NOVO ENGINEERING®

CLIENT:	VotingWorks
PROJECT:	VXScan
DOCUMENT NUMBER:	VWX-002-D003
DOCUMENT TITLE:	4.0 Emissions Test Report
REVISION:	X01
DATE:	7/23/2024

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1.0 PURPOSE AND SCOPE

The purpose of this test is to verify that the unintentional electromagnetic emissions from the VXScan do not exceed the limits for FCC Class B devices.

2.0 REFERENCES

2.1 Internal References

Document Number	Document Title
N/A	VxScan Electromagnetic Compatibility (EMC), Environmental, and Vibration Testing RFP, 5/1/2024 Version
N/A	VxScan v3.1 and v4.0 Tests of Normal Function, 5/20/2024 Version

2.2 External References

Document Number	Document Title
47 CFR 15	FCC Part 15 Class B, Unintentional Radiators

3.0 ACRONYMS AND TERMS DEFINED

Acronym	Definition
EUT	Equipment Under Test
EMC	Electromagnetic Compatibility
NRTL	Nationally Recognized Testing Laboratory

Term	Definition
Shoeshine Mode	A mode in which the machine repeatedly scans the same ballot without user intervention

4.0 ITEMS UNDER TEST, MATERIALS, EQUIPMENT, AND CONDITIONS

The VXScan device is placed in a shielded room and its emissions are monitored during operation using antennas and an RF spectrum analyzer.

4.1 Items Under Test

Item	Item #	Rev	Lot #	Sample Size
EUT	VXScan	4.0	n/a	1

4.2 Materials

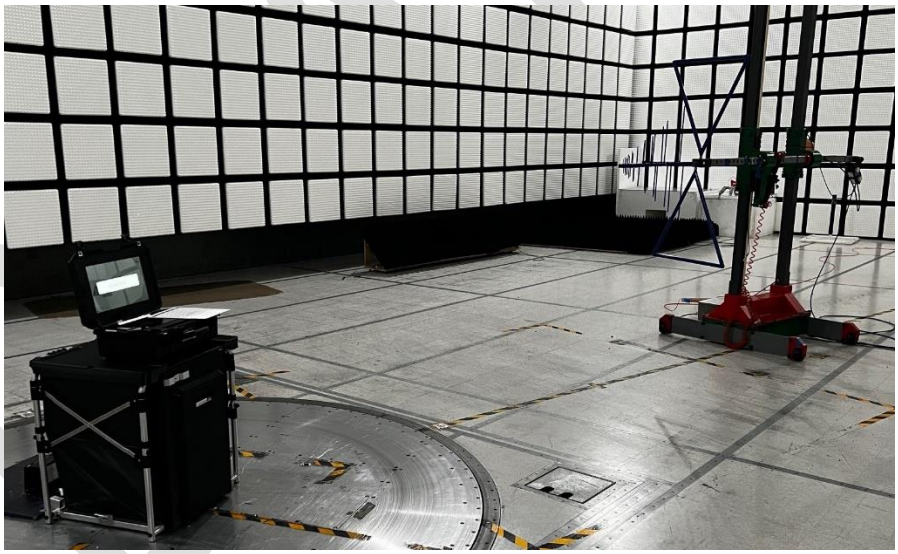
Item	Item#	Lot #	Sample Size
Sample Ballots			

4.3 Conditions

The test is performed in an electromagnetically shielded room at a NRTL (Nemko USA).

5.0 PROCEDURE

The EUT is placed in a shielded room and its emissions are monitored during operation using antennas and an RF spectrum analyzer. The EUT is operated in shoeshine mode during the test to ensure as many of the internal components are active as possible and normal operation is simulated. During the test, the EUT is rotated, the antenna height is varied, and the antenna is oriented horizontally and vertically to ensure a thorough measurement of emissions from all angles and directions. Detailed scans of the emissions from the EUT are recorded at many frequencies, heights, angles and polarizations. The frequencies cover the range from 30MHz to 18GHz in two bands: 30MHZ – 1GHz and 1GHz – 18GHz due to antenna limitations.



