ALLUVION
Biological Consulting

Corporate Office
690 Saratoga Ave Suite 205 San Jose CA 95129
Office (408) 784-4397 Fax (510) 372-6606

Sacramento Office
3050 Fite Circle Suite 205 Sacramento CA 95827
Office (925) 989-7900 Fax (510) 373-6606

Leah Davis
Marine Resources Management Specialist, Office of Protected Resources
NOAA Fisheries | U.S. Department of Commerce
leah.davis@noaa.gov

Subject: Annual Hydroacoustic Monitoring Report - Alameda Marina Shoreline Improvement Project 2020-2021

Dear Leah Davis,

Please see attached the Hydroacoustic Monitoring Report for the Alameda Marina Shoreline Improvement Project. This report summarizes monitoring conducted from August 1, 2020 to July 31, 2021 in accordance with the Incidental Harassment Authorization (IHA). No Level A take was recorded during the monitoring period and Level B take for all species was within thresholds prescribed by the IHA.

We trust that this report contains sufficient information for your needs. If you have any questions, please contact me at the contact information listed below.

Best Regards,

Jenerro Lockhart | Principal Ecologist
Alluvion Biological Consulting

Cc:
Brendan Murphy, Brendan@pacificdevelopment.com (Project Manager)
Sean Murphy, Sean@pacificdevelopment.com>
Shawn Zovod, szovod@lubinolson.com
Randahl Hagen, Rhagen@dutragroup.com

Alameda Marina Shoreline Improvement Project- Hydroacoustic Monitoring 2020-2021 Annual Report

Prepared for: Pacific Shops, Inc.
1815 Clement Ave
Alameda, CA
94501

Prepared by: Thomas Gast
Thomas Gast & Associated Environmental Consultants
791 8th Street, Suite H
Arcata, CA 95521

October 8, 2021, First Draft
December 2, 2021, Address NMFS Comments

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Introduction

Project Background

The Alameda Marina Shoreline Improvement Project is located on a 20.9-acre area along the Oakland Estuary in the City of Alameda, California (Figure 1). The estuary is connected to the Central San Francisco Bay with the San Leandro Bay to the southeast. The connection between the San Francisco Bay and the San Leandro Bay was completed by the Corps in 1913 via dredging which in turn created Alameda Island and Coast Guard Island.

The goal of the project was to make repairs to address safety concerns, update marina facilities, address seismic resistance criteria, address sea level rise, reconfigure the marina piers, and create a new waterfront park. Piles were to be removed and installed as part of sea wall maintenance, refurbishment of the wharf and marina, and for boat hoist construction. Additionally, temporary sheet piles were needed to construct cofferdams to facilitate outfall refurbishment.

Piles and sheet piles were driven using vibratory hammer and impact hammer in water depths of 0 to approximately 25 ft Bottom substrate consisted of heterogeneous fill at 0-5 ft, young bay deposits of clay at 5-13 ft, older bay deposits of compressible sediment at 13-25 ft, Merritt sand at 25-40 ft, and San Antonio Formation clay at 40 ft onward. In total 930 piles were proposed to be installed over two years.

Need

Authorization for incidental takings are only granted if National Marine Fisheries Service (NMFS) finds that the taking will be of small numbers, have negligible impact on the species or stock(s), and will not have unmanageable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other “means of effecting the least practicable adverse impact” on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stocks for taking for certain subsistence uses (referred to in shorthand as “mitigation”); and requirements pertaining to the mitigation, monitoring and reporting of the takings are set forth.

Pile driving activities associated with the construction of piers in the project area produce underwater anthropogenic noise that may affect the behavior or hearing of marine mammals. Permanent Threshold Shift (PTS) is the permanent reduction of sensitivity of the ear with a decreasing ability to detect sound. Certain levels of noise exposure can cause PTS to occur in marine mammals. Two threshold metrics are identified by NMFS that contribute to the onset of PTS in marine mammals, weighted cumulative sound exposure level (SELCUM) and peak sound pressure (PK). NMFS assumes the onset of PTS to occur when PK is exceeded or SELCUM is exceeded for a calculated duration. Hydroacoustic monitoring was employed to ensure compliance with NMFS’ incidental harassment authorization.

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

Figure 1. Project Area Map of Alameda Marina Shoreline Improvement Project (Haase 2019)

No critical habitat for marine mammal species was identified within the Project area. However, two known harbor seal haulout sites are near the project area. One site is located on Yerba Buena Island approximately 6.6 miles from the Project Area. The other site is located on the southern side of Alameda Island, approximately 7.8 miles away from the Project area. Though suitable forage is not present within the project area, the channel serves as a movement corridor for pinnipeds and cetaceans. The shallow and constrained channel limits accessibility for large whales, as they were not likely to be observed near the Project Area. Six species of marine mammals were included for Level B incidental harassment authorizations (IHAs): Common bottlenose dolphin (*Tursiops truncates*), harbor porpoise (*Phocoena phocoena*), California sea lion (*Zalophus californianus*), Northern fur seal (*Callorhinus ursinus*), Northern elephant seal (*Mirounga angustirostris*), and harbor seal (*Phoca vitulina*).

Thresholds

The NMFS issued IHAs for two years to Pacific Shops, Inc. to incidentally harass, by Level B only, marine mammals during construction activities associated with the Project. These issuances are published in the Federal Register Vol. 85, No. 122 and specify the Level A harassment thresholds (Table 1) and isopleths (Table 3), and Level B harassment thresholds and isopleths (Table 2). These authorizations were effective from August 1, 2020 to July 31, 2021 for year 1 and from August 1, 2021 to July 31, 2022 for year 2. Level A harassment zones are areas where PTS onset could be caused by the pressure levels (Table 1). Level B harassment zones are defined as sound pressure levels (SPLs) that are equal to or exceed a threshold of 160 dB rms for impact driving and 120 dB rms for vibratory pile driving (Table 2).

Table 1. Thresholds identifying the onset of PTS. L_{pk} is the peak sound pressure and L_E is the cumulative sound pressure.

Hearing group	PTS onset acoustic thresholds * (Received Level)	
	Impulsive	Non-impulsive
Low-Frequency (LF) Cetaceans	*Cell 1:* $L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB;	*Cell 2:* $L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	*Cell 3:* $L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB;	*Cell 4:* $L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	*Cell 5:* $L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB	*Cell 6:* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7:* $L_{pk,flat}$: 218 dB; $L_{E,PW,24h}$: 185 dB	*Cell 8:* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9:* $L_{pk,flat}$: 232 dB; $L_{E,OW,24h}$: 203 dB	*Cell 10:* $L_{E,OW,24h}$: 219 dB

Table 2. Pile driving source levels and distances to Level B harassment thresholds described in Federal Register/ Vol. 85, No. 122

Source	Source level at 10 m (dB re 1 µPa rms)	Level B harassment threshold (dB re 1 µPa rms)	Distance to Level B harassment threshold (m)
VIBRATORY			
16-in Timber (removal)	152	120	1,359
12-in Square Concrete (removal)	155		2,154
Steel sheet pile	160		4,642
30-in Steel Pipe	170		21,544
36-in Steel Pipe	170		21,544
Wide Flange Beam	155		2,154
IMPACT			
14-in Square Concrete	166	160	25
16-in Square Concrete	166		25
24-in Concrete piles	176		117
Wide Flange Beam (attenuated [a])	194 (187)		[b] 631
30-in Steel Pipe (attenuated [a])	190 (183)		[b] 341
36-in Steel Pipe (attenuated [a])	193 (186)		[b] 541

Table 3. Calculated distances to Level A harassment isopleths described in Federal Register/ Vol. 85, No. 122

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

Source	Level A—radius to isopleth (m)			
	MF cetaceans	HF cetaceans	Phocids	Otariids
VIBRATORY				
16-in Timber (removal)	<1	2	<1	<1
12-in Square Concrete (removal)	<1	4	2	<1
Steel sheet pile	1	19	8	<1
30-in Steel Pipe	<1	12	5	<1
36-in Steel Pipe (Year 1)	1	19	8	<1
36-in Steel Pipe (Year 2)	<1	12	5	<1
Wide Flange Beam	<1	3	1	<1
IMPACT				
14-in Square Concrete	<1	26	12	<1
16-in Square Concrete	<1	26	12	<1
24-in Concrete piles	4	139	62	5
Wide Flange Beam (attenuated)	9	299	135	10
30-in Steel Pipe (attenuated)	3	102	46	3
36-in Steel Pipe (Year 1, attenuated)	12	406	183	13
36-in Steel Pipe (Year 2, attenuated)	8	256	115	8

Methodology

Thomas Gast & Associates Environmental Consultants (TGAEC) conducted hydroacoustic monitoring for all pile driving activities for the Alameda Marina Shoreline Improvement Project. TGAEC used Cetacean Research Technology (CRT) sound monitoring equipment and software. A CR1a model and CR1 model hydrophone were used, with a sensitivity of -199 dB re 1V/µPa. Each hydrophone was calibrated using a piston phone with coupler. Each hydrophone was interfaced with a cable to a Panasonic Toughbook PC connected through a SpectraDAQ-200 precision data acquisition sound card. SpectraPLUS-SC signal analysis software was used for noise monitoring. Proprietary TGAEC software was used to output PK, SEL_{CUM}, and RMS data during pile driving.

Table 4. Hydroacoustic monitoring equipment used on the Alameda Marina Shoreline Improvement Project

Item	Specifications	Quantity	Usage
Hydrophone CR1, CR1A Cetacean Research Technology	Sensitivity of -198 --204 dB re 1µPa	3	Capture underwater sound pressure levels for record and analyzation
Piston phone	Accuracy- IEC 942 (1988) Class 1	1	Field calibration of hydrophone

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

Item	Specifications	Quantity	Usage
SpectraDAQ-200 Soundcard	Sampling Rate: Up to 192kHz	3	Transfers data from hydrophone to computer software
Panasonic Toughbook PC	Compatible with digital signal analyzer	3	Records digital data to hard drive
SpectraPLUS-SC Software	Real-time spectrum analysis of live input	3	Analyzes noise data
TGAEC Proprietary Software	Reports PK, SEL_{CUM}, and RMS	1	Real time strike reporting and summarization

Calibration of each hydrophone was performed each day using the pistonphone. Each hydrophone was attached to an anchor and a float to suspend the hydrophone in the water column. A direct line of acoustic transmission was maintained for each hydrophone. Two hydrophones were used, one in the near position, relatively close to the pile and one far position that was distant from the pile. A near hydrophone was deployed from a boat at a water depth ranging from 1 -2 meters with a proximity of 10-43.2 m from the pile being driven. A far hydrophone was deployed from the docks at a water depth ranging from 2-3 m at a distance of 68.4 -173 m. No flow-induced noise reduction techniques were required.

All active pile driving time and underwater sound levels were monitored and recorded in real time. The pile type, duration in seconds, type of hammer, number of strikes, hydrophone distance and depth, and pile depth were recoded for each event. The minimum, maximum, and mean were recoded for Peak (dB, re:1 µPa). The mean SEL_{CUM} (dB, re:1 $\mu Pa^2 s$) and RMS (dB, re:1 µPa) were recorded and reported daily. Any other sources of noise that influenced ambient sound such as aircraft or boats were also documented.

Results

TGAEC monitored the vibratory driving of two 36 inch steel piles on either side of the Building 3 Wharf, two temporary H-piles for the outfall cofferdam, and six temporary sheet piles for the outfall cofferdam (Figure 2) (Monitoring results itemized in Appendix A, Table 1). TGAEC monitored the impact driving on six Promenade Wharf precast 16 inch concrete piles (Monitoring results itemized in Appendix A, Table 2).

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

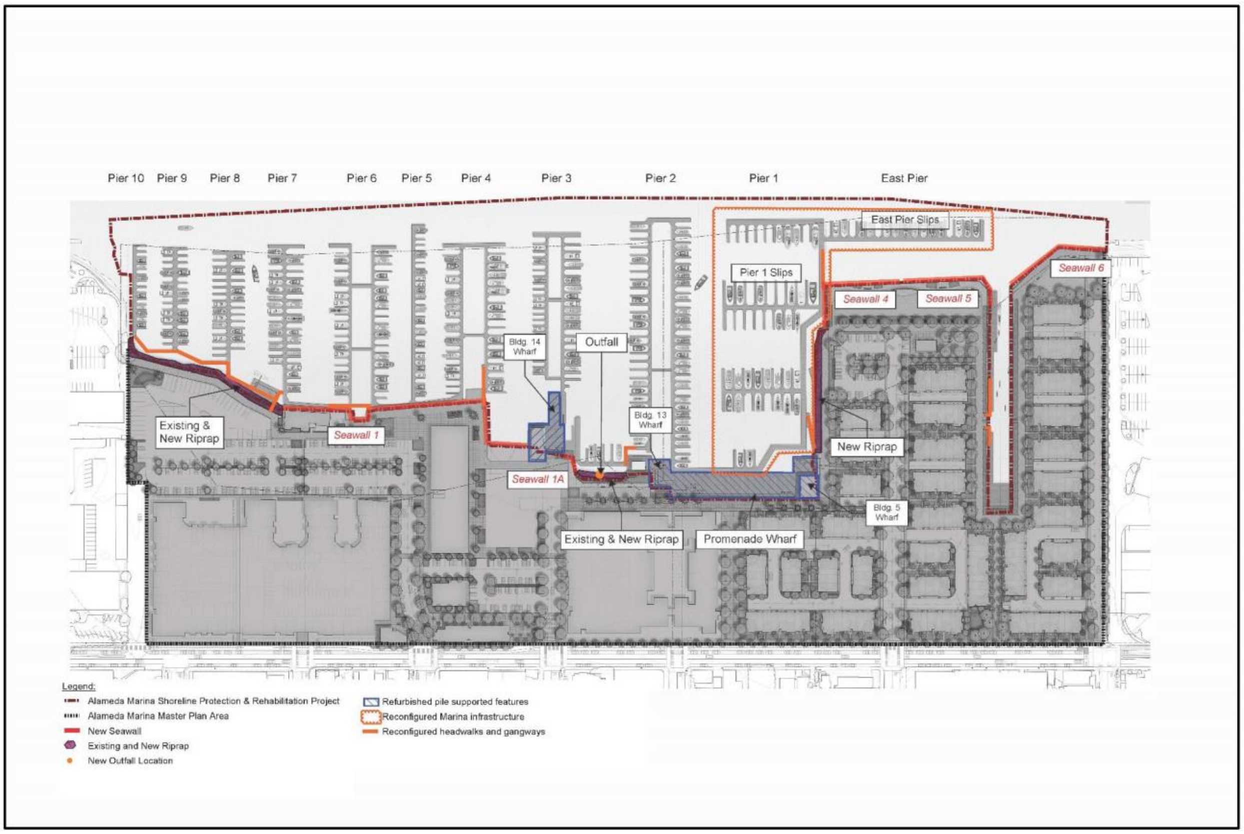

Figure 2. TGAEC monitored pile driving in the areas of Piers 1 and 2. Graphic from the Alameda Marina Hydroacoustic Monitoring Plan (Illingworth and Rodkin 2020).

