.652	3.552	12.711	27.945	4C
5939	CO HQ BLDG (14185)	7.224	1.216	107,864.84		58.67	61.971	61.971	100	2A
25168	CO HQ BLDG (14185)	22.474	0.893	37,705.04		58.651	5.112	45.508	11.233	2A
39986	CO HQ BLDG (14185)	31.464	0.787	271,497.31		57.574	23.168	40.851	56.712	4A

For the yellow highlighted buildings, we recommend checking the building for excessive use, *(Continued on pg. 6)*

ADDRESSING METER DATA QUALITY (CONT. FROM PG. 5)

as systems most likely were left on during non-duty hours. While the probability is wasted energy, in some cases, there is a small chance that these may also be a bad meter.

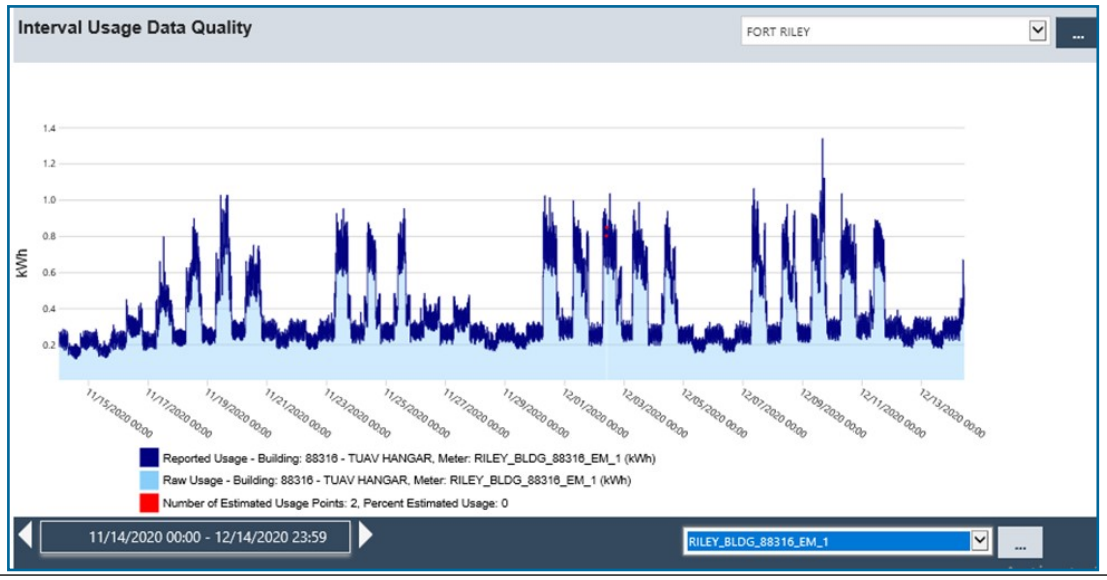
In the chart below, those buildings below the median are highlighted in green, light blue and red. Note the median is highlighted in the darker blue at 29.33. Below the median, the green highlighted cells indicate buildings with good energy management practices, but there still is room for improvement. The light blue highlighted cells show buildings with exceptional energy use, with a 95% estimated probability that they are in the top 75 percentile and only a very slight possibility of a bad meter. The red highlighted cells indicate buildings with an 85% probability that they have a bad meter, a wrong meter multiplier, meter connectivity issues, or the meter is just not reporting enough to set a baseline.