6.0 ACCEPTANCE CRITERIA

The magnitude of the emissions must be below the specified limit line on the graph.

7.0 DATA ANALYSIS

The NRTL provides graphs and tables to summarize the test. The graphs show an overview of the emissions over the full frequency band. The table gives a list of frequencies that are either over the limit or close to it.

8.0 DATA

The graphs and tables are included in the appendix.

9.0 RESULTS

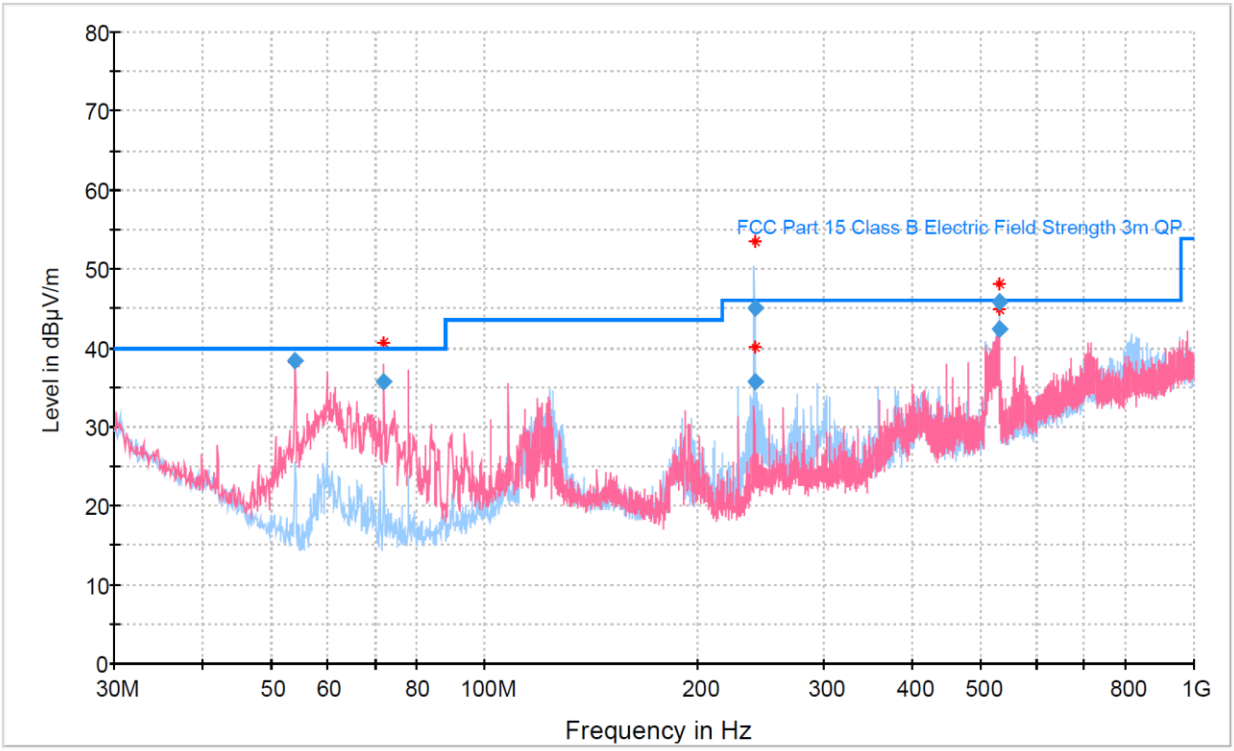
These were preliminary scans and not the final test, so there is no pass or fail. However, with a few minor modifications, the unit is likely to pass the formal test when it is performed.

10.0 CONCLUSION & RECOMMENDATIONS

The VXScan device scans are looking good and have no egregious emissions. Removing the separate USB 2.0 cable from the display as was originally planned and adding some additional grounding should allow the unit to pass the test. See the data section for details.