Transmission Loss Coefficient Calculations

Underwater sound is attenuated with distance away from the source. Two hydrophones were deployed allowing calculation of the transmission loss coefficient. Transmission loss varied widely due to the complexity of the marina with pilings, boats, docks, and shallows. Equation 1 was used to calculate the transmission loss coefficients for each pile (Table 5).

Equation 1. Transmission Loss coefficient

$$B = (L_2 - L_1)/Log(\frac{D_1}{D_2})$$

Where:

B= the transmission loss coefficient

L_1= the sound level at the near hydrophone (HP)

L_2 = the sound level at the far HP

D_1 = the distance of the near HP to the pile

D_2= the distance of the far HP to the pile

Table 5. Transmission Loss Coefficients calculated using the sound data from the near and far hydrophones using the Maximum peak and RMS sound pressures.

				Peak	RMS
11/18/2020	East	36" Steel Pipe	Vibratory	19.97	22.08
11/19/2020	West	36" Steel Pipe	Vibratory	22.93	24.44
11/20/2020	West	H-Pile	Vibratory	26.08	14.79
11/20/2020	East	H-Pile	Vibratory	23.47	15.12
11/23/2020	Sheet_1	Sheet	Vibratory	24.85	18.96
11/24/2020	Sheet_2	Sheet	Vibratory	20.12	19.69
11/24/2020	Sheet_3	Sheet	Vibratory	14.62	16.52
11/24/2020	Sheet_4	Sheet	Vibratory	18.07	19.74
11/24/2020	Sheet_5	Sheet	Vibratory	28.22	28.56
11/24/2020	Sheet_6	Sheet	Vibratory	33.94	31.38
1/4/2021	Precast_1	16" Precast concrete	Impact	14.76	12.64
1/5/2021	Precast_1	16" Precast concrete	Impact	12.68	13.34
1/5/2021	Precast_2	16" Precast concrete	Impact	12.84	13.22
1/5/2021	Precast_3	16" Precast concrete	Impact	19.53	17.81
1/5/2021	Precast_4	16" Precast concrete	Impact	23.02	20.64
1/5/2021	Precast_5	16" Precast concrete	Impact	23.69	20.04

Level A Harassment Zones

Level A harassment zones are determined by dual metrics for impact, peak and accumulated sound pressure. The peak metric was not an issue for these piles (Table 1 and Appendix A). The NMFS 2020 spreadsheet was used to calculate the isopleths of the Level A harassment zones cumulative sound exposure level for both the impact and vibratory driving.

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

Table 6. Level A harassment zone PTS isopleths calculated from the 2020 NMFS Spreadsheet in meters.

	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
11/18/2020	1.5	9.8	5.4	0.9
11/19/2020	7.3	41.0	23.8	4.7
11/20/2020	0.3	4.9	2.0	0.1
11/23/2020	0.4	3.5	1.8	0.2
11/24/2020	2.3	14.4	8.1	1.4
1/4/2021	0.0	0.9	0.4	0.0
1/5/2021	1.1	23.5	11.6	1.2

No marine mammal harassment is permitted within the Level A zone. Marine mammal monitors watch for marine mammals and stop the pile driving if one is close to the Level A zone. The Level A Zone is initially based on estimates of the duration and sound pressures from previous projects. When the cumulative sound pressure level neared the estimated threshold on 11/19/2020, pile driving was ceased. The long duration and greater sound pressure levels produced by driving the recalcitrant pipe pile increased the Level A isopleths above those predicted in the IHA. Mr. Gast communicated this to Mr. Oates, the lead Marine Mammal Monitor, and he increased the shutdown zone to 100 meters, the predicted isopleth if similar underwater noise were to continue throughout the day. Similarly, on 11/24/2020, Mr. Gast made a recommendation to Mr. Oats to increase the shutdown zone to 50 meters due to the initial calculations showing that the initial Level A isopleths would be exceeded. The final analysis, using the calculated spreading loss coefficient, determined that the cumulative sound pressure was within the IHA estimated limits. Likewise, after monitoring the concrete piles on January 5, 2021, Mr. Gast made multiple isopleth estimations for Level A and Level B marine mammal monitoring zones, depending on the number of piles that could be driven in one day. The Level A isopleths estimation for ten piles per day (SELss=155 dB, 1500 strikes per pile) resulted in an exclusion zone of 98 meters for high frequency cetaceans and 44 meters for Phocid Pinnipeds.

Level B Harassment Zones

Level B harassment zones are determined by the RMS sound level pressure (160 dB rms for impact driving and 120 dB rms for vibratory pile driving). Table 7 shows the wide variability of the underwater noise produced by each pile.

Table 7. Level B harassment isopleths per pile.

Date	Pile ID	Pile type	Method	Isopleth
11/18/2020	East	36" Steel Pipe	Vibratory	1239
11/19/2020	West	36" Steel Pipe	Vibratory	1366
11/20/2020	West	H-Pile	Vibratory	429

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
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tgast@tgaec.com

11/20/2020	East	H-Pile	Vibratory	228
11/23/2020	Sheet_1	Sheet	Vibratory	1162
11/24/2020	Sheet_2	Sheet	Vibratory	1700
11/24/2020	Sheet_3	Sheet	Vibratory	5201
11/24/2020	Sheet_4	Sheet	Vibratory	1913
11/24/2020	Sheet_5	Sheet	Vibratory	170
11/24/2020	Sheet_6	Sheet	Vibratory	126
1/4/2021	Precast_1	16" Precast concrete	Impact	8
1/5/2021	Precast_1	16" Precast concrete	Impact	13
1/5/2021	Precast_2	16" Precast concrete	Impact	4
1/5/2021	Precast_3	16" Precast concrete	Impact	21
1/5/2021	Precast_4	16" Precast concrete	Impact	19
1/5/2021	Precast_5	16" Precast concrete	Impact	14

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Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

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Appendix A: Summary Data and Analysis Tables

Appendix A tabularizes the hydroacoustic data collection and analysis. Each pile was monitored for the entire driving time. The seconds/strikes listed are for both installation and monitoring. The seconds represent the actual driving time. There were numerous stops and starts during driving and the pauses were not included in the seconds column.

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
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tgast@tgaec.com

Appendix A-1. Summary data and analysis for vibratory pile driving at Alameda Marina in 2020.

Near Hydrophone					Distance m	Depth m	
Date	**Pile ID**	**Pile Type**	**Dive Method**	**Seconds**	**Pile to HP**	**Pile**	**HP**
11/18/2020	East	36" Steel Pipe	Vibratory	2598	10	3.15	5.5
11/19/2020	West	36" Steel Pipe	Vibratory	7523	8.5	2.35	3.4
11/20/2020	West	H-Pile	Vibratory	1116	11.4	~1	1.95
11/20/2020	East	H-Pile	Vibratory	2247	11.4	~1	2.4
11/23/2020	Sheet_1	Sheet	Vibratory	823	14.4	~1	1.95
11/24/2020	Sheet_2	Sheet	Vibratory	997	12.4	~2	3.15
11/24/2020	Sheet_3	Sheet	Vibratory	635	11.4	~2	3
11/24/2020	Sheet_4	Sheet	Vibratory	3853	10.4	~1.5	2.1
11/24/2020	Sheet_5	Sheet	Vibratory	337	9.8	1.5	1.5
11/24/2020	Sheet_6	Sheet	Vibratory	508	9.8	~0.5	1.5

Near Hydrophone		Peak dB				SELs-s dB			RMS dB		
Date	**Pile ID**	**max**	**mean**	**median**	**cSEL dB**	**max**	**mean**	**median**	**max**	**mean**	**median**
11/18/2020	East	194.77	182.59	175.84	200.46	175.79	166.22	162.20	175.79	166.22	162.20
11/19/2020	West	202.36	194.61	194.08	212.61	177.39	173.90	174.44	177.39	173.90	174.44
11/20/2020	West	173.77	157.39	153.64	174.26	153.05	143.30	140.56	153.05	143.30	140.56
11/20/2020	East	169.64	153.80	150.39	172.95	151.53	139.66	134.46	151.53	139.66	134.46
11/23/2020	Sheet_1	182.32	171.93	171.18	185.69	163.59	156.15	155.81	163.59	156.15	155.81
11/24/2020	Sheet_2	190.81	177.30	174.37	191.98	175.29	162.08	159.27	175.29	162.08	159.27
11/24/2020	Sheet_3	185.75	179.00	177.78	192.77	171.27	163.93	162.73	171.27	163.93	162.73
11/24/2020	Sheet_4	188.38	181.07	180.83	200.67	171.87	164.70	165.68	171.87	164.70	165.68
11/24/2020	Sheet_5	177.68	171.93	171.54	180.56	160.95	155.36	152.80	160.95	155.36	152.80
11/24/2020	Sheet_6	179.37	170.68	170.13	182.22	160.70	154.75	154.29	160.70	154.75	154.29

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tgast@tgaec.com

Far Hydrophone					**Distance m**	**Depth m**	
Date	**Pile ID**	**Pile Type**	**Dive Method**	**Seconds**	**Pile to HP**	**Pile**	**HP**
11/18/2020	East	36" Steel Pipe	Vibratory	2598	173	3.15	4.65
11/19/2020	West	36" Steel Pipe	Vibratory	7523	68.4	2.35	4.82
11/20/2020	West	H-Pile	Vibratory	1116	79.6	~1	5.8
11/20/2020	East	H-Pile	Vibratory	2247	78.4	~1	5.8
11/23/2020	Sheet_1	Sheet	Vibratory	823	79.6	~1	5.4
11/24/2020	Sheet_2	Sheet	Vibratory	997	77.4	~2	6.7
11/24/2020	Sheet_3	Sheet	Vibratory	635	76.8	~2	6.7
11/24/2020	Sheet_4	Sheet	Vibratory	3853	76.4	~1.5	5.8
11/24/2020	Sheet_5	Sheet	Vibratory	337	76.8	1.5	5.3
11/24/2020	Sheet_6	Sheet	Vibratory	508	76.8	~0.5	5.3

Far Hydrophone		**Peak dB**				**SELs-s dB**			**RMS dB**		
Date	Pile ID	**max**	**mean**	**median**	**cSEL dB**	**max**	**mean**	**median**	**max**	**mean**	**median**
11/18/2020	East	168.79	156.64	151.31	172.81	148.72	138.88	135.94	148.72	138.88	135.94
11/19/2020	West	181.59	173.85	173.39	189.75	155.21	151.77	151.93	155.21	151.77	151.93
11/20/2020	West	151.76	145.14	145.29	161.11	139.72	130.82	129.09	139.72	130.82	129.09
11/20/2020	East	149.99	141.61	139.54	160.93	138.99	127.00	124.48	138.99	127.00	124.48
11/23/2020	Sheet_1	163.87	156.95	134.81	171.24	148.05	142.07	141.05	148.05	142.07	141.05
11/24/2020	Sheet_2	174.81	161.56	138.54	176.46	159.54	146.42	143.39	159.54	146.42	143.39
11/24/2020	Sheet_3	173.64	165.85	141.34	178.53	156.42	150.24	148.95	156.42	150.24	148.95
11/24/2020	Sheet_4	172.73	163.58	158.27	183.46	155.07	147.61	142.06	155.07	147.61	142.06
11/24/2020	Sheet_5	152.45	146.13	145.35	153.92	136.02	129.82	127.00	136.02	129.82	127.00
11/24/2020	Sheet_6	149.02	141.73	141.32	153.01	131.03	126.69	126.30	131.03	126.69	126.30

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Near hydrophone referenced to 10m using the calculated transmission loss coefficients from Table 5

		Peak dB				SELs-s dB			RMS dB		
Date	**Pile ID**	**max**	**mean**	**median**	**cSEL dB**	**max**	**mean**	**median**	**max**	**mean**	**median**
11/18/2020	East	194.77	182.59	175.84	200.46	175.79	166.22	162.20	175.79	166.22	162.20
11/19/2020	West	200.74	192.99	192.46	210.88	175.67	172.18	172.72	175.67	172.18	172.72
11/20/2020	West	175.25	158.88	155.12	175.75	154.53	144.79	142.04	154.53	144.79	142.04
11/20/2020	East	170.98	155.14	151.73	173.81	152.39	140.52	135.32	152.39	140.52	135.32
11/23/2020	Sheet_1	186.25	175.87	175.11	188.69	166.59	159.15	158.81	166.59	159.15	158.81
11/24/2020	Sheet_2	192.69	179.18	176.25	193.86	177.17	163.96	161.15	177.17	163.96	161.15
11/24/2020	Sheet_3	186.58	179.83	178.61	193.71	172.21	164.87	163.67	172.21	164.87	163.67
11/24/2020	Sheet_4	188.69	181.38	181.14	201.01	172.21	165.04	166.02	172.21	165.04	166.02
11/24/2020	Sheet_5	177.43	171.69	171.29	180.31	160.70	155.11	152.55	160.70	155.11	152.55
11/24/2020	Sheet_6	179.07	170.39	169.83	181.92	160.40	154.45	153.99	160.40	154.45	153.99

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tgast@tgaec.com

Appendix A-2. Summary data and analysis for impact pile driving at Alameda Marina in 2021