			120	bad	110		98		
			371	good	371		371		
			32.3%		29.6%		26.4%		
		median	0.257	0.10	29.33		27.337	10.93	
Square	Cat Code	Base Loa	Watts/SF	12 Months C	Rescaled	12 Months	12 Months	% of Da	Climat
14864	CO HQ BLDG (14185)	3.498	0.235	104,188.1	29.406	23.917	23.917	100	3A
64845	CO HQ BLDG (14185)	13.342	0.206	398,480.3	29.33	20.968	20.968	100	3B
41401	CO HQ BLDG (14185)	8.013	0.194	240,167.9	29.228	19.794	19.794	100	5B
35918	CO HQ BLDG (14185)	6.466	0.18	194,991.7	29.046	18.524	18.524	100	3B
16456	CO HQ BLDG (14185)	3.485	0.212	116,978.6	26.097	24.255	24.255	100	3B
33237	CO HQ BLDG (14185)	14.275	0.43	479,612.8	26.002	49.237	49.373	99.726	2A
14513	CO HQ BLDG (14185)	3.293	0.227	111,158.3	25.952	26.134	26.134	100	3A
23617	CO HQ BLDG (14185)	2.549	0.108	86,499.9	25.816	12.497	12.497	100	5B
37964	CO HQ BLDG (14185)	27.08	0.713	925,402.8	25.634	83.174	83.174	100	3A
5952	CO HQ BLDG (14185)	2.513	0.422	109,246.2	20.094	62.628	62.8	99.726	2A
16006	CO HQ BLDG (14185)	3.594	0.225	158,191.8	19.848	33.723	33.816	99.726	2A
5945	CO HQ BLDG (14185)	0.752	0.126	34,028.9	19.358	19.531	19.531	100	2A
25168	CO HQ BLDG (14185)	6.028	0.24	147,265.6	19.255	19.965	37.18	53.699	2A
5968	CO HQ BLDG (14185)	0.712	0.119	33,664.1	18.469	19.247	19.3	99.726	2A
54872	CO HQ BLDG (14185)	13.966	0.255	664,072.7	18.422	41.294	41.294	100	2A
34215	CO HQ BLDG (14185)	60.969	1.782	3,012,365.2	17.73	300.412	300.412	100	3A
4800	CO HQ BLDG (14185)	0.929	0.194	45,837.4	17.711	32.584	32.673	99.726	2A
27667	CO HQ BLDG (14185)	3.379	0.122	167,299.0	17.692	20.633	20.633	100	3B
55333	CO HQ BLDG (14185)	8.627	0.156	432,217.6	17.484	26.653	26.653	100	3A
1821	CO HQ BLDG (14185)	1.957	1.075	99,121.3	17.299	185.731	185.731	100	3A
5945	CO HQ BLDG (14185)	1.413	0.238	72,441.3	17.086	41.578	41.578	100	2A
12180	CO HQ BLDG (14185)	1.456	0.12	45,351.2	16.722	12.705	21.37	59.452	2A
19142	CO HQ BLDG (14185)	2.294	0.12	120,408.1	16.686	21.463	21.463	100	3A
31035	CO HQ BLDG (14185)	3.245	0.105	171,227.1	16.556	18.825	18.877	99.726	2A
46376	CO HQ BLDG (14185)	9.494	0.205	513,676.5	16.191	37.794	37.794	100	3B
3707	CO HQ BLDG (14185)	0.695	0.187	38,573.8	15.781	35.505	35.505	100	3A
40219	CO HQ BLDG (14185)	31.593	0.786	1,798,418.8	15.389	152.575	152.575	100	3A
5927	CO HQ BLDG (14185)	0.746	0.126	43,983.2	14.817	25.321	25.39	99.726	2A
40219	CO HQ BLDG (14185)	21.486	0.534	1,273,536.0	14.779	108.045	108.045	100	3A

Multipliers

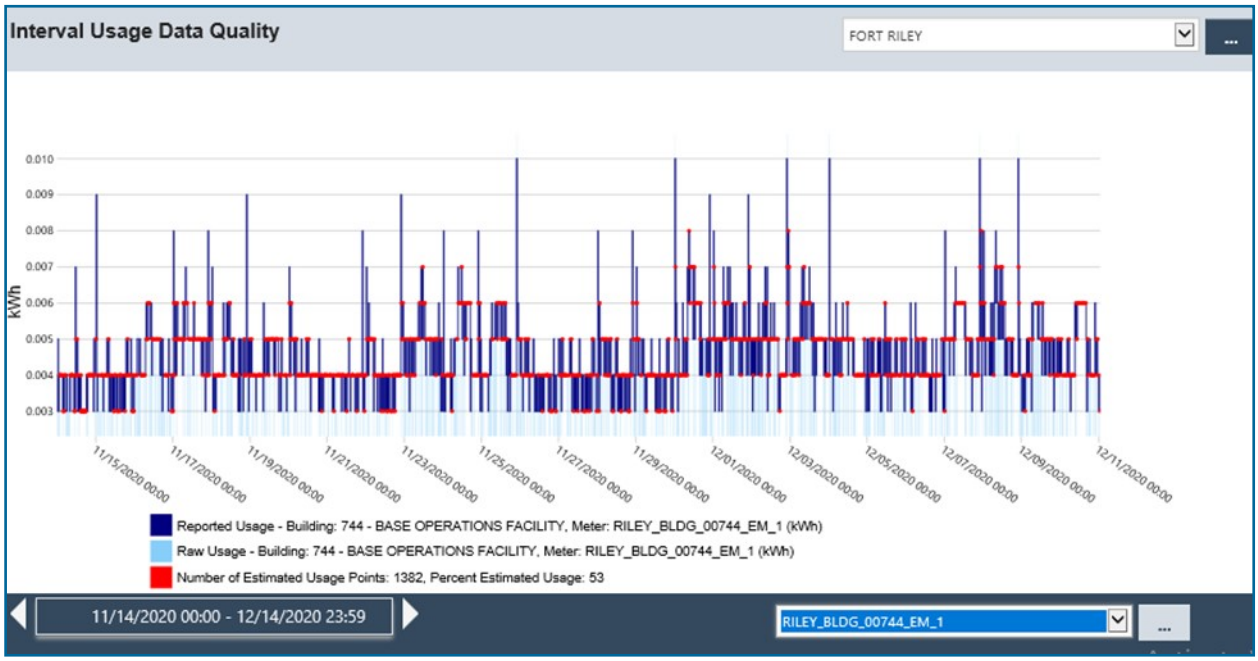
Multipliers are usually applied at the meter to convert the meter signal based on the voltage and length of the wire run to the CT. These are shown on the design and can vary in many different multiplier numbers. It could also be applied as a mWh or Wh to kWh at the EEDRs or on submission to MDMS in error. In this case the meter is off by 1000X either way. We are finding that certain meters are not currently configured properly and can be over or underreporting in MDMS. We have assessed that the meters that are underreporting are doing so significantly. The graph for these meters usually has a curve, varies consistently and can be off by a factor of anywhere from 2 to 1000. And this can mask other issues, especially if it's off by 1000.