APPENDIX 1: DATA

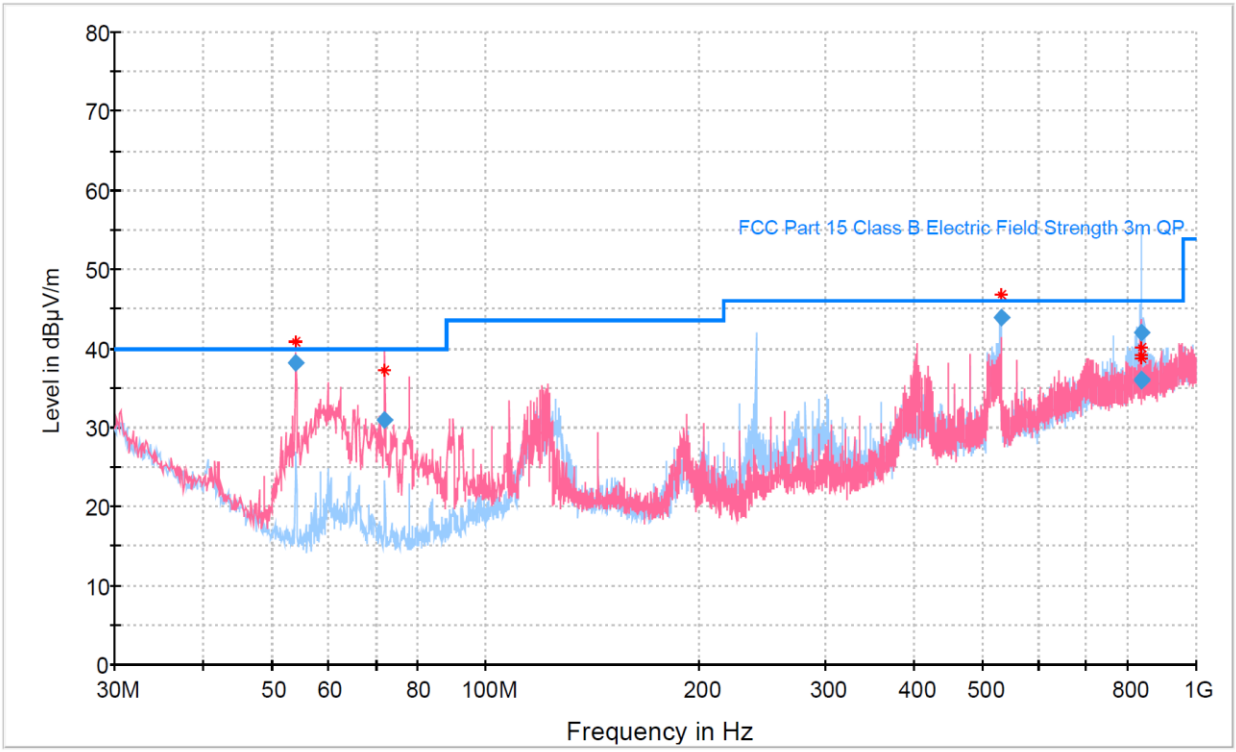
This is the baseline scan. This is the stock configuration except a broken ground wire between the two halves of the scanner was repaired and an additional chassis ground connection was added between the ground lug on the scanner PC board and the metal frame of the unit.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
53.979000	38.32	40.00	1.68	5000.0	120.000	109.0	V	137.0	14.1	
72.004000	35.73	40.00	4.27	5000.0	120.000	126.0	V	56.0	13.8	
240.008000	35.62	46.00	10.38	5000.0	120.000	352.0	H	293.0	19.6	
240.014000	45.11	46.00	0.89	5000.0	120.000	126.0	H	167.0	19.6	
531.122000	42.46	46.00	3.54	5000.0	120.000	265.0	H	33.0	27.3	
531.978000	45.83	46.00	0.17	5000.0	120.000	129.0	H	128.0	27.3	