Near Hydrophone					Pulse	Distance m	Depth m	
Date	**Pile ID**	**Pile Type**	**Dive Method**	**Strikes**	**Duration seconds**	**Pile to HP**	**Pile**	**HP**
1/4/2021	Precast_1	16" Precast concrete	Impact	193	1.336	43.2	2.7	8.3
1/5/2021	Precast_1	16" Precast concrete	Impact	904	1.467	31.6	2.7	7.3
1/5/2021	Precast_2	16" Precast concrete	Impact	649	1.354	28.7	2.2	7.3
1/5/2021	Precast_3	16" Precast concrete	Impact	78	1.335	17	6	7.3
1/5/2021	Precast_4	16" Precast concrete	Impact	1177	1.386	31.3	2.2	7.3
1/5/2021	Precast_5	16" Precast concrete	Impact	993	1.415	10.4	1.9	5.4

Near Hydrophone		Peak dB				SELs-s dB			RMS dB		
Date	Pile ID	**max**	**mean**	**median**	**cSEL dB**	**max**	**mean**	**median**	**max**	**mean**	**median**
1/4/2021	Precast_1	168.58	164.01	163.90	160.72	140.84	137.86	137.71	153.85	150.87	150.72
1/5/2021	Precast_1	172.82	167.52	166.79	171.36	147.36	141.79	141.13	160.37	154.80	154.15
1/5/2021	Precast_2	167.35	162.37	162.09	163.50	138.07	135.44	135.25	151.08	148.45	148.26
1/5/2021	Precast_3	179.86	174.80	174.56	167.56	153.32	148.64	148.70	166.33	161.65	161.71
1/5/2021	Precast_4	180.19	172.46	163.15	173.16	149.39	142.58	135.93	162.40	155.59	148.94
1/5/2021	Precast_5	191.07	177.70	173.66	179.43	159.38	149.46	147.84	172.39	162.47	160.85

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tgast@tgaec.com

Far Hydrophone					**Distance m**	**Depth m**	
Date	**Pile ID**	**Pile Type**	**Dive Method**	**Strikes**	**Pile to HP**	**Pile**	**HP**
1/4/2021	Precast_1	16" Precast concrete	Impact	193	97.8	2.7	5.6
1/5/2021	Precast_1	16" Precast concrete	Impact	904	89.6	2.7	7.6
1/5/2021	Precast_2	16" Precast concrete	Impact	649	89.4	2.2	7.6
1/5/2021	Precast_3	16" Precast concrete	Impact	78	77.4	6	7.6
1/5/2021	Precast_4	16" Precast concrete	Impact	1177	84.8	2.2	7.6
1/5/2021	Precast_5	16" Precast concrete	Impact	993	84.8	1.9	7.6

Far Hydrophone		**Peak dB**				**SELs-s dB**			**RMS dB**		
Date	Pile ID	**max**	**mean**	**median**	**cSEL dB**	**max**	**mean**	**median**	**max**	**mean**	**median**
1/4/2021	Precast_1	163.34	159.26	158.92	156.00	137.31	133.38	133.25	150.32	146.39	146.26
1/5/2021	Precast_1	167.08	161.59	161.28	165.33	141.38	135.76	135.05	154.39	148.77	148.06
1/5/2021	Precast_2	161.02	157.34	157.27	156.94	132.48	128.91	128.36	145.49	141.92	141.37
1/5/2021	Precast_3	167.00	162.92	162.79	155.72	140.46	136.92	136.97	153.47	149.93	149.98
1/5/2021	Precast_4	170.23	162.53	158.20	163.44	140.30	133.64	130.58	153.31	146.65	143.59
1/5/2021	Precast_5	169.48	158.77	156.77	160.90	140.74	131.19	129.18	153.75	144.20	142.19

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tgast@tgaec.com

Near hydrophone referenced to 10m using the calculated transmission loss coefficients from Table 5

		Peak dB				SELs-s dB			RMS dB		
Date	**Pile ID**	**max**	**mean**	**median**	**cSEL dB**	**max**	**mean**	**median**	**max**	**mean**	**median**
1/4/2021	Precast_1	177.96	173.39	173.28	168.75	148.87	145.89	145.74	161.88	158.90	158.76
1/5/2021	Precast_1	179.15	173.85	173.12	178.02	154.02	148.46	147.80	167.03	161.47	160.81
1/5/2021	Precast_2	173.23	168.25	167.97	169.38	143.95	141.31	141.13	156.96	154.32	154.14
1/5/2021	Precast_3	184.36	179.30	179.06	171.67	157.43	152.75	152.81	170.44	165.76	165.82
1/5/2021	Precast_4	191.60	183.86	174.56	183.39	159.61	152.80	146.16	172.62	165.81	159.17
1/5/2021	Precast_5	191.47	178.11	174.06	179.83	159.79	149.86	148.25	172.80	162.87	161.26

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Located in the Historic Jacoby Storehouse on the Arcata Plaza, 4th floor, Suite H
tgast@tgaec.com

Appendix B: One-third octave band spectrum and power spectral density plots

Appendix B depicts one-third octave band spectrum and power spectral density plots as histograms. Each histogram bin is one-third octave and displays the average sound pressure level (dB re 1uPa) rms for eight representative strikes (impact driving) or ten seconds of vibratory driving. For each pile there is a plot for the near hydrophone and the far hydrophone.

Thomas Gast & Associates Environmental Consultants; PO Box 1137, Arcata, California 95518; Office (707) 822-8544
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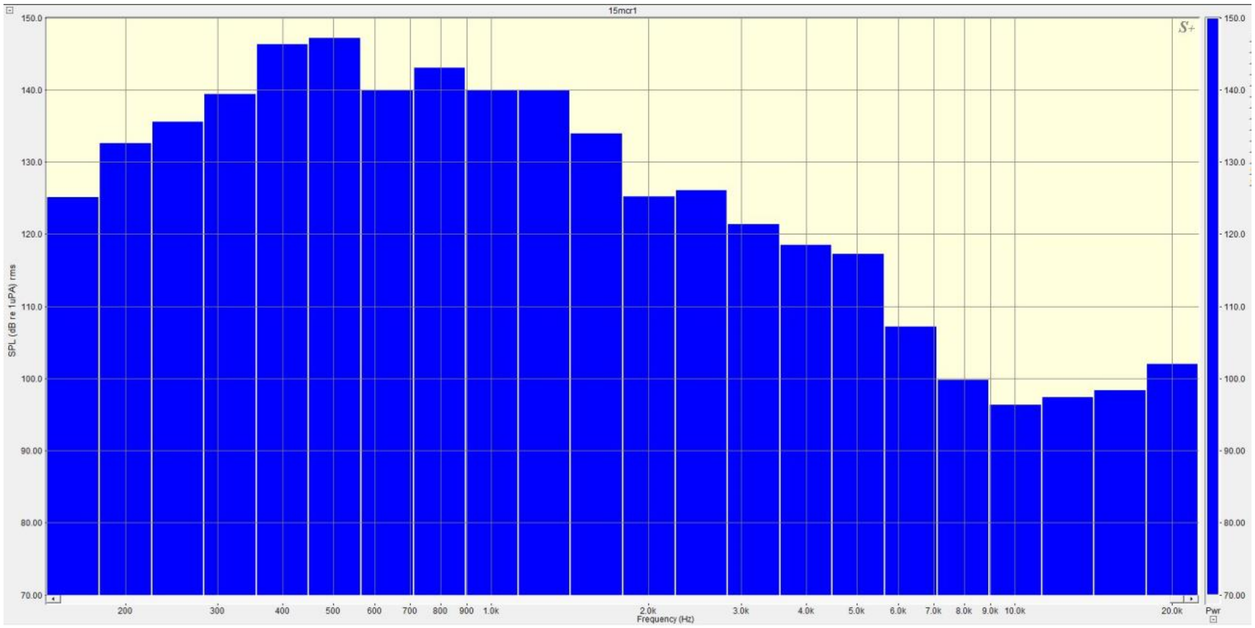
tgast@tgaec.com

Appendix A-1. Power frequency histograms.

11/18/2020 East 36” Steel Pipe

Near



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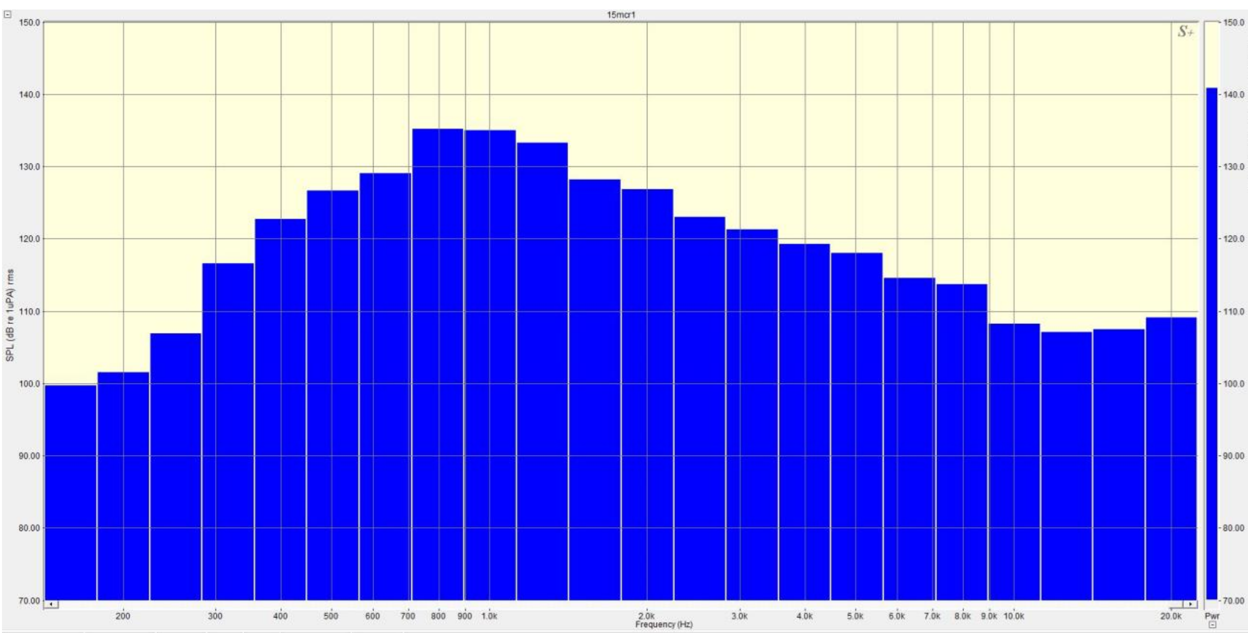

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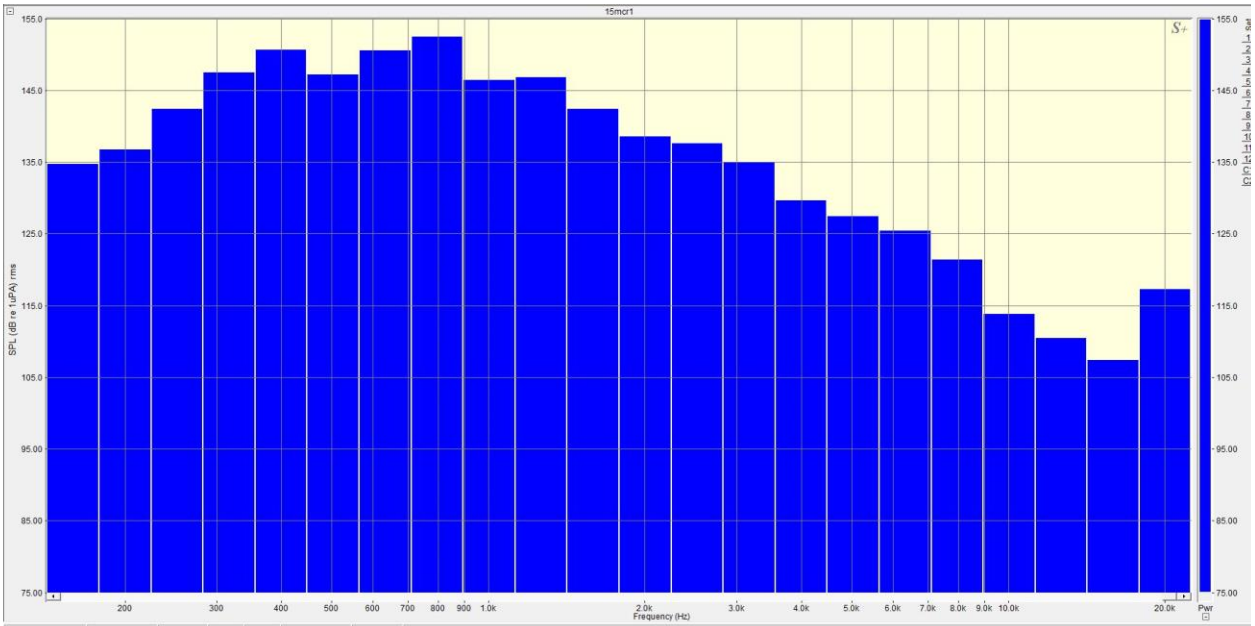
11/19/2020 West 36” Steel Pipe