In the example shown below, the meter is probably around 10X off which means it has to be corrected at the meter itself . *(Continued on pg. 7)*

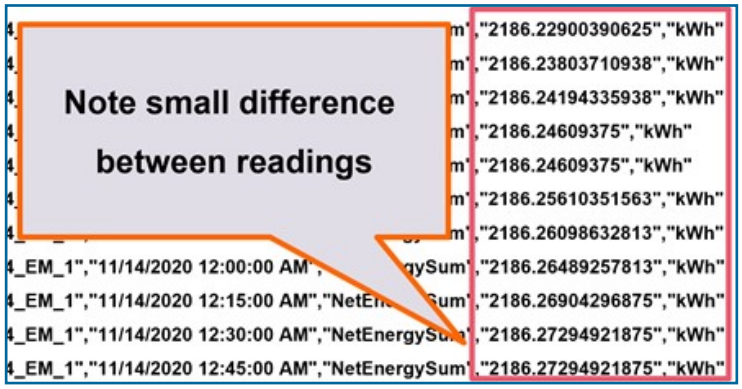


ADDRESSING METER DATA QUALITY (CONT. FROM PG. 6)

This next example has two issues. The intervals are reading at .003 kWh, which indicates the meter multiplier is off by 1000X, as none of our meters should report that low. We can see a second problem also in an excess of estimated usage problem as well, given that the estimated usage is at 53%, which is above our recommended 35% threshold.

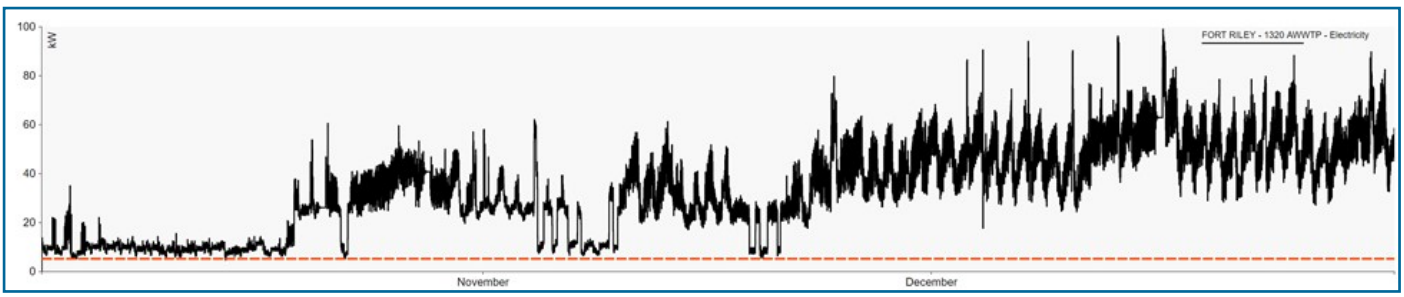


In the example file of readings to the right, there is only a very small difference between the readings in the meter file.