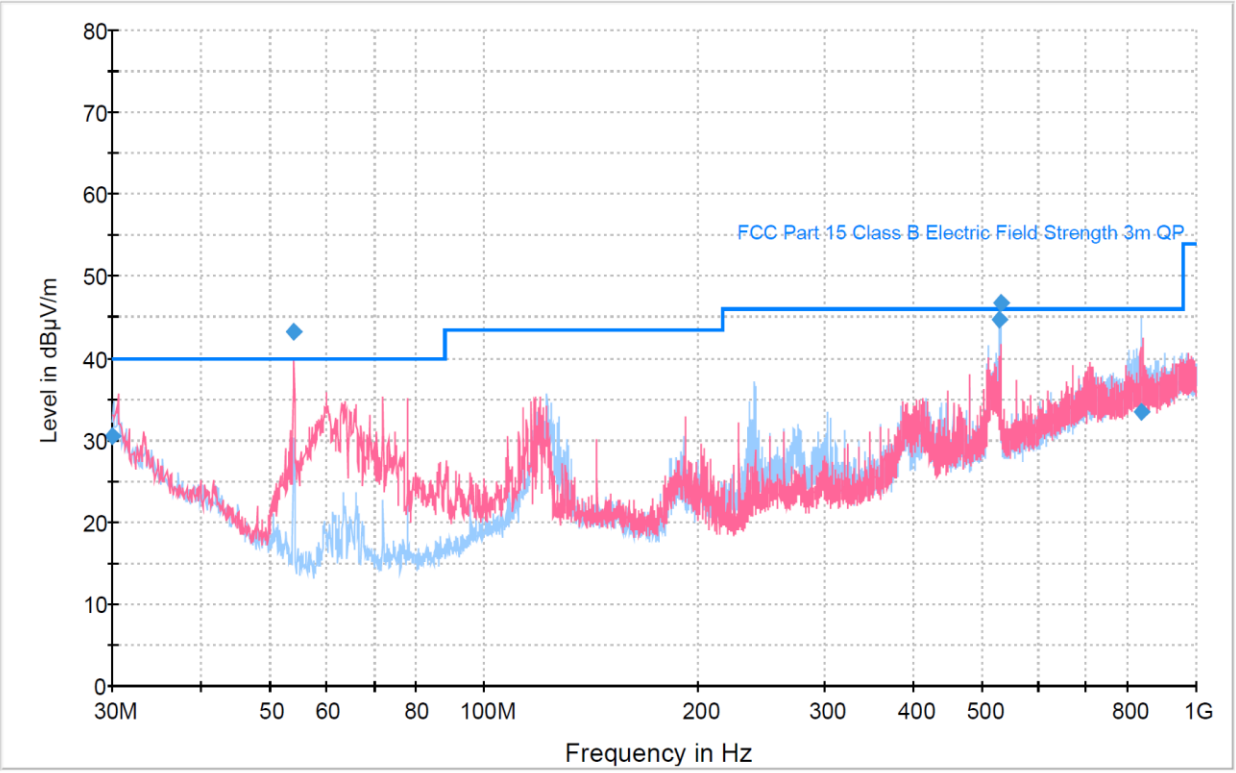
For this scan, the display's ground connection was improved so the ring lug had full contact with the mounting frame of the display.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
54.019000	38.16	40.00	1.84	5000.0	120.000	109.0	V	174.0	14.1	
72.061000	30.98	40.00	9.02	5000.0	120.000	120.0	V	201.0	13.8	
531.932000	43.95	46.00	2.05	5000.0	120.000	255.0	H	32.0	27.3	
836.159000	35.96	46.00	10.04	5000.0	120.000	144.0	H	139.0	31.9	
837.236000	36.12	46.00	9.88	5000.0	120.000	100.0	H	181.0	32.0	
837.767000	42.01	46.00	3.99	5000.0	120.000	98.0	H	284.0	32.0	