Near



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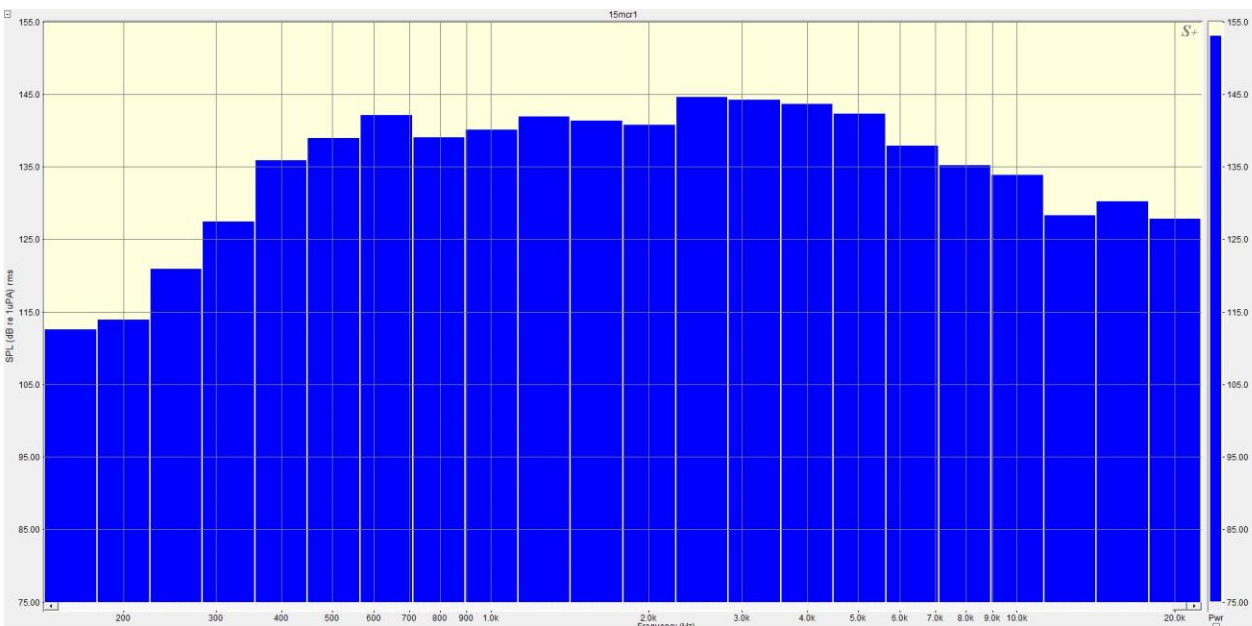

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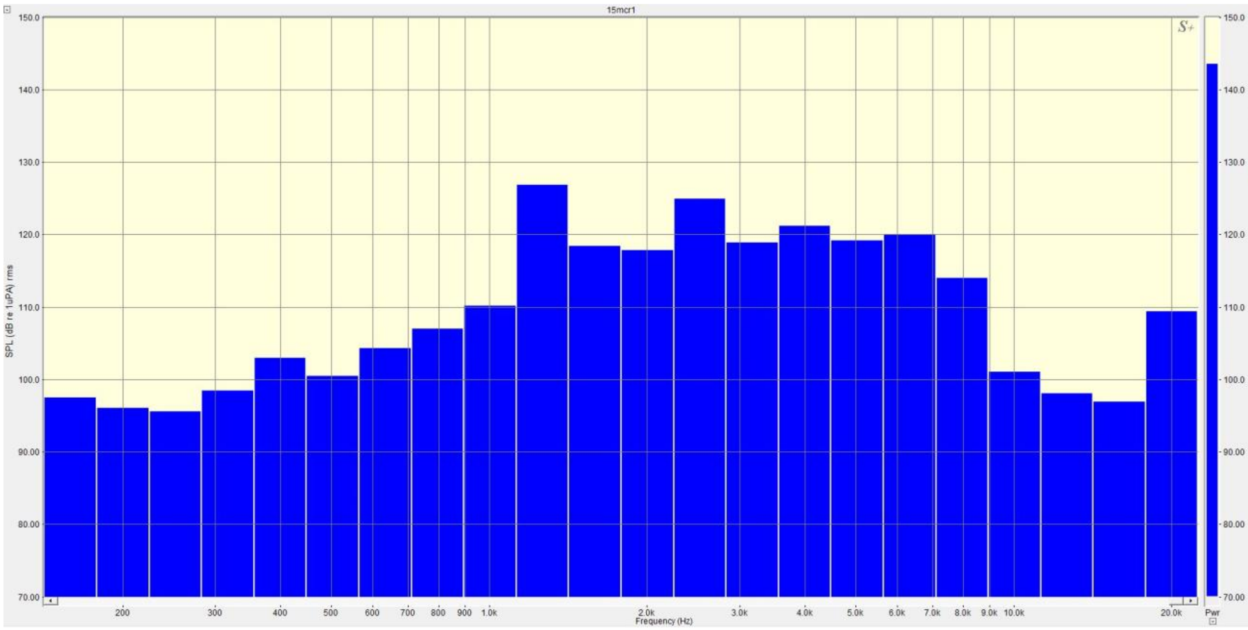
11/20/2020 West H-Pile

Near



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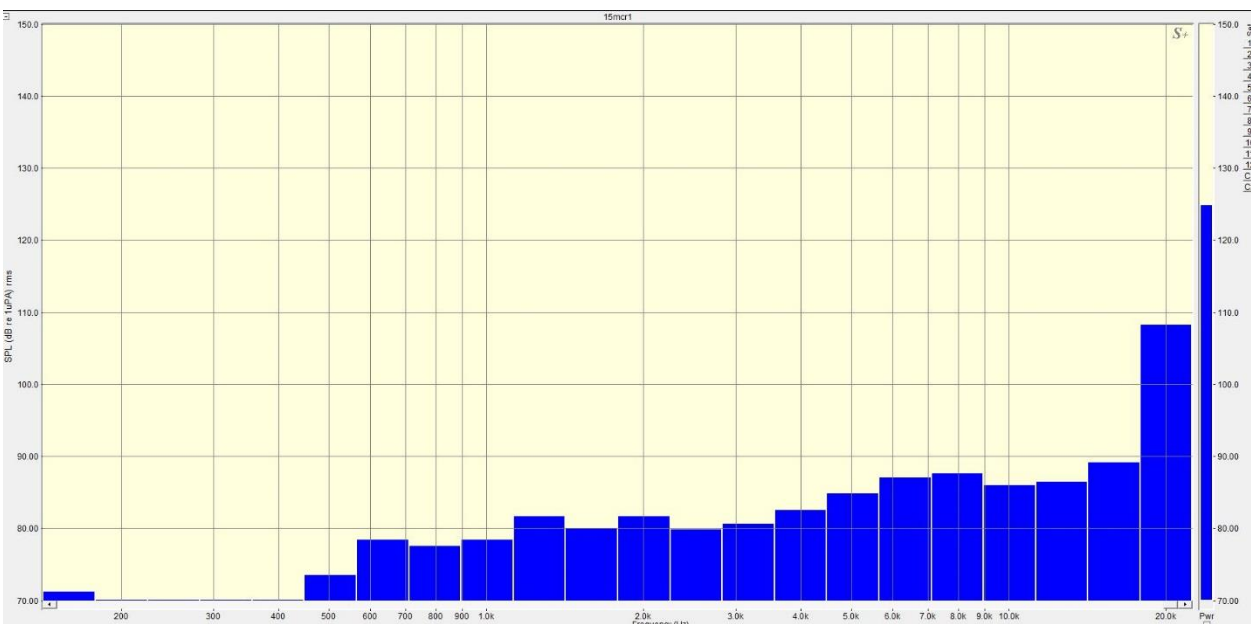

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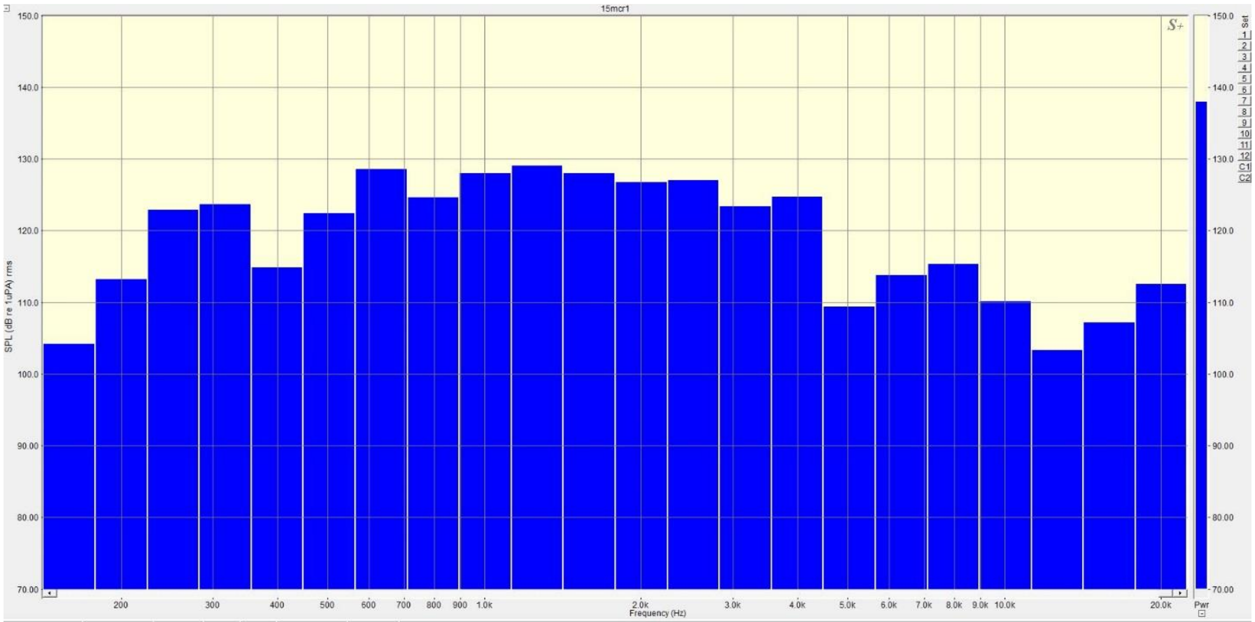
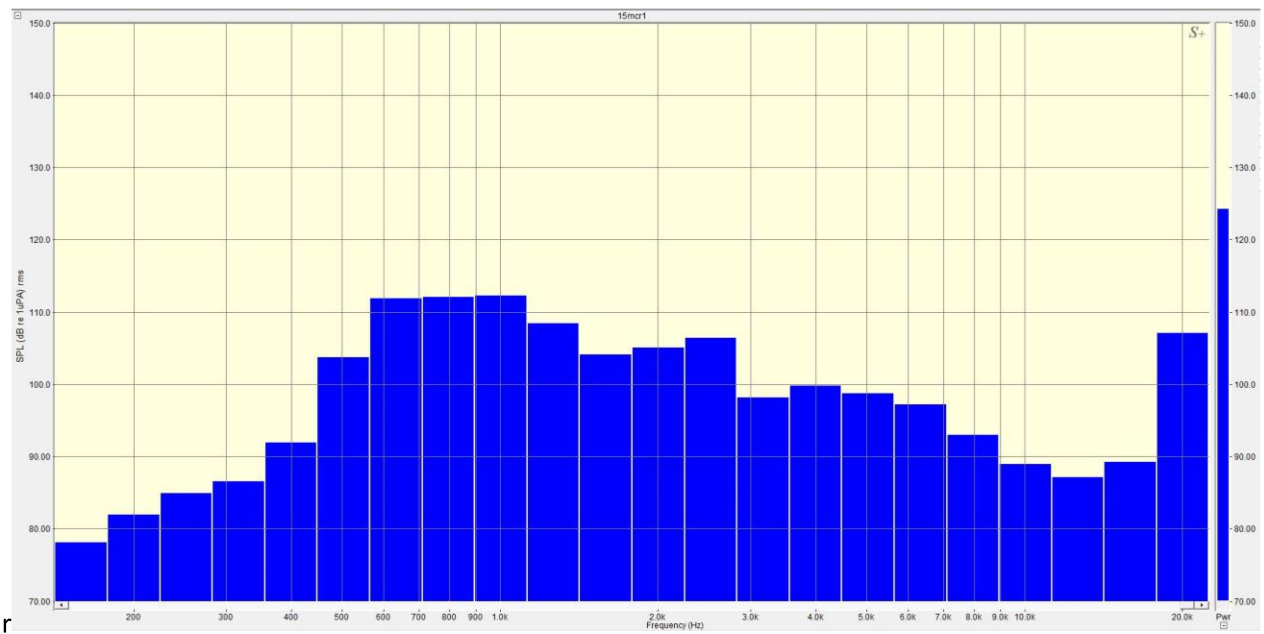
11/20/2020 East H-pile

Near





Far

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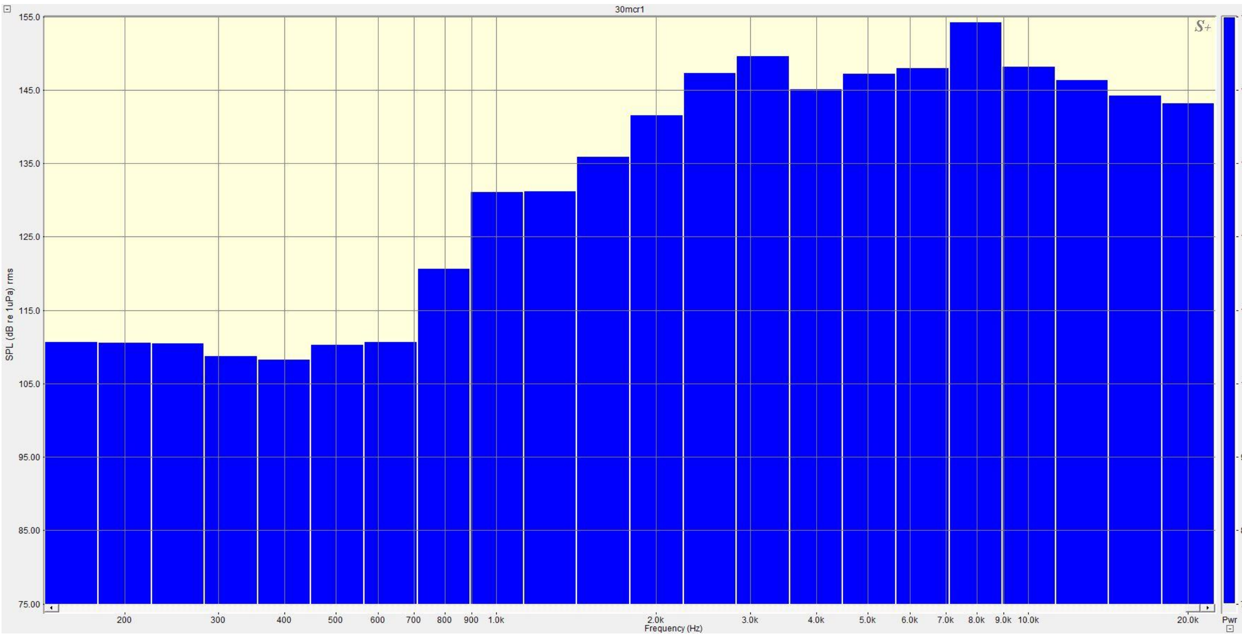
11/23/2020 Sheet_1