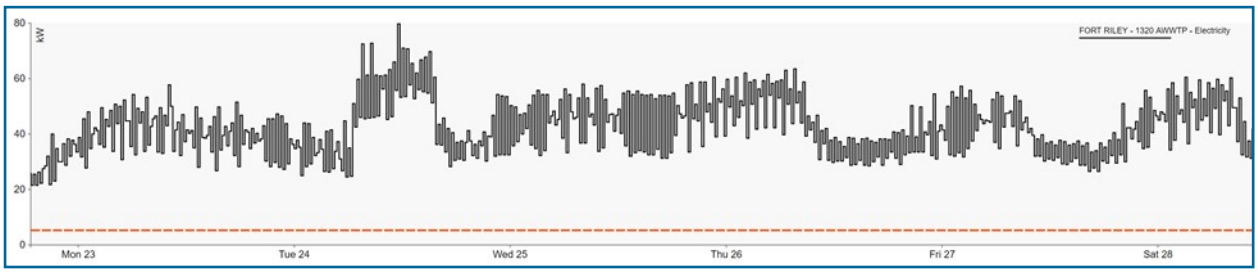
Multiple Issues

Some meters have multiple issues that need to be addressed. The usual indicator for this is that the usage does not represent a sine wave or curve, they could have redundant readings masking other issues, and there could be other issues as well. In the graph below, notice there is no distinct pattern. *(Continued on pg. 8)*

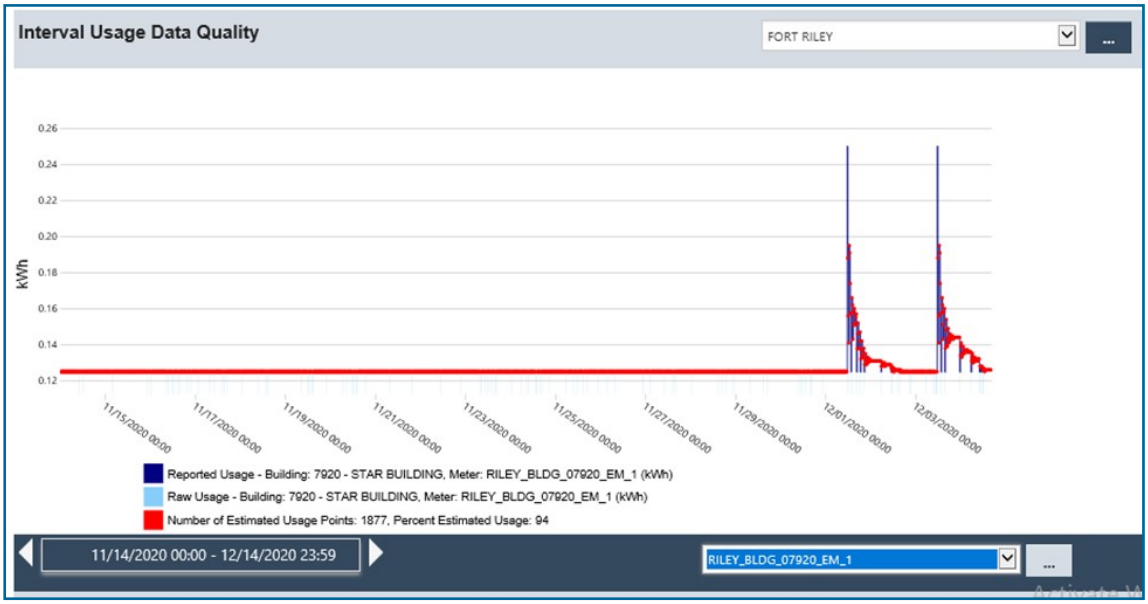


ADDRESSING METER DATA QUALITY (CONT. FROM PG. 7)

In the below graph, we have zoomed in on almost a week's worth of data. There are clearly multiple issues with this meter, but no indication of what those issues could be.



In the example below, the meter is not connected enough to provide adequate data for the energy manager to use in any analysis. In addition, the meter has a multiplier problem and is also underreporting.



Is Baseload in Tolerance?

We have found that the baseload translated to watts per sf is a good metric to apply for all facilities. Each baseload can be compared against the other benchmarks in that facility Category Code. The median for that Category Code doesn't vary much across the Army and is not affected by climate zones. In general any building that has a baseload that is 2X the median has an 85% probability that the meter is bad. Any number that is less than .5X the median has the same probability on the lower end. This value does not help in determining the underlying problem but it is accurate as a benchmark on determining meter issues.

Next Steps for Meters

So now that we know what types of problems are causing data quality issues, what should be the preferred sequence of steps for resolving these meter problems?

1. Check and fix the priority of meter data transmission.
2. Check on the flux (up/down) on several meters to determine the cause. We believe this is probably due to off sync on transmission of values somewhere between the meter and the EEDRS.
3. Check on meters with a multiplier.
4. Fix your truncated values to read to .001 precision.
5. Have a follow-up call with the MDMS Outreach Team to discuss findings and we will rerun our meter analysis and check back with you.

Remember, your MDMS Program Team is here to help, so feel free to reach out any time you need assistance or have questions/concerns via the Army Meter Service Desk (AMSD).