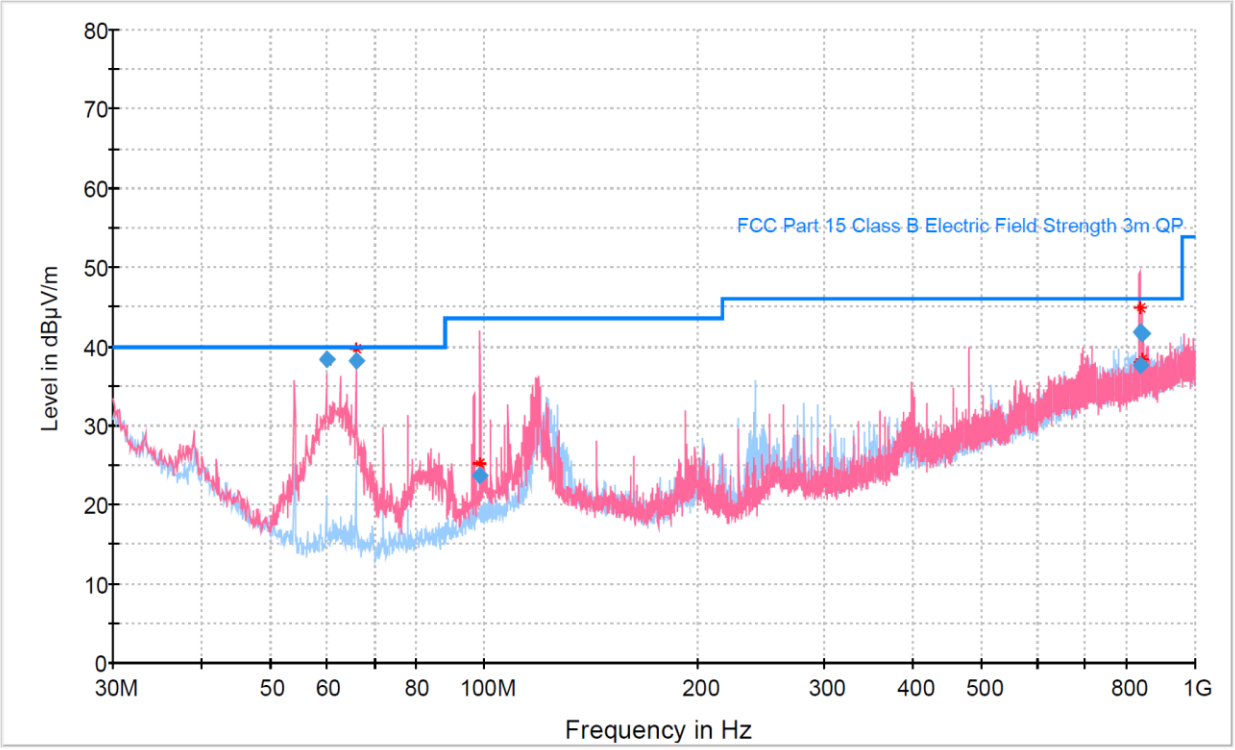
For this scan, a ground wire was added between the printer/scanner access door and the chassis.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
30.040000	30.52	40.00	9.48	5000.0	120.000	402.0	V	150.0	26.6	
53.979000	43.29	40.00	-3.29	5000.0	120.000	100.0	V	197.0	14.1	
529.832000	44.66	46.00	1.34	5000.0	120.000	119.0	H	137.0	27.2	
531.139000	46.71	46.00	-0.71	5000.0	120.000	129.0	H	137.0	27.3	
836.250000	33.45	46.00	12.55	5000.0	120.000	155.0	H	255.0	31.9	