Near



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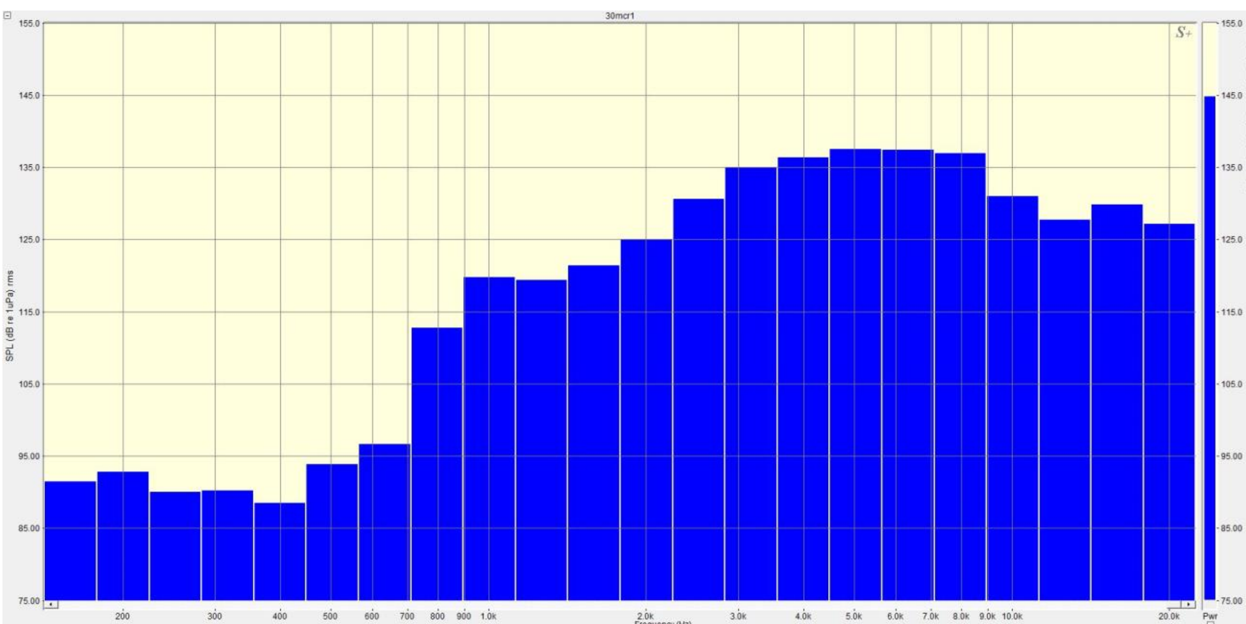

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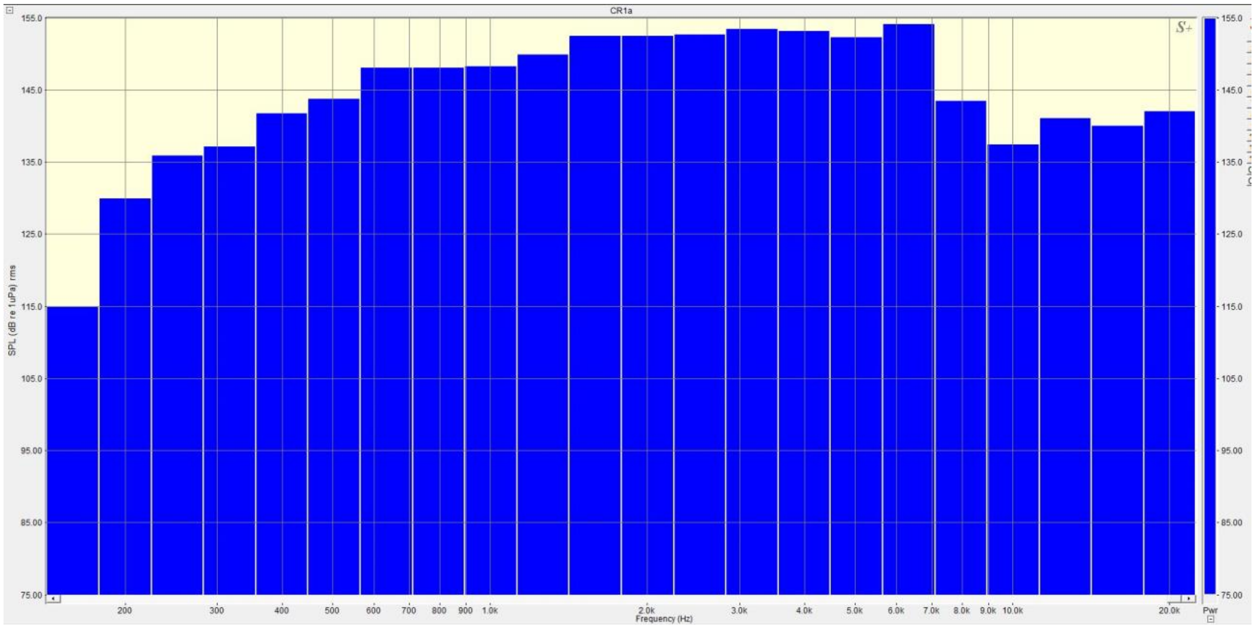
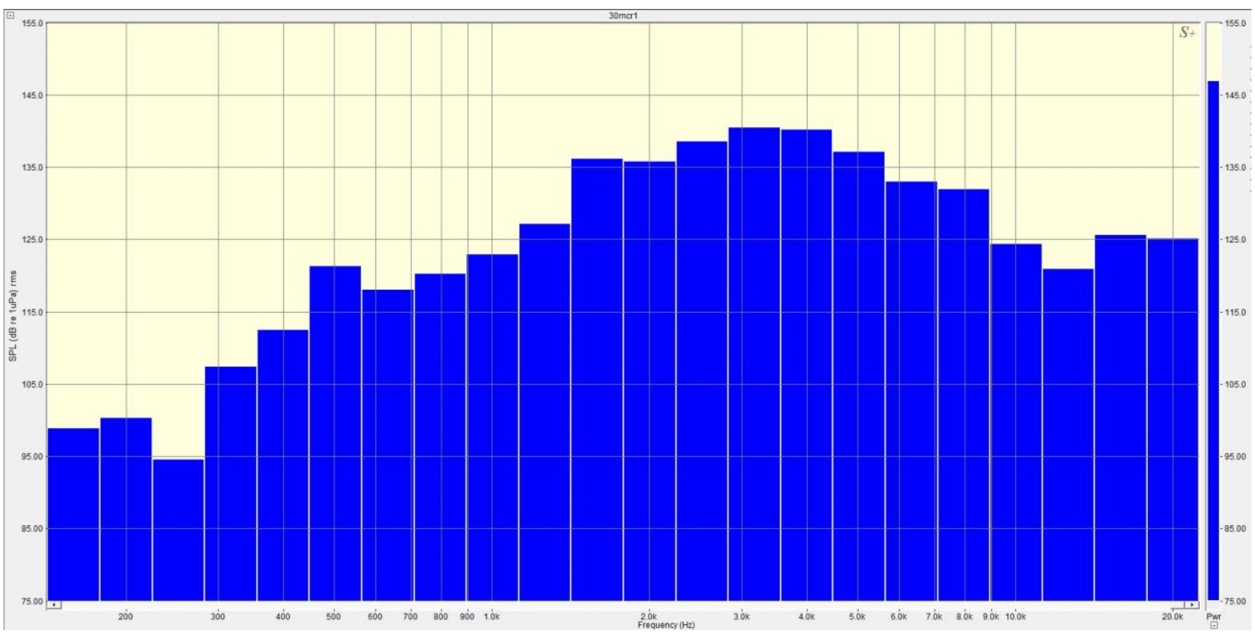
11/24/2020 Sheet_2

Near



Far



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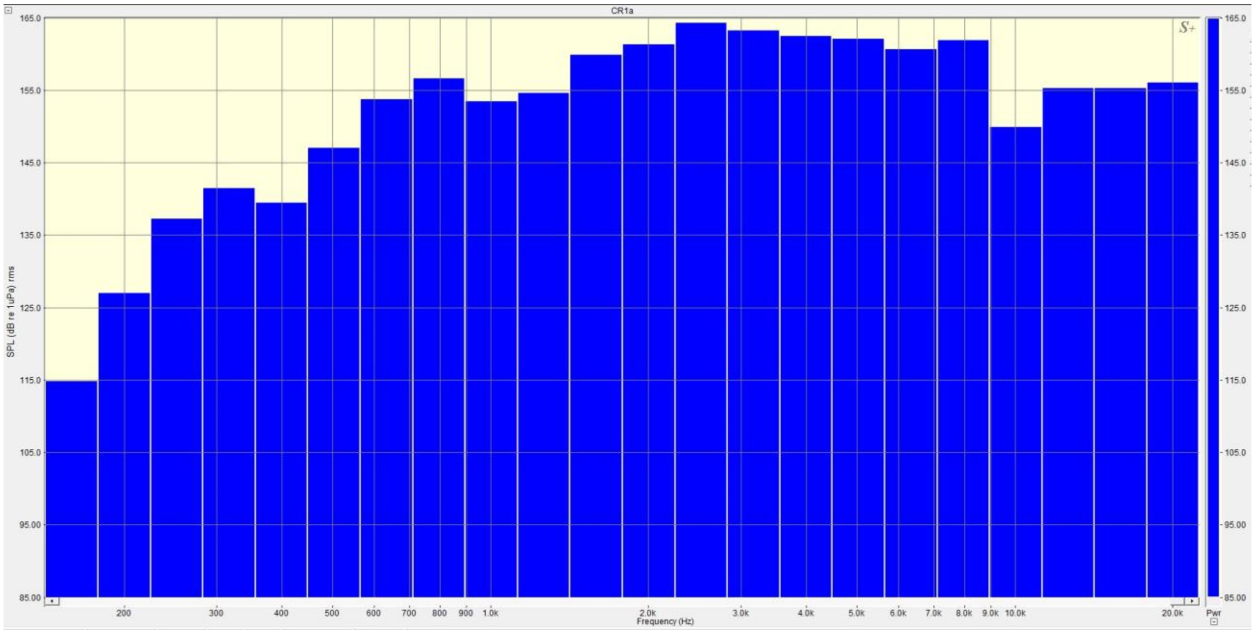
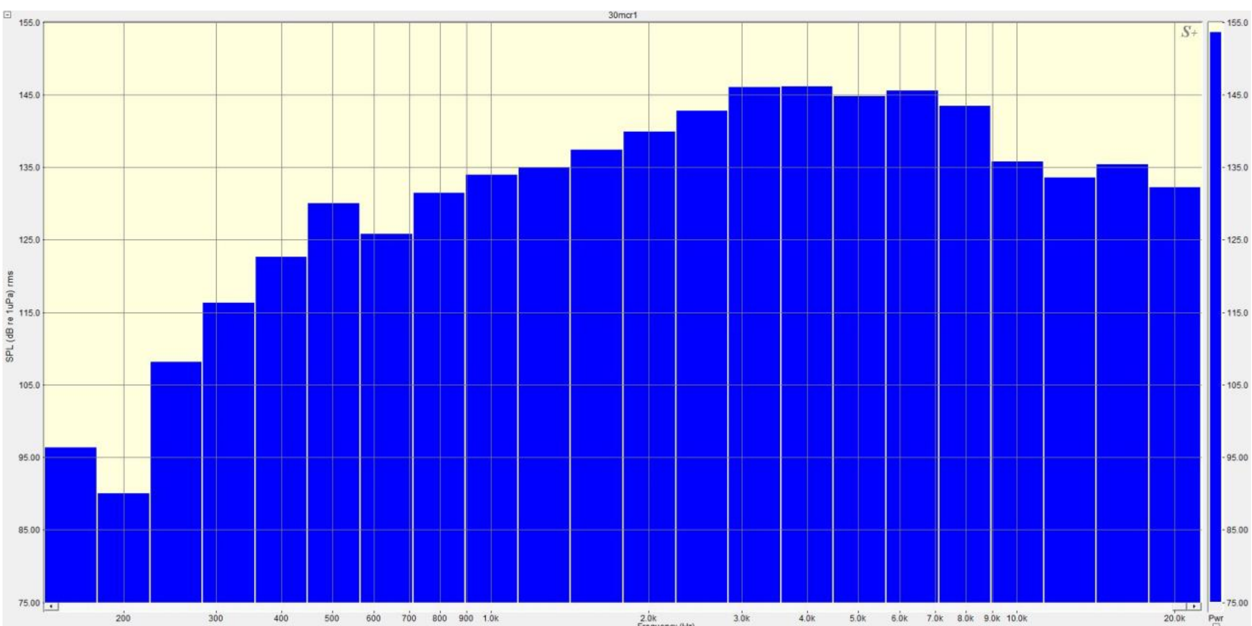
11/24/2020 Sheet_3

Near



Far



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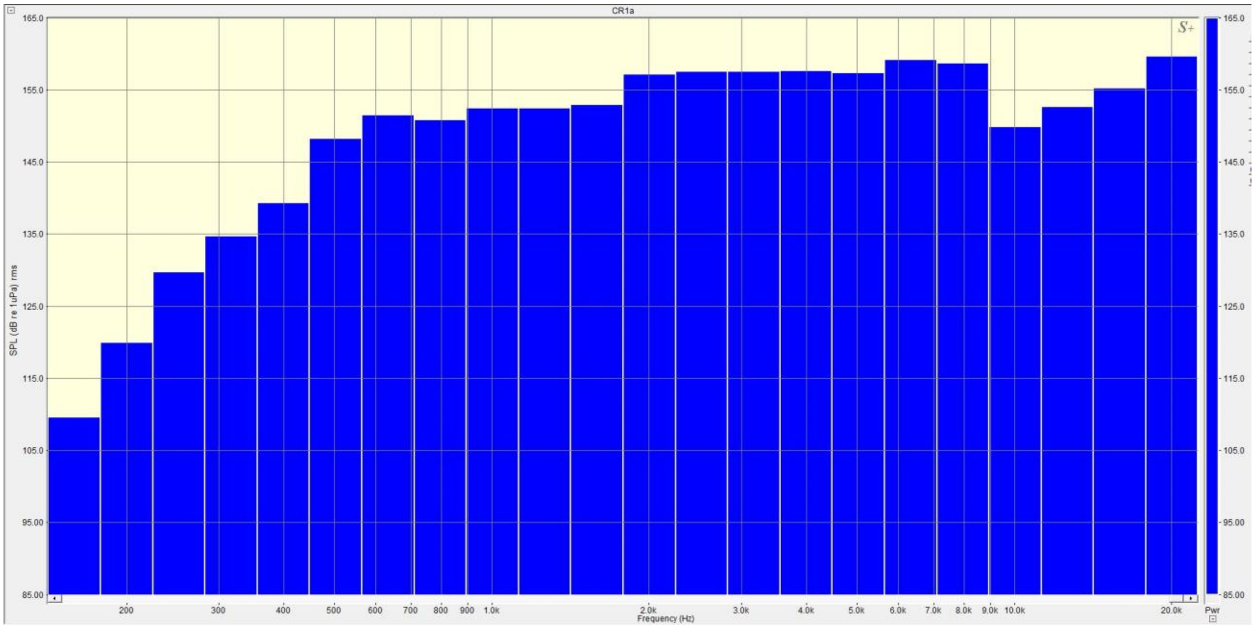
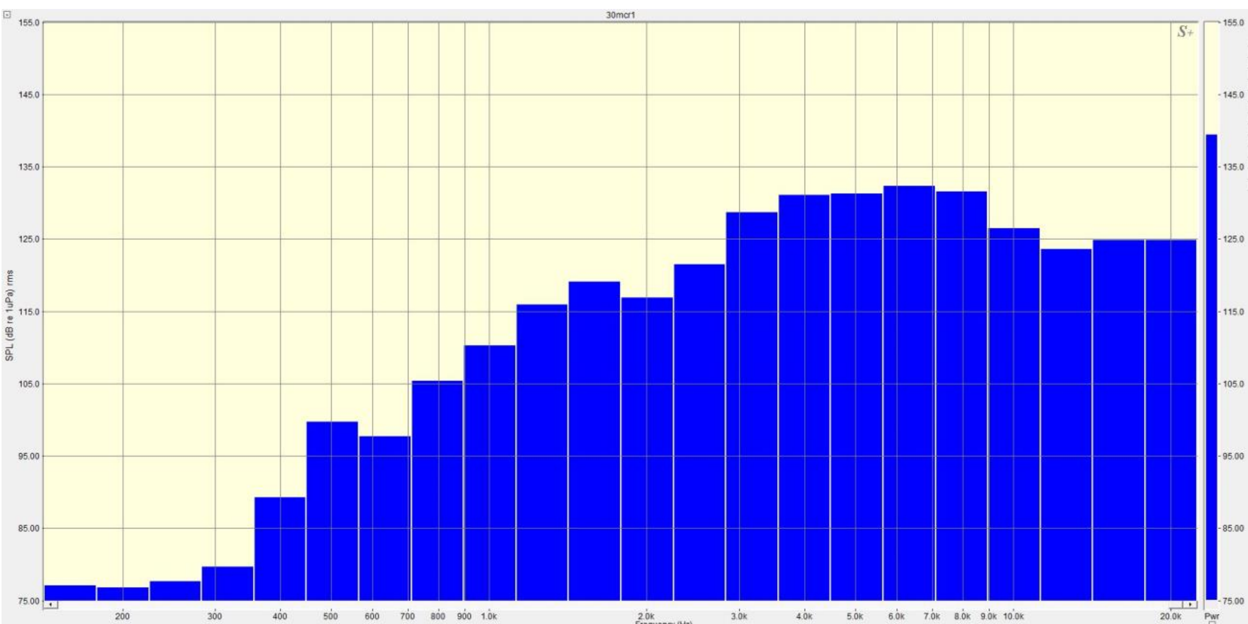
11/24/2020 Sheet_4

Near



Far



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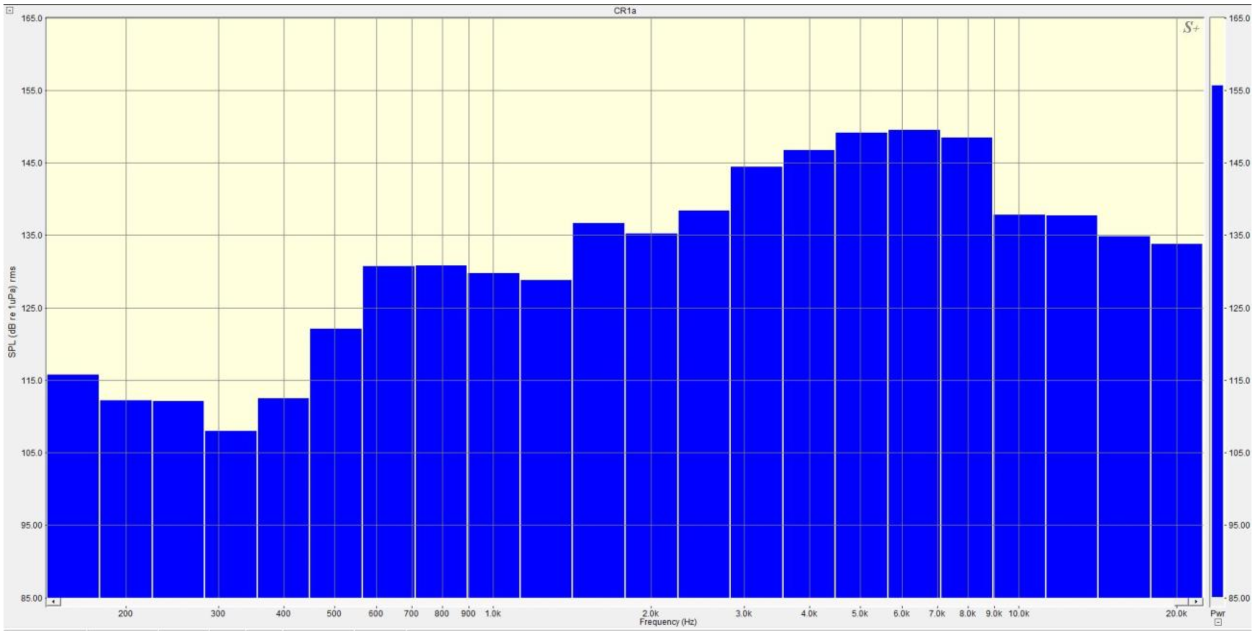
11/24/2020 Sheet_5

Near



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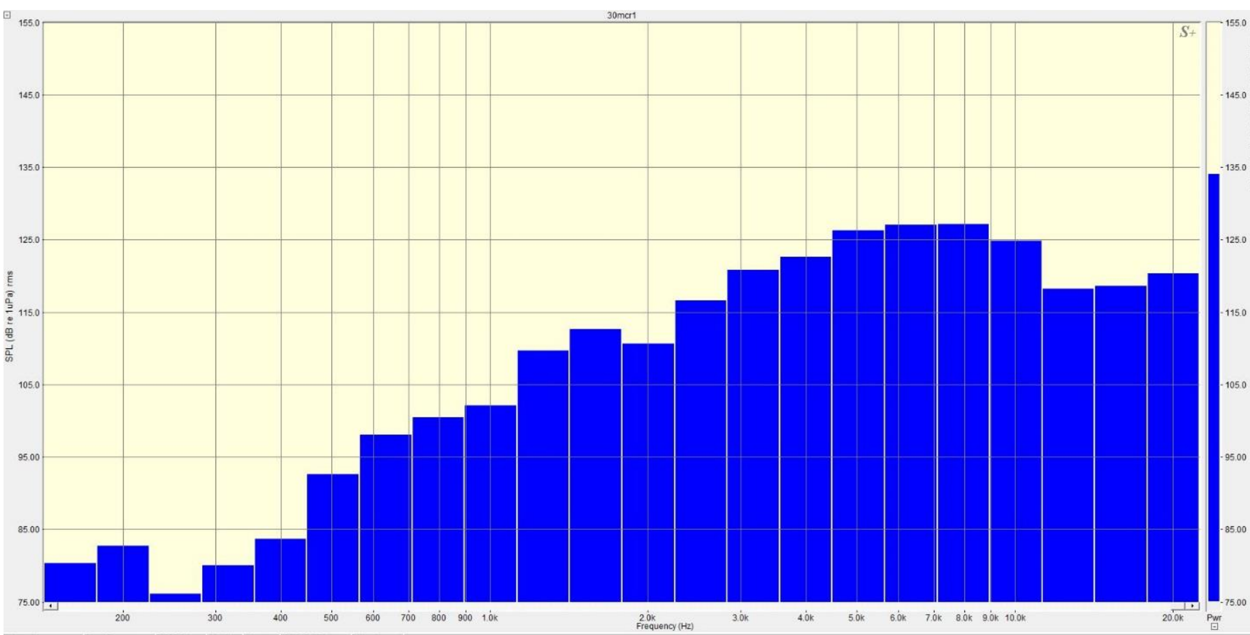

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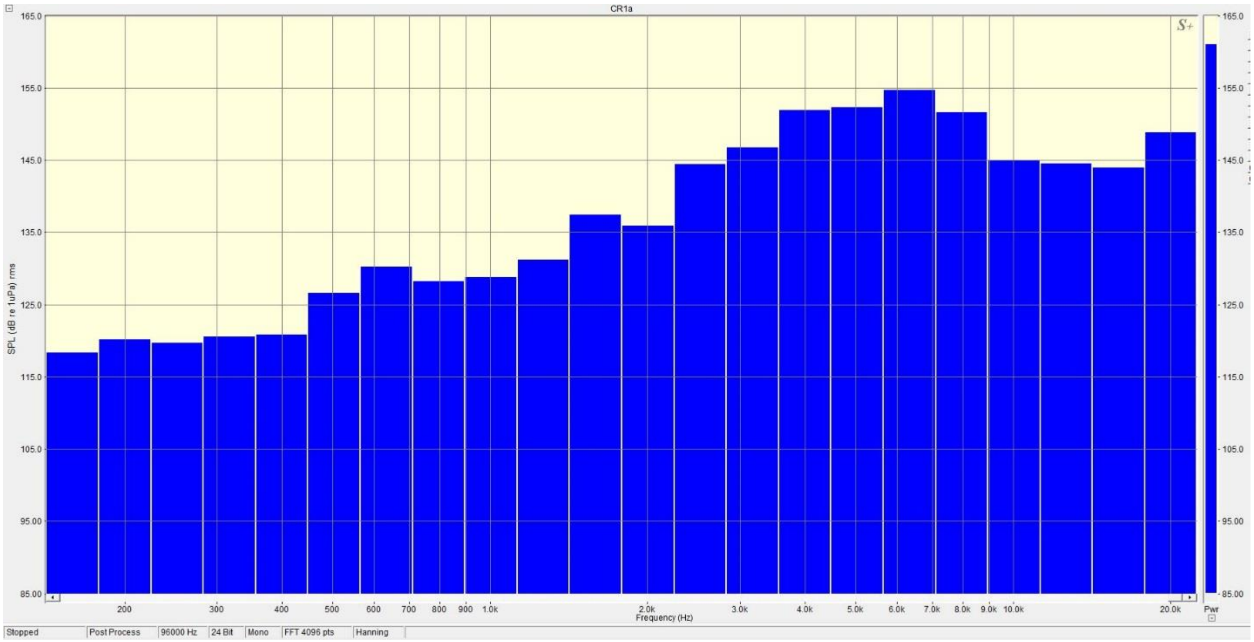
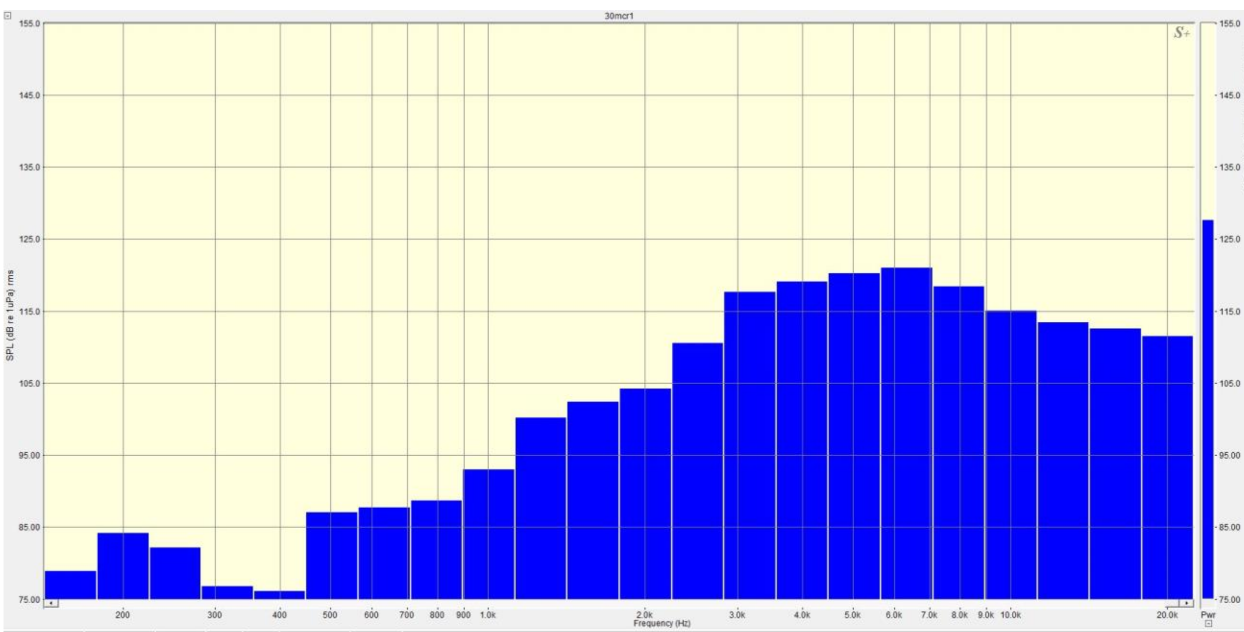
11/24/2020 Sheet_6