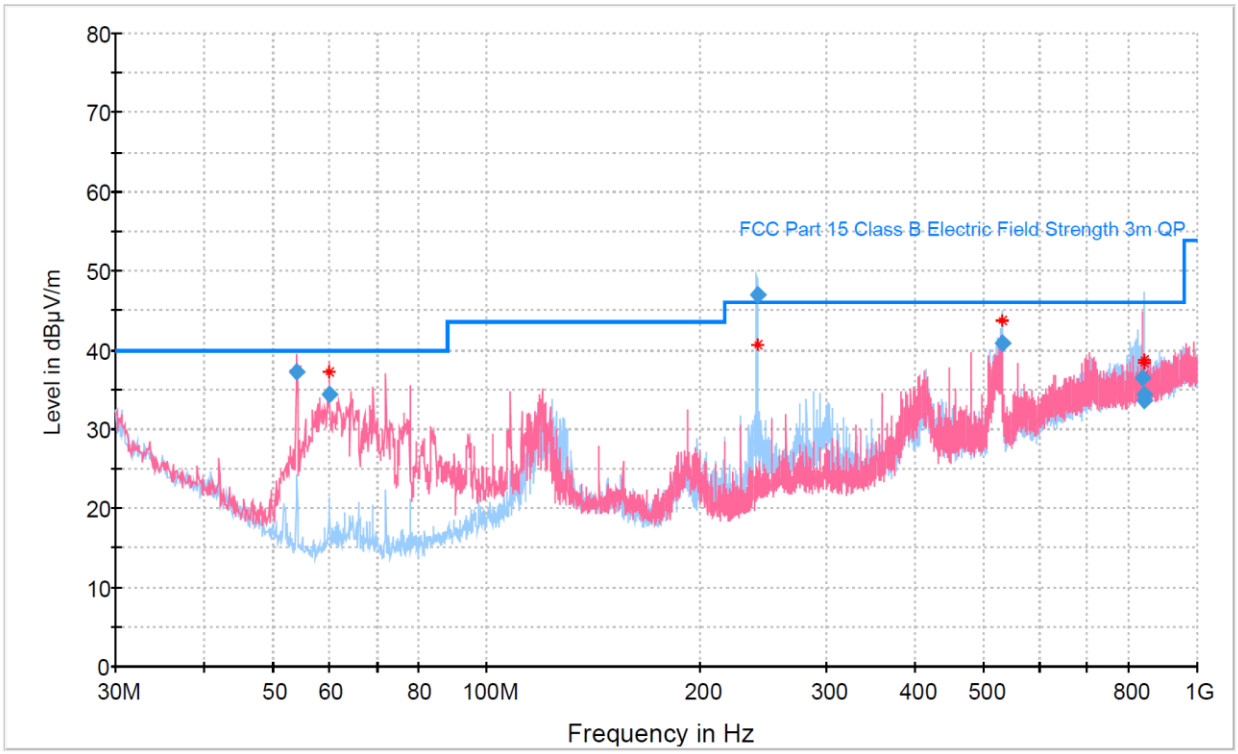
The display was unpowered during this scan to see what frequencies were a result of the display. Note that 240MHz is significantly reduced and 530MHz is gone. USB 2.0 is the source of the 240MHz signal, so there will still be some emissions at that frequency from other areas of the system even when the display is powered off.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
59.993000	38.41	40.00	1.59	5000.0	120.000	112.0	V	161.0	12.6	
66.007000	38.18	40.00	1.82	5000.0	120.000	98.0	V	204.0	13.0	
98.519000	23.68	43.50	19.82	5000.0	120.000	112.0	V	68.0	17.5	
836.038000	41.85	46.00	4.15	5000.0	120.000	363.0	V	88.0	31.9	
836.136000	37.52	46.00	8.48	5000.0	120.000	186.0	V	52.0	31.9	
843.747000	41.58	46.00	4.42	5000.0	120.000	114.0	V	90.0	32.3	

This is the final scan with the display grounded and turned on. There is reasonable margin on all frequencies except for the 240MHz. The final display module will not require a separate USB 2.0 cable and power cable, so 240MHz should drop significantly and be well under the limit.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
53.979000	37.20	40.00	2.80	5000.0	120.000	100.0	V	142.0	14.1	
59.993000	34.39	40.00	5.61	5000.0	120.000	175.0	V	91.0	12.6	
240.008000	46.98	46.00	-0.98	5000.0	120.000	119.0	H	185.0	19.6	
532.052000	40.81	46.00	5.19	5000.0	120.000	128.0	H	20.0	27.3	
837.032000	36.55	46.00	9.45	5000.0	120.000	146.0	V	284.0	31.9	
843.776000	34.31	46.00	11.69	5000.0	120.000	274.0	H	290.0	32.3	
844.187000	33.57	46.00	12.43	5000.0	120.000	288.0	H	154.0	32.3	

REVISION HISTORY AND APPROVALS

Rev	Description	CR#	Date	Submitted By
X01	Submitted to Client	N/A	7/23/2024	D. Dull