Near



Far



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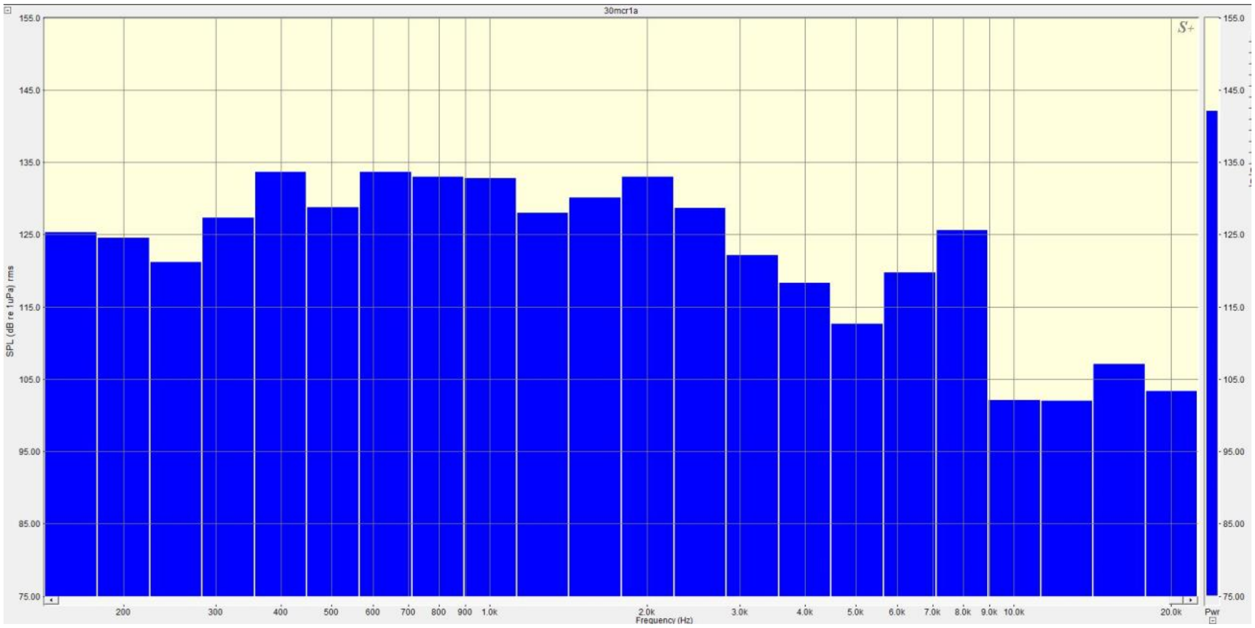
tgast@tgaec.com

1/4/2021 Precast_1

Near



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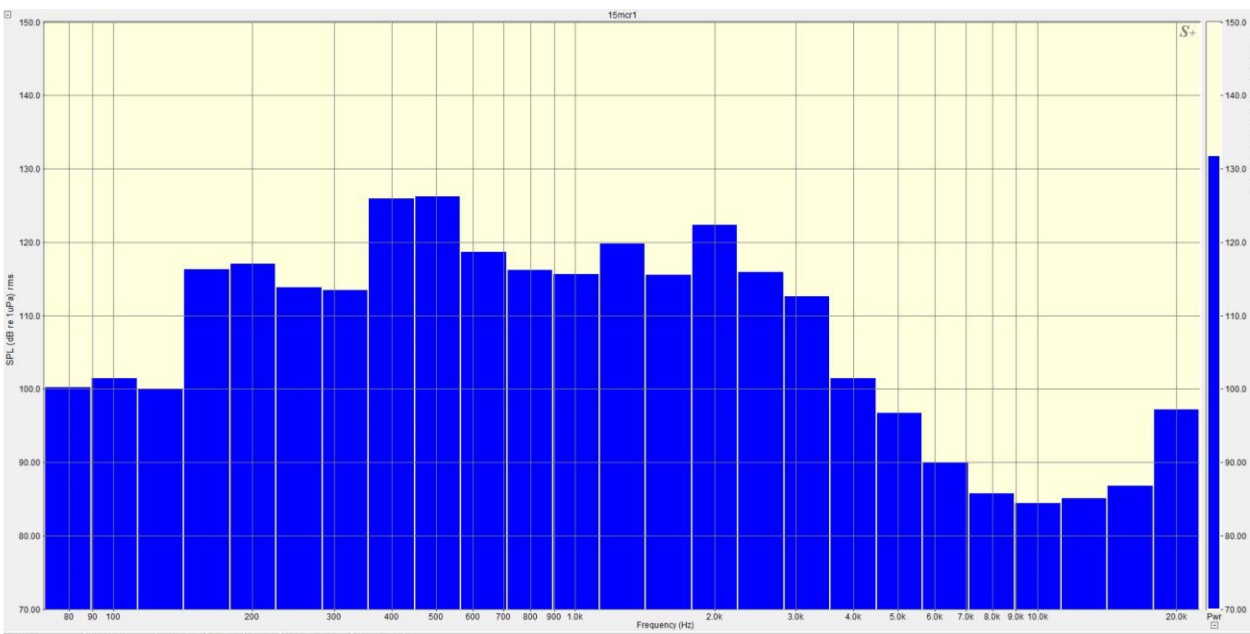
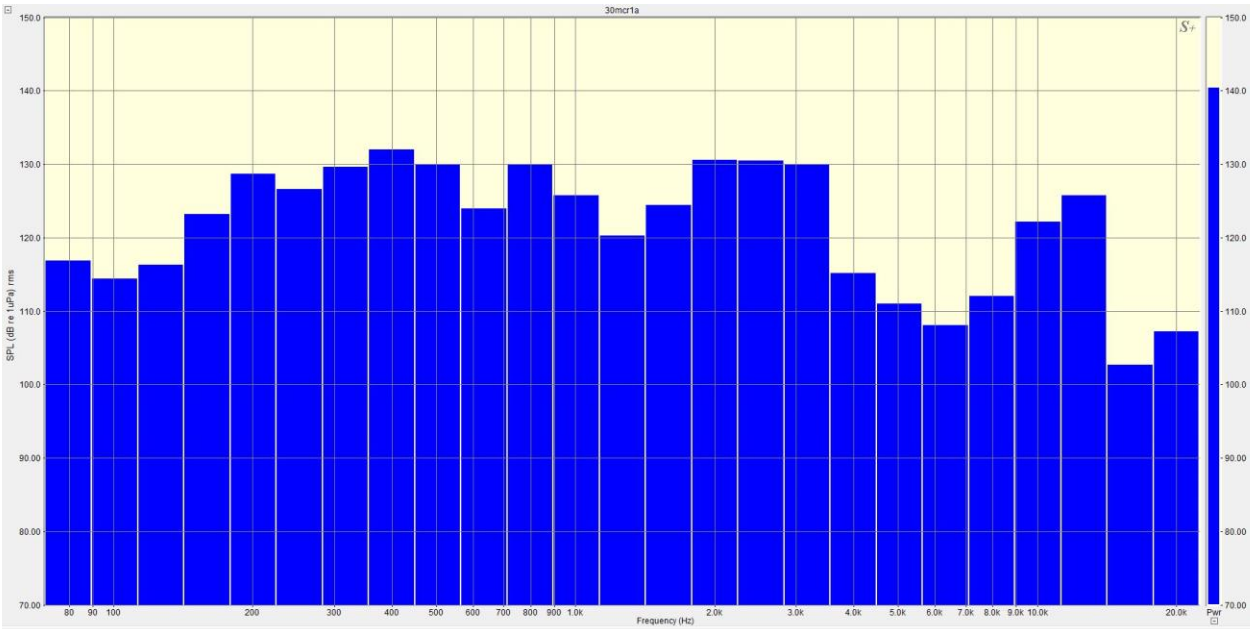


1/5/2021 Precast_1

Near



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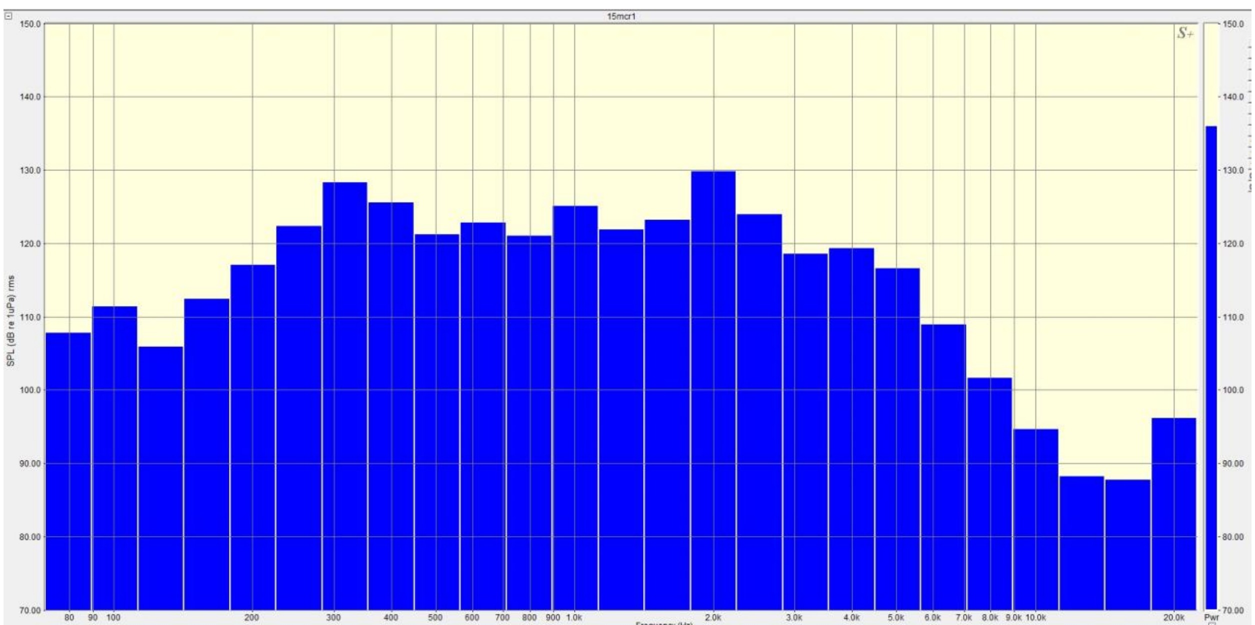

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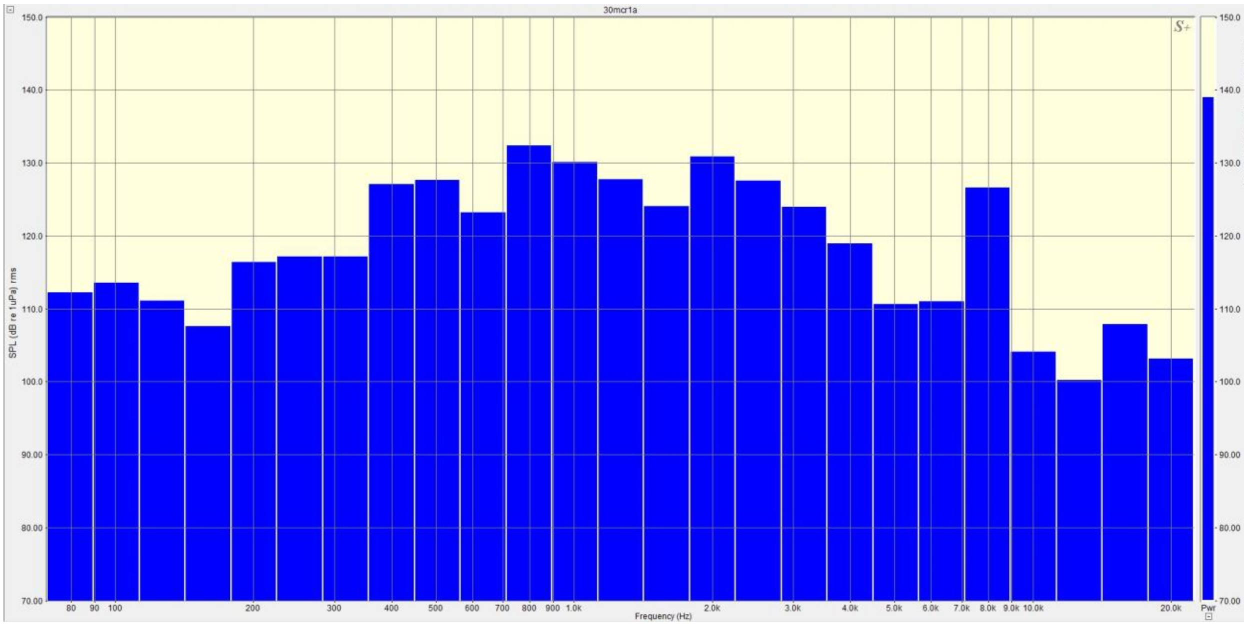
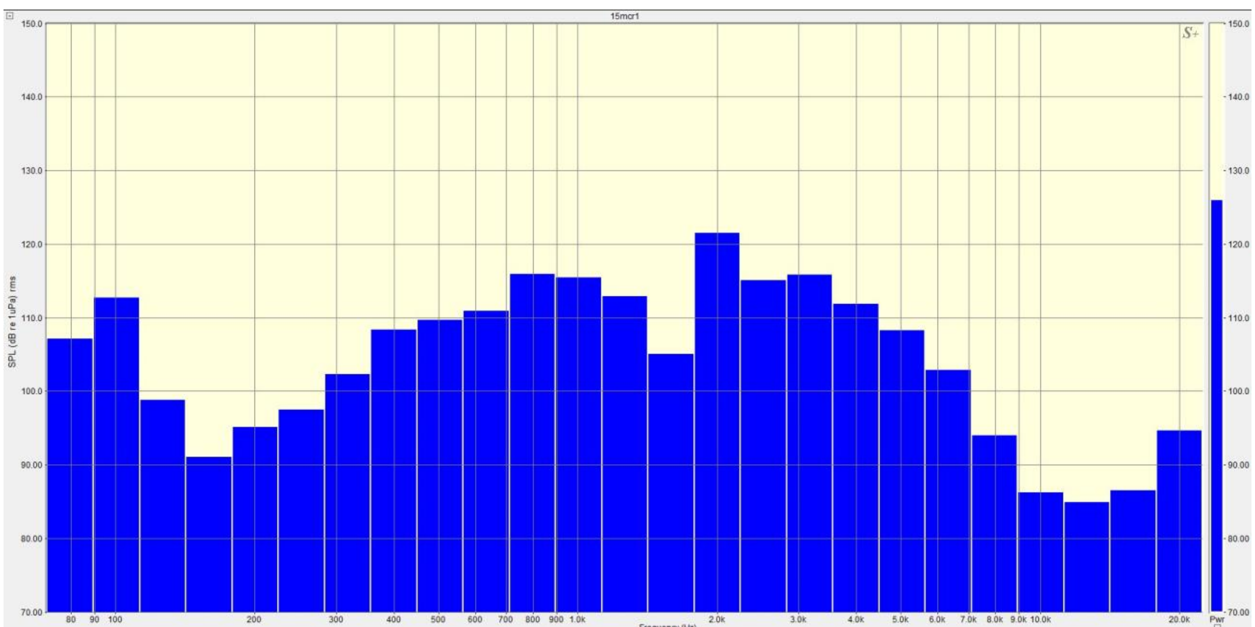
1/5/2021 Precast_2

Near

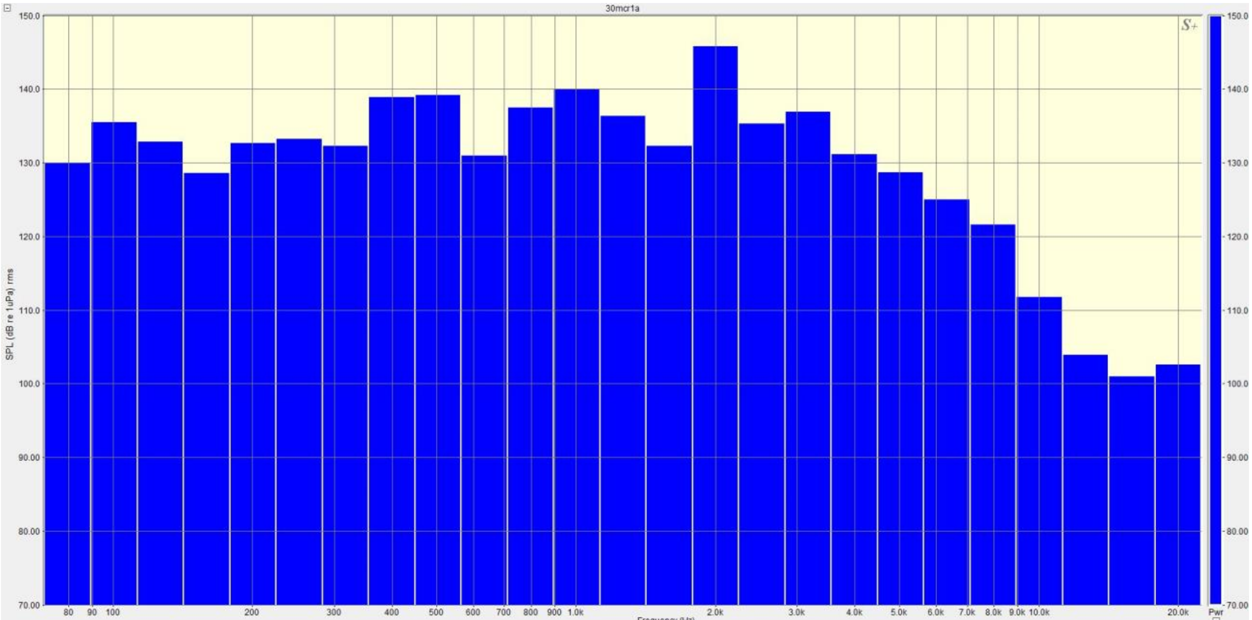


Far



1/5/2021 Precast_3

Near



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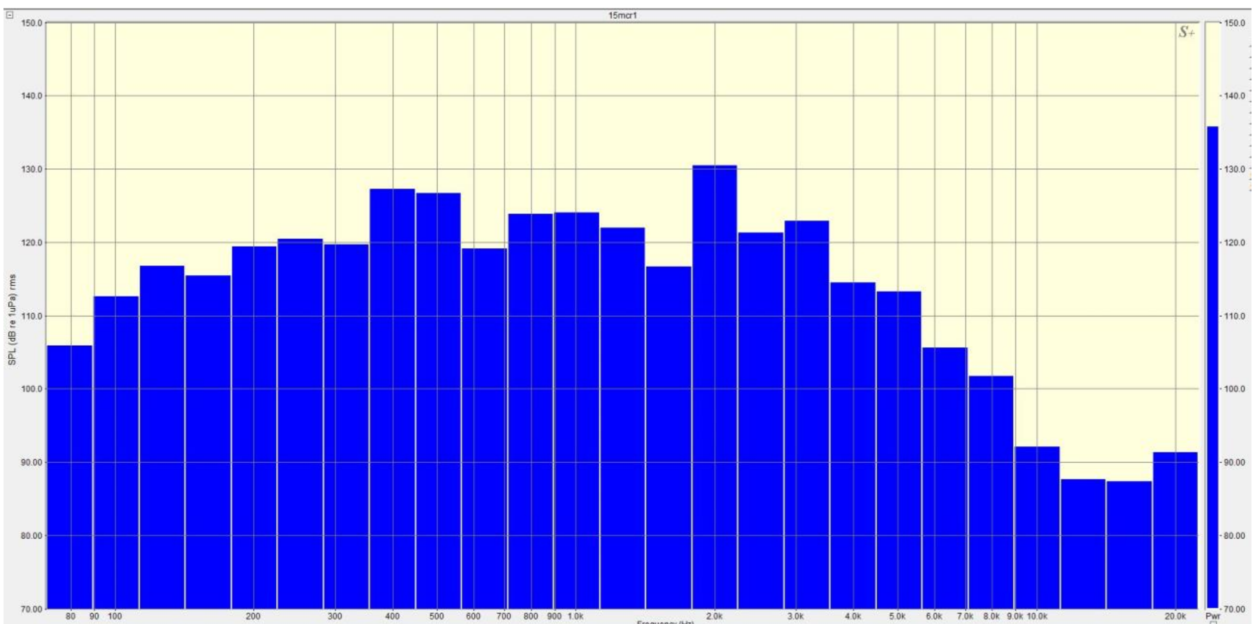

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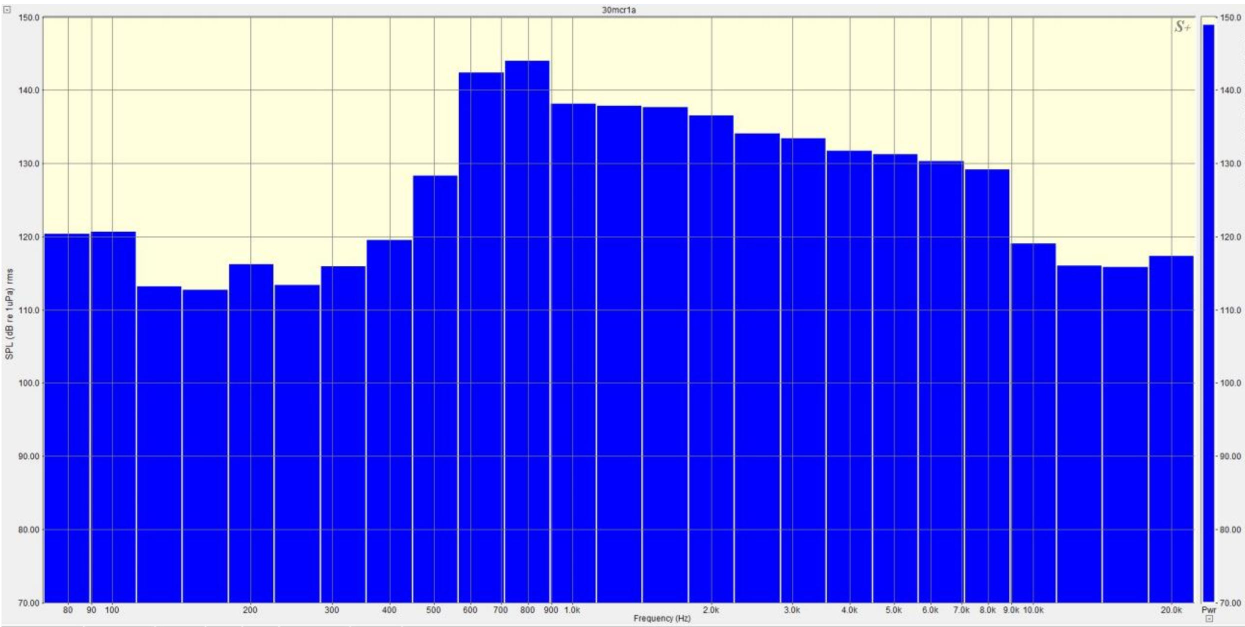
tgast@tgaec.com

1/5/2021 Precast_4

Near



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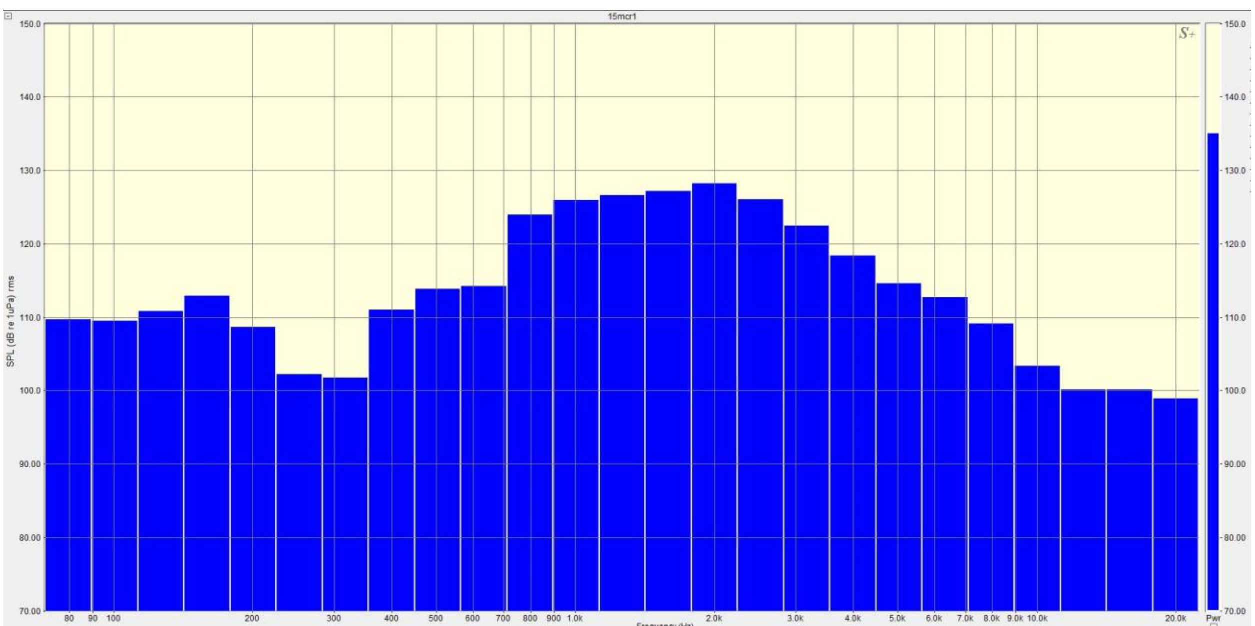

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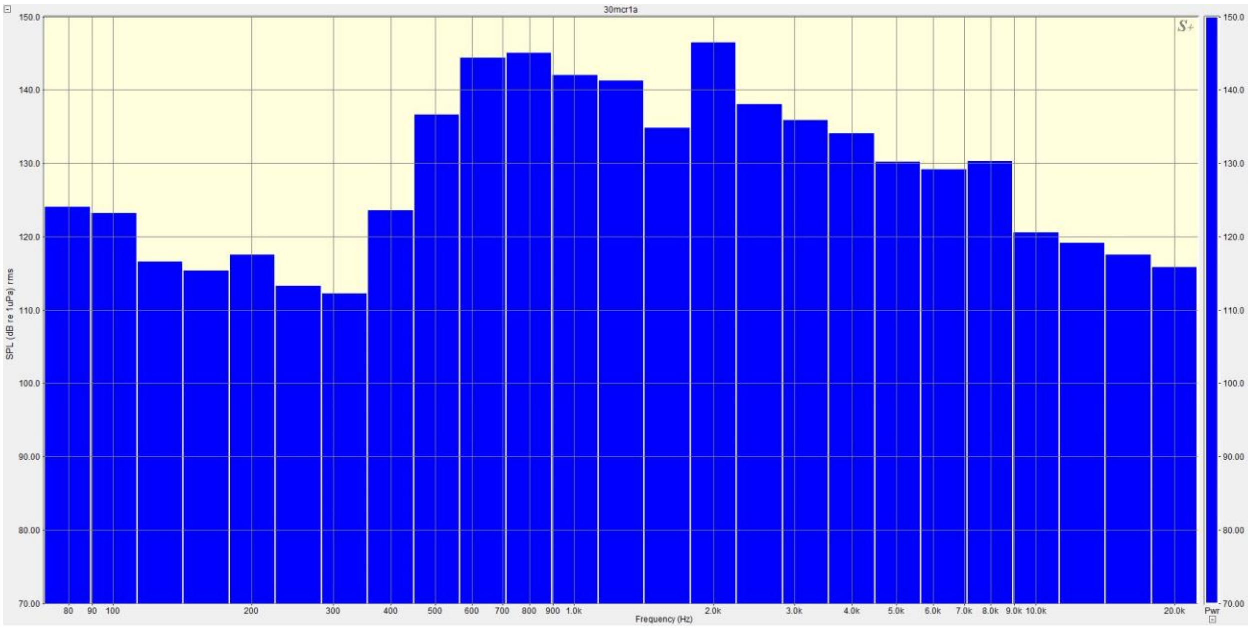
1/5/2021 Precast_5

Near



Far